IAQ in museums and archives



IAQ2010
9th Indoor Air Quality meeting

Chalon-sur-Saône, France

21-23 April 2010

Chalon sur Saône

Germolles

haute école neuchâtel berne jura arc conservation - restauration la chaux-de-fonds

Foreword

The art and science of conservation

We are proud and happy to have been chosen as the location for this 9th edition of the international conference of the IAQ Working Group - IAQ2010 which is taking place in France for the first time.

Burgundy is a region which is famous for its heritage, its gastronomy, its wine production and its bucolic landscapes. All in all, a land which invites discovery. Chalon-sur-Saône has all of these. Our town has a strategic geographical position, a past punctuated by illustrious events and personalities, who contributed to a fascinating history. The birthplace of photography, we are quite naturally creating a centre of Higher Education and Research and Development geared towards new technologies of image and sound. We are favouring the establishment of businesses in the forefront of these areas which offer high added value.

Conscious of the importance of the links with our cultural and historical past, our policy is to wish to prevent long-term degradation. Safeguarding our heritage is a major challenge for us all. Let us not forget that it constitutes the material of history for future generations. In a way, we are its guardians. By your work you are today contributing to conserve this heritage, to be able to pass it on for tomorrow. To this end you have chosen to work together to share, to make the most of your experience and your knowledge. IAQ is a positive and interactive coming together which is absolutely necessary when we know the irreversible damage which an inadequate environment can cause on collections, objects, works of art, archives or any historic building.

Thank you for your participation in this conference, for your contributions, and I wish you all a good stay in Chalon-sur-Saône.

Christophe SIRUGUE
Mayor of Chalon sur Saône and Deputy
President of « Greater Chalon » conurbation

Préface

L'art et la science de la conservation-restauration

Pour cette 9ème édition de la conférence internationale du groupe de travail IAQ - IAQ2010 qui se tient pour la première fois en France, nous sommes fiers et heureux d'avoir été choisis pour vous accueillir.

La Bourgogne est une région réputée pour son patrimoine, sa gastronomie, sa viticulture et ses paysages bucoliques. Une terre, en somme, qui invite à la découverte. Chalon-sur-Saône, c'est tout cela à la fois. Notre ville bénéficie d'une position géographique stratégique, d'un passé ponctué d'événements et de personnages illustres, qui ont contribué à écrire une histoire passionnante. Berceau de la photographie, nous développons, tout naturellement, sur notre territoire une offre en Enseignement Supérieur, en Recherche et Développement tournée vers les nouvelles technologies de l'image et du son. Nous favorisons l'implantation d'entreprises à forte valeur ajoutée/ de pointe dans ces domaines.

Fort de nos liens avec notre passé culturel et historique, nous souhaitons mener une politique de prévention des dégradations à long terme. La sauvegarde de la mémoire constitue un enjeu majeur pour nous tous. N'oublions pas qu'elle constitue également les matériaux de l'histoire pour les générations futures. Nous en sommes, en quelque sorte, les gardiens. De par votre travail, vous contribuez aujourd'hui à conserver ce patrimoine, pour le léguer demain. Pour cela, vous avez choisi le travail de concert afin de partager, de capitaliser vos expériences et vos savoirs. IAQ est une rencontre positive et interactive absolument nécessaire lorsque l'on sait/connaît les dommages irréversibles que peut causer un environnement inadéquat sur les collections, les objets, les œuvres, les archives ou tout bâtiment ancien.

Je vous remercie de votre participation à ce colloque, de vos contributions et à toutes et à tous je souhaite un bon séjour à Chalon-sur-Saône.

Christophe SIRUGUE
Député-maire de Chalon sur Saône
Président de la Communauté d'agglomération « Le Grand Chalon »

Introduction

IAQ (Indoor Air Quality) conferences are dedicated to the dissemination of research results, knowledge exchange and progress updates in the field of indoor air quality related research in museums, archives and collections. IAQ was set up in 1998 to advance knowledge of carbonyl pollutants and their effects in the museum environment. Since then, 8 generations of IAQ conferences have expanded its theme and considered a number of significant challenges of IAQ in heritage science such as; pollution-induced corrosion and degradation mechanisms, air quality monitoring (including new measurement devices), pollutant mitigation, dust and air quality standards/guidelines. Scientists, conservators, curators and museum personnel have contributed to a wealth of information in past meetings, details of which can be found on our dedicated website: www.iaq.dk.

This year, on behalf of IAQ, Chalon-sur-Saône (F) through the City of Chalon-sur-Saône, is delighted to host IAQ 2010, co-organised by SARL Germolles – Palais ducal en Bourgogne (F), the City of Chalon-sur-Saône and the Haute Ecole de Conservation-restauration at La Chaux-de-Fonds (CH). The theme of the 9th IAQ meeting is to examine the impact of indoor air policy on conservation professionals, although all aspects relating to IAQ in heritage science are considered. Field trips to cultural heritage sites are organised to illustrate the theme of the conference.

The organisation of IAQ2010 would not have been possible without the constant support of the scientific committee that contributed largely to the selection of the communications and posters presented but also to publicising the event in the conservation community. This involvement will be maintained during the conference since some members have accepted -and we thank them for that- to chair some sessions. The organisation of the workshops has met the enthusiasm of a large number of experts. We thank them for their availability which hopefully will favour the exchange of knowledge and experience. Some laboratories and companies have kindly contributed to the workshops by sending us equipment and analytical systems free of charge. If the local conservation professionals have through this technical and scientific support been initiated to environmental measurements, we hope that all participants will benefit from this newly acquired experience.

We are aware of the chance to welcome to Chalon-sur-Saône and for a few days so many international experts of indoor air quality inside buildings conserving heritage collections. Our wish is that you find this conference interactive and stimulating. As regards ourselves, we will do our best to help you appreciate the real Burgundian spirit.

The organising committee

Introduction

Les conférences IAQ (Indoor Air Quality) présentent les résultats des travaux de recherche menés dans le domaine de la qualité de l'air au sein des musées, des archives et des collections. Leur autre objectif est de favoriser l'échange des nouvelles connaissances entre les différents professionnels. Le groupe de travail IAQ a été établi en 1998 afin d'étudier l'effet des polluants carbonylés sur les objets des collections. Depuis, les domaines abordés lors des conférences IAQ se sont multipliés, ceci afin de répondre aux nombreux challenges en sciences patrimoniales comme les mécanismes de corrosion et d'altération induits par les polluants, le contrôle de ceux-ci (et en particulier le développement de nouveaux dosimètres), leur prévention, les standards et recommandations sur la qualité de l'air et la présence de particules de poussière… Les chercheurs, les conservateurs-restaurateurs, les conservateurs et le personnel des musées ont, au travers des conférences IAQ, contribué massivement à l'enrichissement des savoirs. Les informations rassemblées sont accessibles sur le site www.iaq.dk.

La ville de Chalon-sur-Saône (F) est heureuse d'accueillir, au nom d'IAQ, la conférence IAQ2010. La conférence est co-organisée par la société SARL Germolles – Palais ducal en Bourgogne (F), la ville de Chalon-sur-Saône et la Haute Ecole de Conservation-restauration de La Chaux-de-Fonds (CH). Pour cette IX^{ème} édition, nous souhaitons tout particulièrement examiner l'impact sur les professionnels de la conservation-restauration des nouvelles recherches environnementales de ces dernières années. Des ateliers sur sites sont organisés afin d'illustrer ce propos autour de cas concrets. Les autres aspects liés à la qualité de l'air en science patrimoniale sont également couverts.

L'organisation d'IAQ2010 n'aurait pas été possible sans le soutien du comité scientifique qui a largement participé à la sélection des communications et des posters présentés mais également à la promotion de l'évènement auprès des professionnels de la conservation-restauration. Cette implication sera maintenue au cours du colloque puisque certains membres ont accepté de présider certaines sessions. Nous les remercions vivement pour cet engagement sans faille. La mise en place des ateliers a rencontré l'enthousiasme d'un grand nombre d'experts. Qu'ils soient eux aussi remerciés pour leur disponibilité qui, nous l'espérons, favorisera l'échange de savoirs et d'expériences. Certains laboratoires et entreprises ont généreusement participé à ces ateliers en fournissant gracieusement équipements et systèmes d'analyses. Si les professionnels chalonnais de la conservation-restauration ont pu, grâce à ce soutien technique et scientifique, s'initier aux mesures environnementales, nous espérons que l'ensemble des participants pourront profiter de cette expérience nouvellement acquise.

Nous mesurons la chance d'avoir pu rassembler à Chalon-sur-Saône et pour quelques jours des experts internationaux de la qualité de l'air au sein des bâtiments conservant des collections patrimoniales. Notre souhait est que vous trouviez cette conférence interactive et stimulante. Quant à nous, nous ferons en sorte que le vrai esprit bourguignon agrémente agréablement votre séjour.

Le comité d'organisation

Organising committee / Comité d'organisation

- **Christian Degrigny**, *Haute Ecole de Conservation-restauration (HECR) Arc, La Chaux-de-Fonds, CH & SARL Germolles, Mellecey, France*. christian.degrigny@gmail.com
- **Claire Bois-Pacros**, *director of the Museum, Heritage and Tourism division, City of Chalon-sur-Saône, France.*

Scientific committee / Comité scientifique

Dario Camuffo, *National Research Council, Institute of Atmospheric Sciences and Climate, Padova, Italy*
Christian Degrigny, *Haute Ecole de Conservation-restauration Arc, La Chaux-de-Fonds, Switzerland & SARL Germolles, Mellecey, France*
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Morten Ryhl-Svendsen, *National Museum, Copenhagen, Denmark*
Alexandra Schieweck, *Fraunhofer Wilhelm-Klauditz-Institute* - WKI, *Braunschweig, Germany*
Matija Strlic, *University College London - Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, United Kingdom*
Jean Tétreault, *Canadian Conservation Institute - CCI, Ottawa, Canada*

Edition of the abstracts
Christian Degrigny / Leslie Cleaver

Topics covered / Thèmes abordés

Topic 1: the theme
Research projects carried out since 1990 on the monitoring and the mitigation of pollution inside heritage buildings (museums, archives, historic buildings…) have initiated strategies for the better preservation of artefacts in the long term. We would like to review how this knowledge is currently used by professionals working in the field. Are these strategies actually put into practise? If yes, what are the difficulties encountered? This theme will be covered particularly during the first day of the conference through case studies and field trips to cultural heritage sites (museums, city library, archives, churches…) of Chalon-sur-Saône.

Other topics covered

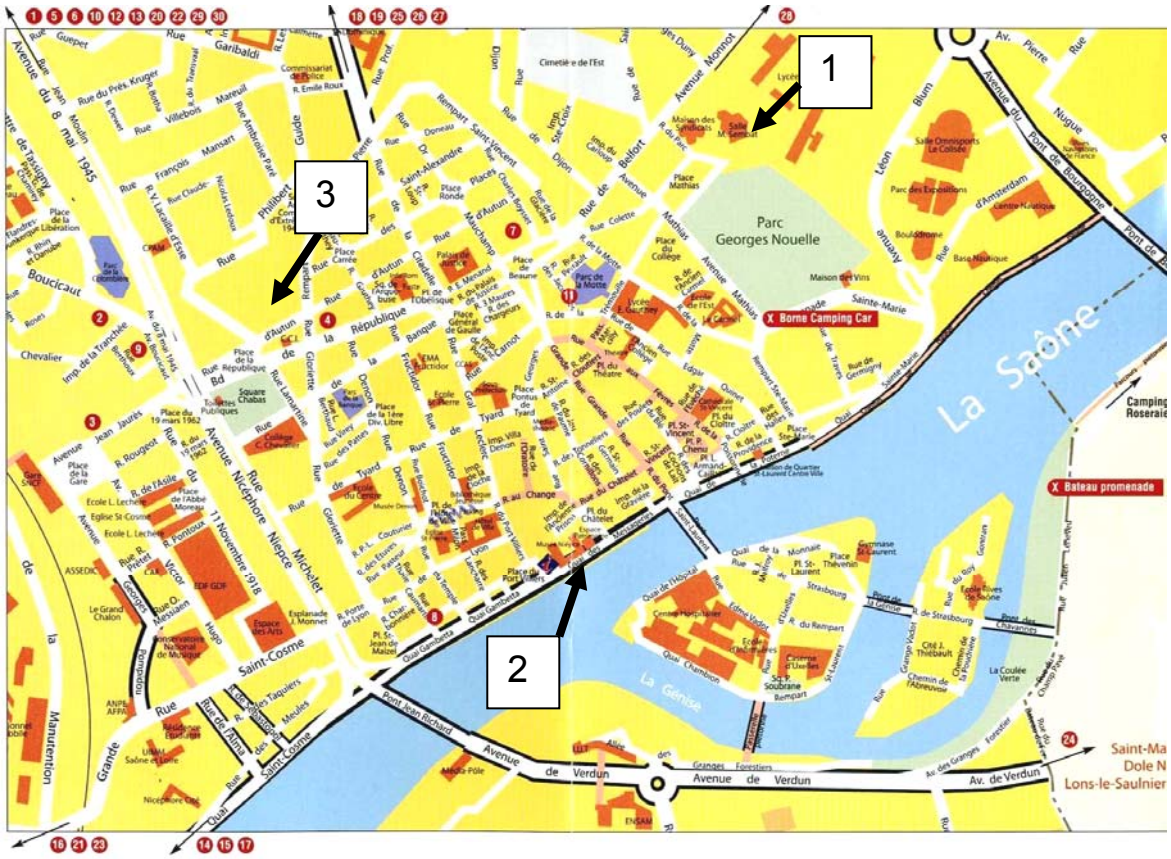
- **Topic 2**: Analysis
- **Topic 3**: Interaction of air pollutants and objects
- **Topic 4**: Analysis & Interaction of air pollutants and objects
- **Topic 5**: Problems and applications in practice & Preventive measures

The programme of the conference

Agenda

	21 April Topic 1		22 April Topics 1-3	23 April Topics 4-5
8.00 – 9.00	Registration & downloading of PP presentations	**8.00 – 9.00**	Registration & downloading of PP presentations	Downloading of PP presentations
9.00 – 9.20	Opening session			
9.20 – 10.40 + 15 min. discussion	Topic 1 – session 1	**9.00 – 10.20** + 15min. discussion	Topic 1 – session 3	Topic 3 – session 2
10.55 – 11.25	Coffee break	**10.35 – 11.05**	Coffee break	Coffee break
11.25 – 12.45 + 15 min. discussion	Topic 1 – session 2	**11.05 – 12.25** + 15min. discussion	Topic 2 – session 1	Topic 4 – session 1
13.00 – 14.15	Lunch	**12.40 – 14.10**	Lunch	Lunch
14.30 – 16.00	Workshops at Chapel de la Colombière & Niepce museum	**14.10 – 15.30** +15min. discussion	Topic 2 – session 2	Topic 4 – session 2
		15.45 – 16.15	Coffee break	Coffee break
16.30 – 18.00		**16.15 – 17.35** + 15min. discussion	Topic 3 – session 1	Topic 5
19.00	Reception at the City hall	**19.30**	Conference dinner at Château de Germolles	Dinner with COST D42 participants

Location



1. Marcel Sembat hall : conference hall
2. Nicephore Niepce museum
3. Chapel de la Colombière

Programme of the conference

Wednesday 21 April 2010

TOPIC 1 (Theme of the conference) - Session 1

Chair: *Christian Degrigny*

21.04	Main author(s)	Institution	Title
09.20-09.30	**F. André**	City of Chalon-sur-Saône, Culture and Heritage division, Chalon-sur-Saône, FR	Preventive conservation and restoration; a technical and financial challenge for local authorities
09.30-10.00	**A-C. Besson, J. Barbarin and H. Joannelle**	Niepce Museum, Denon Museum, Public Library, Chalon-sur-Saône, FR	The conservation of documents: a strategic objective
10.00-10.20	**E. François**	Municipal Archives, Chalon-sur-Saône, FR	A complex remodelling
10.20-10.40	**C. Morin-Dufoix**	Direction of Heritage Services for Chalon sur Saône, Chalon-sur-Saône, FR	Worship and conservation: a conflict of priorities. The example of the Chapel of the Dormition, Assumption and Glorification of the Virgin at St Vincent's Cathedral, Chalon-sur-Saône

TOPIC 1 (Theme of the conference) - Session 2

Chair*: John Havermans*

21.04	Main author(s)	Institution	Title
11.25-11.45	**E. Dahlin et al.**	Norwegian Institute for Air Research, Kjeller, NO	Involvement of conservation professionals in an EU funded project
11.45-12.05	**G. Leijonhufvud and T. Broström**	University of Gothenburg, Department of Conservation, Gothenburg, SE	Managing environmental control in Gripsholm Castle – a study of the decision process
12.05-12.25	**E. Spiegel and R. Drewello**	University of Bamberg, Institute for Archaeology, Building and Heritage Conservation, Bamberg, DE	Pollution mitigation: the gap between research and application. An empirical study of the present situation and management of indoor air pollution in German collections
12.25-12.45	**I. Spulber et al.**	University College London, Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, UK	'Heritage Intelligence' – Environmental monitoring with wireless intelligent sensor systems

Afternoon sessions: workshops at Nicephore Niepce museum and chapel de la Colombière, Chalon-sur-Saône (see locations on the map, page 11).

The details of the workshops will be given onsite to the participants.

Thursday 22 April 2010

TOPIC 1 (Theme of the conference) - Session 3

***Chair**: Lorraine Gibson*

22.04	Main author(s)	Institution	Title
09.00-09.20	**T. Grøntoft**	Norwegian Institute for Air Research, Kjeller, NO	Modelling of air quality for paintings in microclimate frames and experiences of the Norwegian Institute for Air Research, NILU, in providing "air quality services for cultural heritage professionals"
09.20-09.40	**J. Havermans**	Netherlands Organisation for Applied Scientific Research, Built Environment and Geosciences, Delft, NL	The Dutch Archival Act and harmonisation
09.40-10.00	**S. Lopez-Aparicio et al.**	Norwegian Institute for Air Research, Kjeller, NO	Air quality assessment in cultural heritage locations by dosimetry
10.00-10.20	**A. Jeberien et al.**	University of Applied Sciences, Hochschule für Technik und Wirtschaft Berlin, Berlin, DE	Implementing preventive measures in the development process of display cases for the *Brandenburg State Museum of Archaeology*

TOPIC 2 (Analysis) - Session 1

***Chair:** Terje Grøntoft*

22.04	Main author(s)	Institution	Title
11.05-11.25	**A. Schieweck and T. Salthammer**	Fraunhofer Wilhelm-Klauditz-Institut WKI, Material Analysis and Indoor Chemistry, Braunschweig, DE	Indoor air quality within museum showcases
11.25-11.45	**M. Strlic et al.**	University College of London, Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, UK	The scent of degradation: VOCs as a source of information
11.45-12.05	**O. Ramalho et al.**	University Paris-Est, Building Scientific and technical Centre, Marne-la-Vallée, FR	Relationship between the emission of volatile organic compounds from paper and cellulose degradation
12.05-12.25	**A. Lattuati-Derieux et al.**	National Museum of Natural History, Research Centre on Conservation of Collections, Paris, FR	Assessment of the degradation of polyurethane foams from contemporary art objects

TOPIC 2 (Analysis) - Session 2

***Chair:** Matija Strlic*

22.04	Main author(s)	Institution	Title
14.10-14.30	**C. Gaüzere et al.**	University Paris-Est, Building Scientific and technical Centre, Marne-la-Vallée, FR	Airborne microbiology in museum through molecular approach: preliminary study
14.30-14.50	**J. Smolik et al.**	Institute of Chemical Process Fundamentals AS CR, Laboratory of Aerosol Chemistry and Physics, Prague, CZ	Characterization of airborne particles in the Baroque hall of the National Library in Prague
14.50-15.10	**M. Fornaciari da Passano et al.**	University of Perugia, Department of Applied Biology, Perugia, I	The preventive conservation of cultural heritage in "indoor" environment: the monitoring of biological pollutants potentially biodeteriogens
15.10-15.30	**Y. Joblin et al.**	University Paris-Est, Building Scientific and technical Centre, Marne-la-Vallée, FR	Moulds detection by their volatile organics compounds: use for heritage conservation

TOPIC 3 (Interaction of air pollutants and objects) - Session 1
***Chair**: Alexandra Schieweck*

22.04	Main author(s)	Institution	Title
16.15-16.35	**D. Camuffo, C. Bertolin et al.**	National Research Council, Institute of Atmospheric Sciences and Climate, Padova, I	Thenardite-Mirabilite cycles in historical buildings
16.35-16.55	**L. Robinet et al.**	Synchrotron SOLEIL, IPANEMA, Gif-sur-Yvette, FR	The role of organic pollutants in the alteration of alkali silicate glasses
16.55-17.15	**G. Di Pietro et al.**	Berner Fachhochschule, Bern, CH	Monitoring of indoor air pollution in the stacks of the Swiss National Library
17.15-17.35	**J. Thomas et al.**	National Museum in Krakow, Krakow, PL	Characterisation of fading behaviour of coloured papers during simulated display in anoxia

Friday 23 April 2010

TOPIC 3 (Interaction of air pollutants and objects) - Session 2
***Chair**: Tomasz Lojewski*

23.04	Main author(s)	Institution	Title
09.00-09.20	**J. Tétreault et al.**	Canadian Conservation Institute, Ottawa, CA	Carbonyl vapours and their impact on paper degradation
09.20-09.40	**T-P. Nguyen et al.**	National Library of France, Scientific and Technical Laboratory, Paris, F	Volatile organic compounds in libraries' atmospheres: effects on the written and printed cultural heritage
09.40-10.00	**A. Fenech et al.**	University College London, Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, UK	Volatile aldehydes in libraries and archives
10.00-10.20	**I. Kralj Cigić et al.**	University of Ljubljana, Faculty of Chemistry and Chemical Technology, Ljubljana, SI	Volatile organic compounds in books after mass deacidification

TOPIC 4 (Analysis & Interaction of air pollutants and objects) - Session 1
***Chair:** Morten Ryhl-Svendsen*

23.04	Main author(s)	Institution	Title
11.05-11.25	**M. Odlyha**	Birkbeck College, Thermal Methods and Conservation Science, London, UK	Understanding microclimates in museums, historic houses and churches and their impact on heritage materials
11.25-11.45	**A. Cavicchioli et al.**	University of São Paulo, School of Arts, Sciences and Humanities, São Paulo, BR	Preventive conservation of paintings in São Paulo (Brazil): assessment of damage risk by piezoelectric dosimeters
11.45-12.05	**T. Prosek et al.**	Corrosion Institute, Brest, FR	Survey on air quality control in cultural heritage institutions and development of automated corrosion sensors for real time monitoring
12.05-12.25	**O. Abdel-Kareem**	University of Cairo, Faculty of Archaeology, Conservation Department, Giza, EG	The factors deteriorating the historical textiles in museum of Faculty of Archaeology, Cairo University and approaches for their prevention

TOPIC 4 (Analysis & Interaction of air pollutants and objects)- Session 2

Chair: *David Thickett*

23.04	Main author(s)	Institution	Title
14.10-14.30	**M. Ryhl-Svendsen**	National Museum of Denmark, Lyngby, DK	The generation of indoor air pollution from surface reactions
14.30-14.50	**F. Vichi and F. De Santis**	National Research Council, Research Institute of Atmospheric pollution, Roma, I	The assessment of air quality at the "Galleria dell'Accademia", Florence, Italy
14.50-15.10	**L. De Santoli et al.**	University Sapienza of Roma, Faculty of Architecture Valle Giulia, Roma, I	Long term prediction of marble erosion for the conservation of the statue of David by Michelangelo
15.10-15.30	**M. Sandberg et al.**	University of Gävle, Department Technology and Built Environment, Gävle, SE	Different finishes of plasters – Importance for particle deposition

TOPIC 5 (Problems and applications in practice & Preventive measures)

Chair*: Jean Tétreault*

23.04	Main author(s)	Institution	Title
16.15-16.35	**F.G. France**	Library of Congress, Preservation Research and Testing Division, Washington, USA	Assessing and monitoring visual storage environments
16.35-16.55	**M-J. Guttmann et al.**	ASTRA Museum, Sibiu, RO	Conservation design of a new storage building at ASTRA Museum in Sibiu, Romania
16.55-17.15	**R. Alghazawi et al.**	University of Leiden, Faculty of Archaeology, Leiden, NL	Indoor air quality survey in selected Jordanian museums, storages and archives
17.15-17.35	**M. Mattson et al.**	University of Gävle, Department Technology and Built Environment, Gävle, SE	Portable air cleaners in churches – efficiency and practicability

Notes:
- in the tables above, and when needed, the speaker is underlined,
- in the following abstracts, and when needed, the corresponding author is underlined.

The theme of the conference
(research in IAQ put into practice)

Installation of SO2/NO2 Gradko diffusion tubes at Niepce museum, © Degrigny

Notes

Preventive conservation and restoration; a technical and financial challenge for local authorities

F. André

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Keywords: *authorities, conservation, restoration, prevention, technique, finance*

Abstract

Local authorities (regions, departments, towns or villages) became historically, by law (1905 – the separation of Church and State) or by choice making their own decision by applying legal powers (purchase of private or publicly owned heritage sites – state-owned heritage -, the acceptance of gifts or bequests, the creation of cultural establishments,…), the owners of places of worship or culture or of furniture, heritage funds, archives, museum collections (photography, fine arts, archaeology, ethnography etc).

Because of the nature, the age, the suitability or not of premises used; because of the activity that takes place there (worship, receiving the public, exhibitions, storage, events, research, restoration, laboratory work, etc); because of the nature of what is to be conserved, the varied materials, the constraints involved in effective methods of conservation and finally the way and frequency with which they are to be used, the owning authorities and departments in charge of the management and use of buildings, establishments and art collections, come up against technical and financial needs and restrictions daily especially as they must take account of the need to adopt a long term strategy in this area.

Often long and very expensive (preparatory analyses, technological innovations, works undertaken according to artistic, personnel and material considerations etc), the policy of preventive conservation and restoration which develops, in an increasingly restricted economic and technical environment, often forces authorities to make drastic choices and to define a minimum policy, or even to leave the heritage alone running the risk of further deterioration during that time. Not to mention, in the definition of this policy, the regular clash between a classic approach to maintenance and adaptation of buildings by the municipal technical services departments and the specialised approach of the services managing cultural or religious establishments and their collections.

The town of Chalon-sur-Saône which has two museums (photography and fine arts/archaeology), a listed public library which has an important heritage collection, archives, a varied historical heritage (civil, military, religious, commemorative) representing a period which stretches from the 12th to the 20th century, cannot escape these difficulties, in spite of the positive policy it has declared.

The local examples which will be presented to you today by the managers of our cultural and heritage services will try to convey this reality, the difficulty we have in reconciling the protection of our heritage, the anticipation of disturbance caused by preventive conservation and staff training, regular restoration by professionals, the application of standards and technological means which have come out of your research, but also of the wealth of heritage and culture maintained thanks to the commitment of owning authorities.

Notes

The conservation of documents: a strategic objective

A-C. Besson[1], J. Barbarin[2], H. Joannelle[3]

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Keywords: *documents, preservation, conservation, restoration, environment*

Abstract

The following elements form part of a strategy of control and prevention which can come up against greater or lesser difficulties in its application.

- materials to be conserved (paper, photos, parchments, leather, canvas, others) that require particular conditions,
- old buildings, suitable or not, that have to be managed and used according to the requirements arising from these particular conditions,
- procedures and plans of action or of conservation designed to establish formally the periodic tasks and routines required to apply them, along with a programme of restoration,
- a necessary quality control in the management of the environment, conditioned by the application of suitable measures:
    - human resources (awareness, training),
    - material resources (budgets required for the purchase of materials, furniture, specific treatment or equipment, equipment to control the environment).

Each of the specific lectures will relate experiences which underline one or several of the common subjects previously listed.

They will also illustrate the way in which sources and research in preventive conservation are used every day by professionals and with what limits or constraints.

Notes

A complex remodelling

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Keywords: *archives, industrial building, remodelling*

Abstract

The challenge posed by the remodelling of industrial buildings to house archives can be approached from several angles : from the point of view of balancing the user requirements and the remodelling project, or from the point of view of making old and new technical adaptations work together.

The premises of an Archives Department are divided into three spaces, for the public, for working on documents and administration and finally for conserving the documents. In these three spaces the safety standards, the control of environmental conditions and of surveillance must be different. A remodelling of a traditional building, and, even more complex, of an industrial building, requires a detailed study in order to constitute the technical and technological requirements to be added to the pre-existing ones to meet these specific demands.

Is there a match in this rehabilitation between the style of construction and the use we want to make of it? All the problems can be anticipated and met, it is often a question of the financial, technical and human resources put at our disposal, and so of the political will, over which we have but a small influence.

The understanding of the suitability of remodelling of an archive building also takes place in the context of a general environment: geographical situation relative to the town, road and public transport communications, position in relation to other municipal and cultural services…

Notes

Worship and conservation: a conflict of priorities.
The example of the Chapel of the Dormition, Assumption and Glorification of the Virgin at St Vincent's Cathedral, Chalon-sur-Saône

C. Morin-Dufoix

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Keywords: *chapel, wall paintings, preventive conservation*

Introduction

The cathedral at Chalon-sur-Saône, built between 1080 and the 16th century, is a blend of Romanesque, « Burgundian Gothic » and Neo-gothic styles. Inside, the side-chapel situated in the right-hand side-aisle, near the transept, founded in 1471 by Jean Lamoureux, choral priest of St Vincent's Cathedral, is decorated by tempera paintings, dedicated entirely to the Virgin : the Dormition decorates the back of the niche in the east wall, the Assumption and the Glorification occupy the wall's upper part. The treatment imbued with serenity and modesty, evoking the work of Enguerrand Quarton, seems to be the work of a Burgundian master who was already open to southern influences at the end of the 15th century [1].
The restoration of the wall paintings of this chapel was undertaken by M Hiseo Takahashi in several phases. In 1986, after removing the plaster which concealed and protected the wall paintings, it turned out that only the Virgin's nose was missing: it was « reconstituted » by taking inspiration from the Cappadocian Virgins. The vault awaited restoration in this chapel and sealing work took place in 1995. The next phase, the application of a neutral background, was completed in spring 1997: based on the remains which were still visible, a starry sky was partially reconstituted.

Abstract

Since this restoration, the Town has chosen neither to install traditional heating, which might damage the completed restoration, nor to heat by costly under-floor heating. The Parish has made its own arrangements, and as it now has four church buildings in the town centre, including the former St Peter's Abbey Church, services are held here on the St Vincent's principal altar only during the summer (from Easter to All Saint's Day). During the winter months, therefore, only the Chapter House, which is heated, is used by the parish. Here, the demands of preventive conservation come up with economic considerations both for the Town and for the Parish (which would not be able to finance heating in such a large area in winter)… and environmental considerations since a great deal of heat would be lost.

Reference

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Notes

Involvement of conservation professionals in an EU Funded Project

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Keywords: *microclimate frames, paintings, dosimeters, indoor environment*

Abstract

The main objectives of the EU funded project "Improved protection of paintings during exhibition, storage and transit" - PROPAINT (SSP1 – 044254) [1] have been the following;

-Investigation of the conditions for paintings inside selected microclimate frames during exhibition, storage and transit.

-Analysis of the protective effect of varnishes on paintings generally and in microclimate frames specifically.

-Contribution to preventive conservation standards for microclimate control of paintings on display, in storage and in transit.

-Suggestions for the most suitable design and construction for new microclimate frames.

An important part of the work performed, in order to fulfil the project objectives, has been based on a good cooperation between the project partners and the end-user group formed by conservation professionals from 10 museums and cultural heritage institutions in Europe and overseas. The project objectives were discussed with the end-user group in the beginning of the project and the result of the project has been evaluated by the end-user group in a final seminar. A field test campaign measuring air pollution and climate inside and outside of microclimate frames in several museums in Europe and overseas was performed in cooperation with the end-users during a period of one year by using dosimeters and passive gas samplers. Results from these measurements showed that harmful pollutants might be a problem both in exhibition locations and inside microclimate frames. Surveys of different microclimate frames show that the museums mainly use two types of microclimate frames. As a result from the research performed during the project period, a decision making model for the use of microclimate frames has been produced as part of the preventive measures. In addition detailed descriptions of improved design and construction of microclimate frames based on investigation in the PROPAINT project has been presented to the end-users. Results from the PROPAINT project have been reported to the European Standardisation Organisation CEN, under the Technical Committee 346: Conservation of Cultural Property, as an input to their work on a new standard for showcases and microclimate frames.

Reference

[1] http://propaint.nilu.no

Notes

Managing environmental control in Gripsholm Castle - a study of the decision process

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Keywords: *energy efficiency, decision-making, environment, barriers*

Introduction

This case-study will explore how decisions about the indoor environment in Gripsholm Castle are made and how different interests are negotiated. The view of different stakeholders on the compromise between energy use, preservation and human comfort will be examined and discussed. Barriers to energy conservation and improved preservation will be identified.

Abstract

There is an unrealized potential for energy conservation and improved preservation environments in historic buildings housing sensitive objects. Many historic buildings are operating and installing climate control systems that deviate from an optimum of preservation, use and energy efficiency. In order to understand why this is the case, we need to extend the discussion beyond engineering and conservation science.

Sociologists Guy & Shove [1] have shown that a lot of today's research about energy conservation in buildings is made within what they call the techno-economic paradigm. The notion of a rational decision-maker optimizing utility is a key concept, and the belief that individual, rational actors have the ability to calculate the benefits of different kinds of energy conservation measures is central. Therefore, deviations from the model are perceived as failures caused by different kinds of "barriers", such as lack of information for key decision-makers or market failures. However, several studies have revealed that this approach is incapable of explaining some vital aspects of the decision-making process. Social and cultural practices cannot be excluded; there is no distinct border between technical and non-technical factors. For real improvements of the quality of decisions these social and cultural practices must be accepted, explored and understood.

Gripsholm Castle outside Stockholm is one of the most well-known castles in Sweden. It houses the oldest National Portrait Gallery in the world. The collection has over 4000 paintings, some of them dating back to the 15th century. The castle has a long history of environmental control; already in the 1920´s an electrical heating system was installed to improve the indoor environment with respect to preservation of the artefacts. In this case-study, social and cultural practices that affect the environmental control strategy used today at Gripsholm Castle will be explored. The study will describe how decisions about environmental control are made, and by whom. The relative importance of different factors, consciously or unconsciously included in the decision-making process, will be studied. Another theme that will be scrutinized is how risks connected to the indoor environment are assessed and managed. Finally, the usefulness of relevant indoor climate standards and guidelines, as perceived by the decision-makers, will be examined. The study is carried out with the use of discourse analysis along with interviews with decision-makers and stakeholders such as conservators, building managers and other staff.

The study will provide a deeper understanding of how the compromise between different aspects of environmental control is handled in practice. In particular, it will show how a better understanding of the decision-making process can be used to improve the actual climate at Gripsholm Castle. In general, it will contribute to the development of strategies for decision-making about environmental control.

Reference

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Notes

Pollution mitigation: the gap between research and application.
An empirical study of the present situation and management of indoor air pollution in German collections

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Keywords: *preventive conservation, air pollutant, standards, empirical study*

Introduction

Since the 1970s numerous methods for testing display and storage materials have been developed within the museum sector. The primary goal of these methods is to prevent damage to the objects caused by the materials' potentially harmful emitted substances [1].
The focus of the present work refers to an extensive empirical study that not only examines the current situation with regard to indoor air pollution but also the way in which materials that emit contaminants are handled in German collections. The main question is if the problem itself has been acknowledged, and if a standardized method regarding material pollution mitigation has been established [2].

Abstract

The high return rate (46.5%) of the empirical study "Emission in the museum environment" demonstrates a fundamental concern regarding the handling of harmful substances along with the topicality of the issue. This concern is further proven by the fact that most of the involved institutions (74.7%) not only had experience with this complex of problems, but also acted to remove respective damages. The study points out that these processes often take place without adequate causal research and standardized pollution control methods.
Furthermore the research examines to which degree official measures for pollution mitigation actually have been implemented (e.g. pollution monitoring, testing of display and storage materials, standard requirements outlined during the tenders call). For example only half of the institutions questioned (50.7%) are testing display materials before use (see figure 1).
The study shows that in spite of extensive research, no uniform procedure, let alone standardised methods, have established themselves in museum facilities to date. In conclusion, previous initiatives of the involved museums have resulted in little success, primarily because of irrelevant analysis methods and a lack of standardized methods.

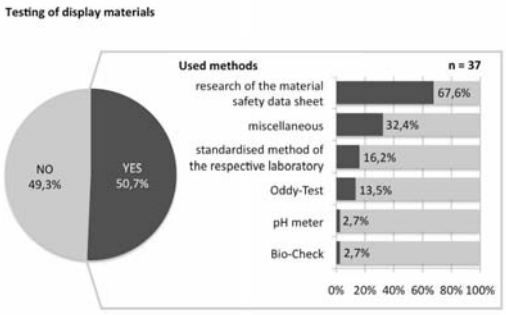

Figure 1: Frequency of the used methods for the testing of display and storage materials.

References

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Notes

‘Heritage Intelligence’ - Environmental monitoring with wireless intelligent sensor systems

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Keywords: *environmental monitoring, wireless sensor networks, heritage intelligence*

Abstract

Wireless mesh sensor technology is finding increasing use in commercial and industrial applications, such as for monitoring traffic, work, built and natural environments. As miniature sensors, based on micro-electromechanical technology, become available for measuring various environmental parameters, their integration into wireless monitoring systems has only recently become possible. Multi-parametric wireless sensors networks are thus now available for use in museums and historic buildings, for objects in transit, and for large outdoor heritage assemblies and sites.
This contribution reports on the integration of a range of chemical and physical sensors - such as temperature, relative humidity, light, volatile organic compounds, formaldehyde, dust - onto a single wireless node. The node network permits remote and reliable data gathering through the exploitation of very low energy consumption, self-powered, geographically-distributed wireless mesh networks.
These network nodes are small, cheap and robust, and can both log data and act as both transmitters and receivers of data. With this technology, there is flexibility in the system and facility for the network to inform the user if a sensor or node fails. Should this happen, nodes can automatically reconfigure communication paths. The network can be accessed by a wired connection or wirelessly using GSM/GPRS.
The system has been tested at different heritage sites: in a gallery environment at The British Museum, at Charlecote Park, a historic house belonging to The National Trust and at the Tower of London, a UNESCO World Heritage Site managed by Historic Royal Palaces. ‘Intelligence’ will be built into the networks to allow the collected data to be processed on the nodes themselves, thus enabling the user to configure a multi-parametric early warning system.
The goal of the Heritage Intelligence project is to develop a smart wireless monitoring system able to assist conservators in addressing issues of cost effective management and preservation.

Reference

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Acknowledgment

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Notes

Modelling of air quality for paintings in microclimate frames and experiences of the Norwegian Institute for Air Research, NILU, in providing “air quality services for cultural heritage professionals”

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Keywords: *modelling, microclimate frames, paintings, air quality services*

Introduction

A more technical presentation of modelling of air quality for paintings in microclimate frames will be followed by a brief discussion of the experiences of the Norwegian Institute for Air Research NILU, in providing “air quality services for cultural heritage professionals”

Abstract

In the EU project PROPAINT measurements of air pollutants inside and just outside a number of microclimate (mc) frames for paintings was performed with dosimeters and passive samplers in a range of mostly European museums. Based on the measurements modelling of the “pollutant impact flux” to the paintings was performed. The calculation of “pollutant impact flux” was based on modelling of the steady state mass balance between the mc-frame inside and the room depending on the ventilation rate and other sources and sinks for the pollutants [1,2]. From the measurements and modelling it could be determined if the mc-frames offered protection against the air-pollutants as compared to the unprotected situation in the room, and if the frame should be better sealed or rather ventilated to reduce the levels of air pollutants and their impact on the paintings inside the mc-frame. The total impact of the air pollutants was calculated by adding the “photo-oxidising flux” of NO_2 + O_3 and the “equivalent acidic impact flux” of acetic + formic acid. The “equivalent acidic impact flux” was found by multiplying the total flux of acetic + formic acid with the expected ratio of the impact concentration levels (thresholds) of NO_2 + O_3 to acetic + formic acid. From the modelling the “threshold levels” for the concentration of acetic + formic acid inside the mc-frames under which frames would not be protective against the air pollutants was calculated. A comparison of the protection performance of a range of mc-frames against the pollution impact on the paintings will be presented. The assumptions in the model, especially regarding the use of “threshold levels” and the general usefulness of the modelling results for practical preventive conservation will be discussed.
Different methods, such as active and passive sampling of particular air pollutants, generic measurement of the quality of the environment by application of dosimeters and related modelling, can be used to evaluate the quality of the indoor air for cultural heritage preservation. An important question is how indoor air policy is decided and implemented by conservation professionals in cultural heritage institutions. The experiences of the Norwegian Institute for Air Research NILU, being a research institute that provides “air quality services for cultural heritage professionals” about the potential for and barriers to examination and subsequent improvement of the indoor air quality for cultural heritage through the diverse channels of provision of these services will be briefly discussed.

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Notes

The Dutch Archival Act and harmonisation

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Keywords: *air quality, harmonization, outdoor pollutants*

Introduction

In 1993, the first document on indoor air quality parameters was presented to improve the storage conditions for archival records. Since 1995, these recommendations were included in the Dutch Archival Act. The conditions were based on international and national studies, presented by Vosteen for the Rijksgebouwendienst [1-5]. Now, more than 10 years after the implementation, it is time to have a closer look at these conditions, and to compare the conditions with measurements from practice.

Abstract

The base of the description of the indoor air quality presented in the Archival Act is the so called air corrosivity as published by the ISA under ISA-71.04-1985 1986 [6]. It describes the growth of corrosion on pure copper. Here class G1 was at that time the most cleanest described environment, and Vosteen calculated that for indoor air quality on archival storage, the levels should be divided by 7.5 and was called Delta-class 1 purity. The name Delta-class was derived from the on-going national action “Deltaplan for conservation” [1]. The Delta 1 indoor air purity is summarized in table 1.

	Growth [Å]	SO_2 [ppb]	NO_x [ppb]	O_3 [ppb]
ISA classification [6]	< 300	< 10	< 50	< 2
Vosteen recommendation [2]	40	< 1.33	< 6.67	< 0.27
Recent draft guidelines July 29 [7]		5.5	10	5

Table 1: Comparison ISA class G1 air quality and the Delta class 1 air quality.

Since Vosteen recommendations became a part of the Archival Act, several research projects have been performed to assess the indoor air quality in Dutch institutions. These are the purified and non purified storage rooms of the National Archives, in the Hague; four repositories of the Royal library in the Hague, a bunker for storage of national heritage and the archive of the Dutch Ministry of Cultural affairs. This paper summarises and compares these results with the National guidelines. It is concluded that air purification is demanded for all locations as the outdoor levels for e.g. NO_x are exceeding 25 ppb. For many locations it was found that the indoor air quality exceeds the given guidelines presented in the Archival Act (see Table 1, Isa and Vosteen). Obviously the purified storage rooms of the National Archive do fulfil these requirements. The Act is only valid for Archival storage and it counts therefore as a recommendation for other repositories. The validity of the Dutch Archival Act should therefore broaden to other important repositories in order to sustain our paper based heritage. Finally, however, as shown in table 1, the Dutch Ministry presented new guidelines including levels of outdoor pollutants to be valid from April 1, 2010 onwards. No fundamental arguments were given for the change of the original levels [7].

References

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Notes

Air quality assessment in cultural heritage locations by dosimetry

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Keywords: *dosimetry, photo-oxidizing effects, outdoor pollutants*

Introduction

This presentation will report results from measurements with dosimeters in locations in cultural heritage institutions. In addition, the application of dosimetry measurements as part of a strategy for the better preservation of artefacts and the encountered difficulties with their use will be discussed.

Abstract

Since its development in the EU MASTER project [1], the EWO dosimeter has been used as both a research and general measurement tool for the evaluation of indoor air quality for better preservation of cultural heritage artefacts. The EWO dosimeter measures the integrated degradation impact of the environment comparable to that observed on organic materials due to photo-oxidizing gases (NO_2 and O_3) and climate (temperature/RH, UV-light).
Measurements of impacts of air pollution on EWO dosimeters were performed in different cultural heritage locations as part of EU projects (e.g. MASTER [1] and PROPAINT [2]), other international projects and as a service to individual institutions. Indoor locations in highly polluted cities showed higher dosimeter response than more rural locations probably due to high infiltration of outdoor generated pollutants such as NO_2 and O_3. In contrast, measurements performed inside enclosures (e.g. showcases / microclimate-frames) showed low response of the dosimeter and hence low photo-oxidizing effects. The importance of such findings for the probable impact on objects in different locations will be discussed. In addition, the use of dosimetry supplied as a consultancy service to or as a practice by cultural heritage professionals will be discussed.

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Notes

Implementing preventive measures in the development process of display cases for the *Brandenburg State Museum of Archaeology*

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Keywords: *display cases, development, pollutants, archaeology*

Introduction

This paper will describe a project that is focused on the development of flexible display cases by the class of conservation and restoration at *Berlin's University of Applied Sciences (HTW)* and the *Brandenburgian Heritage Conservation Department and State Museum of Archaeology (BLDAM)*.

Abstract

The project's focus is the development of a flexible and extendible system of display cases for the temporary exhibition space of the *Brandenburg State Museum* of *Archaeology* in the city of Brandenburg-an-der-Havel. The museum is situated in a medieval monastery, dating from 1286 (see figure 1) and was established in the fall of 2008 after undergoing a thorough reconstruction and renovation of the historical building complex. The museum already offers various permanent exhibits which showcase objects from throughout the region's history. But it also has quite a capacity to house temporary exhibits. This can be done in the three-sided cathedral, which is connected to the monastery complex.

Figure 1: St. Pauli Monastery in Brandenburg-an-der-Havel © K. Franz.

Future exhibitions of the *Brandenburg State Museum* of *Archaeology* will focus on archaeology as well as history in general. Therefore, the required display system needs to be adjustable for different specifications depending on exhibit content, volume or design. At the same time the construction of the display cases must meet current financial demands and of course should meet state-of-the-art preventive conservation requirements, especially aspects of construction materials and air-borne pollutants [1].
In most situations, the exhibition design and construction would be completed before conservation staff and conservation scientists become involved in the process and receive information on the materials being used. For the current project, archaeologists, designers, display constructers, and conservators will be co-working from the beginning in order to prevent undesirable display case constructions. Each profession will develop specific criteria catalogues, which will be discussed and balanced in periodic meetings until a consensus on the construction of the display cases for the *Brandenburg State Museum of Archaeology* is achieved.
Currently, the first stage of the project has started and each working group is compiling their criteria lists. For spring and summer 2010, it is planned to decide on the design and the materials that will be needed for the construction. Thus, preventive conservation aspects for the case system will be formulated throughout the winter of 2009/ 2010 and will - as well as implementation experiences - be included in the final paper.

Reference

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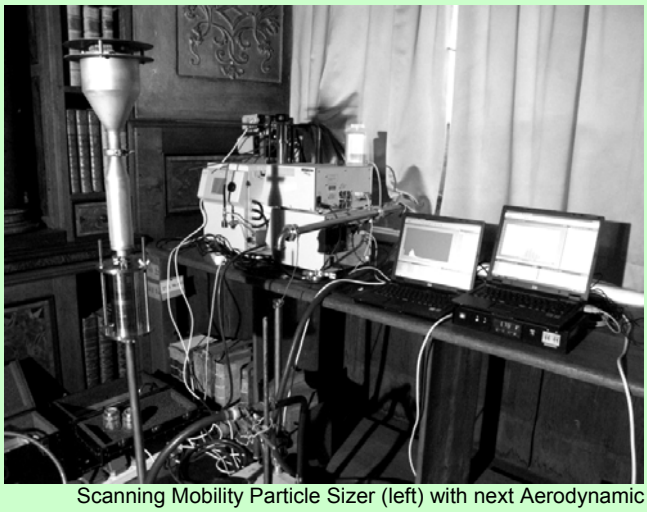
Analysis



Scanning Mobility Particle Sizer (left) with next Aerodynamic Particle Sizer standing on Condensation Particle Counter,© Smolik

Notes

Indoor air quality within museum showcases

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Keywords: *air quality, showcases, materials, emissions*

Introduction

Indoor air quality within museum showcases is still a great concern of conservators. Even though a lot of problematic materials have been eliminated as far as possible during showcase construction, damage and strong odours are still reported. A research project aimed therefore at investigating basic indoor air quality within showcases of different types and ages [1,2].

Abstract

In order to draw conclusions about indoor air quality from specific emission sources, construction and decoration materials currently widely-used for showcase production were subjected to material emission analyses that were performed by use of sophisticated analytical equipment. Both during material emission tests and indoor air analyses within showcases, active air sampling of volatile organic compounds (VOCs), formaldehyde, formic acid and acetic acid was carried out. During showcase investigations, two different construction types were distinguished: (i) modern-type cases mainly constructed from materials that are assumed to be low emissive and (ii) traditional cases mainly built from wooden products. Moreover, air exchange rates in museum cases were documented in order to reveal the influence of air exchange on air quality.
It was found that material choice determines the composition of indoor air quality and consequently the levels of airborne pollutants. Whereas traditional cases are characterized by a rather low range of volatile organic compounds (VOC), but heightened levels of formaldehyde, formic acid and acetic acid, a broad variety of VOCs and still elevated acetic acid concentrations were found in modern showcases. The differences in the span of individual VOCs result from the fact that today product formulations with a wide spectrum of solvents and additives are utilized. These characteristic substances are attributed to the current main emission sources coating materials and rubber sealants.
As the majority of showcases are today constructed as airtight as possible due to conservation demands, organic volatiles generated inside accumulate to highly elevated concentrations because of the nearly static conditions inside the case. In contrast, minor pollutant concentrations occur in an open construction type provided that background values in the surrounding room are low.
It is hard to assess the potentially hazardous impact on artworks, as no alterations can yet be traced back directly to the occurrence of VOCs. Thus, emissions in the museum environment should be kept as low as reasonably achievable and, according to the present state of knowledge, NOAEL-values published by Tétreault [3] should not be exceeded.

References

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Notes

The scent of degradation: VOCs as a source of information

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Keywords: *volatile organic compounds, paper, emission, degradation*

Introduction

Although long discussed, it has not been shown yet what kind of quantitative information is carried by volatiles emitted from degrading materials. In a collaborative piece of research, and using multivariate data analysis, we quantitatively correlated the emissions of volatile degradation products with historic paper properties: rosin, lignin and carbonyl group content, degree of polymerisation of cellulose and paper acidity [1]. This research offers a proof of concept for the development of a 'sniffing' tool for identification of library and archival objects at risk.

Abstract

The analytical approach is based on –omics methodology, i.e. the data-driven inductive approach to research. A new degradomics terminology has been introduced and applied to the study of volatile degradation products. The main volatile degradation products of paper, constituting the particular "smell of old books" were determined using headspace analysis after a 24-h pre-degradation procedure. Using partial least squares and in particular normalised loading weight plots, it was possible to associate volatile degradation markers with rosin and lignin content in paper and thus investigate their effect on degradation of historic paper. A variety of volatiles are of high scientific interest, most notably lipid peroxidation products, thought to originate in the lipid fraction of rosin.
It is proposed for the non-destructive approach to material degradation studies to be used more widely as it is useful for all materials where degradation is of concern, e.g. polymers, food and pharmaceuticals, in addition to heritage studies.

Reference

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Notes

Relationship between the emission of volatile organic compounds from paper and cellulose degradation

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Keywords: *paper, degradation, VOC emissions, PLS regression*

Introduction

The ability to carry out a global yet precise investigation of the state of conservation of paper documents while preserving their physical integrity is currently one of the major challenges in paper conservation research and has direct relevance for museums, libraries and archives. Macromolecular characterisation of cellulose, which relates directly to material properties, can only be carried out using destructive or micro-destructive techniques, while the volatile organic compounds (VOCs) produced during the paper degradation can be analysed using non-destructive techniques. In a comprehensive approach to the study of paper degradation, we investigated both the cellulose macromolecule and the low-molar mass by-products from oxidation and hydrolysis reactions of cellulose, hemicelluloses and lignin in various types of papers. Relationships between these two levels of chemical degradation of paper were studied using statistical tools such as principal component analysis (PCA) and partial least square regression (PLS). The aim was to better comprehend alteration phenomena and to explore the potential of using the relative abundance of specific target VOCs and their emission rates, studied with non-invasive techniques, for determining the state of conservation of a paper object. This research was carried out in the framework of a project funded in 2006 by the French Ministry of Culture.

Abstract

The emissions of VOCs from model papers, aged in closed tubes for various periods of time, were measured using the Field and Laboratory Emission Cell. This sampling technique is entirely non-invasive for the artefact as the cell is placed directly on the paper surface. The VOCs were accumulated on two types of sorbent packings and analysed by liquid chromatography with UV detection and by gas chromatography with dual flame ionisation and mass spectrometry detection. Numerous VOCs produced during the ageing of the papers were identified. The most abundant ones were quantified and their mean emission rates were determined. Acetaldehyde, acetic acid, vanillin, furfural and related heterocyclic compounds, showed a production that increased with ageing time [1,2].
The relationship between the emission rates of the VOCs and the macromolecular degradation of cellulose as measured by size-exclusion chromatography and multiangle laser light scattering detection was studied. Capillary electrophoresis was performed to quantify the most abundant organic acids, and cold extraction pH measurements of the paper were carried out as well. The PCA showed that the different types of papers could be clustered in respective groups according to their VOC emissions. The PLS regression of the VOC emission results allowed modelling of the rate of glycosidic bond breakage in cellulose molecules.

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Notes

Assessment of the degradation of polyurethane foams from contemporary art objects

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Keywords: *museum collections, polyurethane foams, degradation, VOC emission, separative analyses*

Introduction

With the rapid evolution of the chemistry during the 20th century all kind of synthetic polymers have been made available and used for the production of artefacts and materials used by artists to create important pieces that are recognized nowadays as works of art. Unfortunately, some of these polymers are degrading faster than had been expected, and their medium to long term preservation is a challenge to those who care for such items.
This work focuses more precisely on objects made of polyurethane (PU) foams. PU foams are widely present in museum collections, natural history museums, fine art museums, modern art museums, either as part of the artefacts, or as a mean for their storage. PU foams are also largely used in daily home furniture, automobiles, and thermal insulation.
Polyurethanes are a large family of polymers whose composition has evolved over time. They often exhibit specific conservation issues, particularly when they are in the form of foams. The thermal and photochemical degradation mechanism of these foams is not yet fully understood, even if it appears established that they are based on oxidation and/or hydrolysis reactions [1].
Our study focuses on the characterization both of the volatile organic compounds (VOCs) emitted during the natural and artificial ageing of PU foams, and the solvent extractable and polymerized fractions. The aim is to identify potential chemical markers that would provide information about the mechanisms of deterioration of PU foams. The impact of some environmental factors on the foam deterioration are under evaluation and might allow to suggest some protective methods. This research is part of the Popart project supported by the European Commission (grant agreement n° 212218).

Abstract

Modern PU samples with different isocyanate (TDI and MDI) and polyol (ester based and ether based) chemical compositions were subjected to artificial light and thermal ageing. On-site samples naturally aged in different conservation conditions were also collected from museum artefacts, museum storage areas, and from daily life objects. Each sample has been characterized, first visually with the optical microscope or SEM and then by using SPME-GC/MS analyses (off-gassing fraction) and PY-GC/MS analyses (insoluble fraction).
Some compounds (*e.g.* diethylene glycol and glycol ether derivatives) which appear during ageing could be considered as degradation markers. Natural and artificial ageing cause the same degradation pattern. It appears that PU(ester) is more sensitive to thermal ageing than to light ageing, whereas PU(ether) deteriorate primarily by photo-oxidation. Lastly, the analysis of the VOCs using SPME enable to distinguish between PU(ester) and PU(ether) at any point of the degradation process. These results will be presented and illustrated by showing the main morphological changes and analytical data obtained from the selected foam samples.

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Notes

Airborne microbiology in museum through molecular approach: preliminary study

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Keywords: *bioaerosols, indoor air quality, molecular tools, museum*

Introduction

Museums, as institutions receiving the public are subject to large crowds. Air is an effective vector for microorganisms but its microbial content is still little described In museums, microbial quality of air is particularly relevant. Indeed, the respiratory symptoms of members of the public involve airborne microorganisms and many studies have demonstrated their role in the degradation (partial or total) of the media they colonize (wood, textiles, paper, pigment, varnish ...) [1].

Abstract

In this context, a preliminary approach has been conducted in a French museum to study airborne microbiology. This study provides the opportunity to act before the appearance of microbial contamination and so before the deterioration of museum collections.
Traditionally, most studies use culture methods which do not describe the full microbial diversity. Indeed, only 1% of environmental microorganisms can be cultivated [2] and microbial aerosols appear to be particularly subject to non-cultivability because of stresses related to collection methods. Molecular tools, although rarely used in such studies, could provide a better description of airborne microbiology but to our knowledge microbial aerosols from museums have not been investigated using these tools. Assessing the microbial diversity of such sites would enable us to determine possible sources of contamination or adequate treatment solutions.
This work aims to use molecular tools in order to assess airborne microbial diversity and to bring some information about colonization mechanisms to provide effective prevention strategies. Air samples were obtained using an experimental high volume bioaerosol collector located in different rooms and in different parts of the same room. The overall level of fungi and bacteria was assessed by Quantitative Real time PCR (Polymerase Chain Reaction). A qualitative view of the diversity was made using a molecular fingerprints tool, the SSCP (Single Strand Conformation Polymorphism). Four collectors (with different collection principles) were tested in order to choose the suitable one for the study. The first results underline the effectiveness of the high volume aerosol sampler which was the only one to be validated all along analysis steps. Quantitative results show a level of fungi of between 2.89 10^3 and 8.57 10^4GE/m^3 in the air and a level of bacteria of between 2.46 10^5 and 4.60 10^5GE/m^3 in the air. The SSCP analyses show a high diversity in indoor air and a relative stability of the bacterial community structure in the different locations of the museum during a short time (several hours).
To complete and extend the preliminary results of this study, a spatial and temporal monitoring of the microbial diversity and the level of microorganisms in this museum will be undertaken over a period of six months on 25 air samples.

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Notes

Characterization of airborne particles in the Baroque hall of the National Library in Prague

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Keywords: *indoor aerosol, outdoor aerosol, mass size distribution, chemical composition*

Introduction

Airborne particles are one of the major pollutants in outdoor and indoor air. Together with adverse health effect they may negatively influence also ecosystems and cultural heritage. Particles deposit on artworks exhibited in museums and on the surfaces of books in libraries and archives. Coarse particles are abrasive in nature and they can damage works of art by mechanical abrasion when artefacts are moved or handled. Fine particles of acidic or alkaline character may penetrate into the books where they may cause chemical degradation or moistening due to their hygroscopicity [1,2]. In this study we have focused on size-resolved chemical characterization of particulate matter (PM) in the indoor environment of the Baroque Library Hall in Prague.

Abstract

The sampling has been carried out during two intensive campaigns in March and July 2009. Samples of indoor/outdoor PM have been collected and size segregated by two Berner type low pressure impactors that separated particles into 10 size fractions in the size range 0.04-10μm. Size-resolved samples were further weighed and analysed by Ion Chromatography and Proton Induced X-ray emission (PIXE) giving, mass, ionic and elemental size distributions. Results of Ion Chromatography showed that ammonium nitrate in submicron particles evaporated after penetration indoors from the outdoor environment. Comparison of mass size distributions measured indoors and outdoors are shown in figure 1. An example of Ion Chromatography analyses is demonstrated in figure 2.

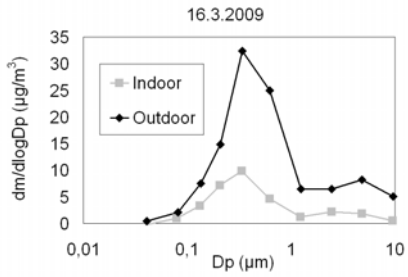

Figure 1: Comparison of mass size distributions measured indoors and outdoors.

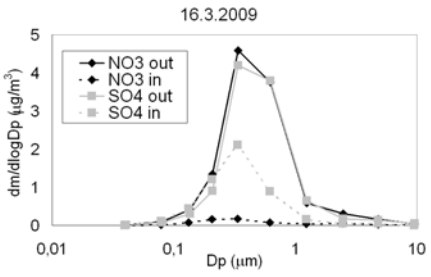

Figure 2: Comparison of mass size distributions of anions measured indoors and outdoors.

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Acknowledgement

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Notes

The preventive conservation of cultural heritage in “indoor” environment: the monitoring of biological pollutants potentially biodeteriogens

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Keywords: *aerobiological monitoring, air quality, fungal spore, biodeteriogens*

Introduction

The effectiveness of the protection and conservation of cultural heritage depends on the preparation of an appropriate security level, environmental monitoring and from the management, care and treatment of the exhibition areas which will protect the works of art from chemical and physical damage. Since the ageing of materials is a spontaneous and irreversible process that cannot be stopped, we can only try to slow it down, protecting objects and artefacts from degradation by many agents that could accelerate it.. Prevention techniques, therefore, play a central role in conservation. In particular, preventive conservation, as direct/indirect actions to slow the effects of degradation on cultural heritage caused by time and use, plays a fundamental role allowing continuous monitoring of the artefact’s condition. Among these measures, the indoor air composition analysis of both biological and chemical pollutants has an important function as it helps to define the actual risk to artefacts [1]. In particular, the qualitative and quantitative study of the aerospora in libraries, archives and museums can be crucial for preventive conservation to avoid or slow down bio-deterioration phenomena, to optimize environment protection procedures and to assess the hygienic risks to human health [2]. The aim of this study was to analyze the indoor environment pollution level of fungal particles in order to promptly detect the presence of airborne microorganisms potentially bio-deteriogens. Moreover, other aims were to assess the risks of environmental biological contamination on the artistic artefacts displayed and to identify emission sources allowing appropriate interventions.

Abstract

The surveys were conducted in the city of Perugia (Umbria, Italy), in particularly valuable historical, artistic and cultural sites with different typologies of exposure and conservation of the artefacts, with different flows of visitors such as museums, historical archives and ancient libraries. The monitoring of particles was performed according to the methods and techniques of aerobiological detection adopting non-invasive instruments suitable for the conservation areas capturing biological particles (fungal spores) suspended in the air and able to qualify and quantify the level of presence of viable and non viable biodeteriogens. The procedures for environmental monitoring were performed through “Hirst” type volumetric sampling for the determination of the non-viable airborne biodeteriogen component and through gravitational samplers for the determination of viable microbe species (in some monitoring areas also a particular “Andersen” volumetric sampler was utilized for the viable part). The research showed, in the study areas, the presence of an appreciable monthly aerosporological level characterized by biodeteriogens potential, variably represented by different fungal types. The methodologies applied provided a reliable description of the biological pollution of air, allowed to prevent situations of risk and to measure their evolution in order to limit the deterioration processes. The investigations also permitted the periodic testing of the conservation status of works of art, the identification of areas with larger biological pollution, with greater risks of damage and contributed to the good management of the conservation areas. A periodic monitoring program of the quantitative and qualitative biological air components can provide essential information for appropriate interventions for prevention, conservation and restoration of cultural heritage in “indoor” environments.

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Notes

Moulds detection by their volatile organic compounds: use for heritage conservation

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Keywords: *fungal development, chemical fingerprint, heritage conservation, polymer sensors*

Introduction

Fungi are common microbial contaminants of indoor environments. Many studies have demonstrated their role in the partial or total degradation of materials they colonize (wood, textiles, paper, pigment, varnish ...). Since 2005 a new technique based on chemical tracers has been developed and validated during different measurements campaigns. This approach is now applied and adapted to various indoor environments (houses, offices, schools, child cares…) and enables the detection of recent and/or hidden contamination.
This technique contributes to the development of a system composed of chemical micro-sensors adapted to field measurements. This system does not require analytical laboratory processing and as such saves valuable time. Another practical implication is to allow continuous monitoring of fungal contamination in indoor environments. Combined with the classical methods, the system would improve identification of the involved fungal species and assess exposure levels.

Abstract

Early in their development and through all their growing phases, fungi produce Volatile Organic Compounds (VOCs) from their metabolism. In opposition to spores, microbial VOCs can diffuse through a layer of material. As such, these VOCs can be used to detect a fungal contamination early in its development as well as hidden contaminations.
In this context, this study aims at developing a new mould detection technique, based on microbial volatile organic compounds and adapted to artworks conservation.
For this purpose, four specific indexes were developed. These indexes, based on the housing index patented by Moularat *et al.*, are dedicated to artwork conservation [1]. Four typical situations were defined according to substrate/mould couples frequently encountered in artworks: three contaminations types by deuteromycetes (two of museums and one of adorned caves) and one by basidiomycetes on wood.
One of these four indexes was validated *in situ* during the measurements done in an adorned cave, before and after the treatment of the site by biocides. The preliminary tests were also performed with polymer sensors which have allowed to distinguish mouldy from sterile environments in laboratory. The tests, performed on the different strains of the study, yielded specific responses of polymer sensors exposed to mouldy environments. All the profiles obtained with the different strains (repeated three times) showed a different behaviour of the sensors' response between a contaminated and a sterile environment.

Reference

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Interaction of air pollutants and objects

Monitoring campaign in the Swiss National Library, © Di Pietro

Notes

Thenardite-mirabilite cycles in historical buildings

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Keywords: *preventive conservation, historical climate, relative humidity, thenardite-mirabilite cycles*

Abstract

It is known that at high relative humidity (RH) levels and low temperatures, Thenardite (Na_2SO_4) is transformed into Mirabilite, i.e. the hydrated crystalline form including $10H_2O$ molecules. The combination of high RH levels and high temperature brings to deliquescence and dissolution. When the RH drops, the crystal changes structure, losing water. Such cycles may be dangerous to structures for the crystallisation pressure. This paper is concerned with the study of how the frequency of these cycles has been changed from the case of unheated historical buildings, as they used to be in past centuries, to the situation where heating systems are operated for the comfort of the occupants.
The indoor climate of historical buildings in past centuries is known from the analysis of series of observations made for health or climatic purposes. Unheated historical buildings had in winter a temperature 5 to 10 °C higher than outdoors due to the solar radiation absorbed by the walls and roof or penetrating through windows. On the other hand, in the summertime, the ventilation operated was sufficient to control overheating but was very modest, generally less than 1°C. In the mid-seasons the indoor-outdoor difference ranged from 0 to 3°C. Indoor RH can be calculated from the levels of the outdoor temperature when the outside vapour reaches saturation. Where the outdoor RH was lower than 100%, the same fraction should be applied to the RH calculated inside.
In the case of unheated historical buildings, the application of the indoor temperature and RH distribution shows that, in most of the calendar months the crystalline form is Mirabilite, or even dissolution, when the outdoor RH is high, but a transformation into Thenardite occurs when outdoor RH returns to average levels (see figure 1).
The situation for heated buildings in winter is different (see figure 2). Calculations performed for a number of European sites have shown that Thenardite-Mirabilite cycles may occur only in the summertime in the case of natural cooling (e.g. underground rooms). Summertime cycles are possible if we suppose that the building structure remains at temperatures lower than the outdoor levels. For leaching air, this implies a rise in RH and possible crystalline transition. On the other hand, winter heating lowers RH below the threshold for crystalline transition and may totally control such cycles. One needs to take care, however, since although indoor heating may be useful for the above cycles, dryness is potentially dangerous for other materials, e.g. wood, paper and tapestry.

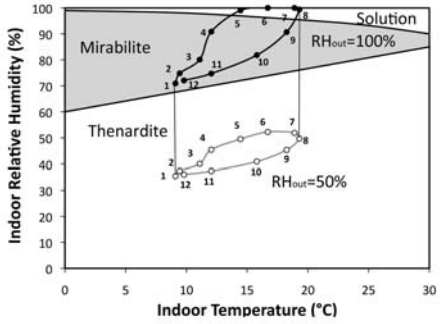

Figure 1: Thenardite-Mirabilite transformations outdoors and in an unheated historical building in Paris, calculated for outdoor RH=50 and 100%. Indoor Humidity Mixing Ratio is supposed to be as outdoors. Numbered labels indicate the calendar months.

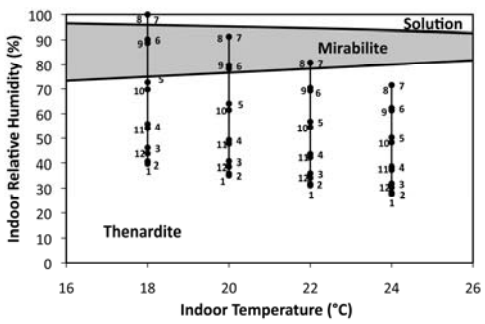

Figure 2: Indoor cycles for a building in Rome whose temperature is kept constant at 18°, 20°, 22°, 24°C respectively, for the local monthly T and RH averages in the 1961-1990 reference period. Humidity Mixing Ratio and numbered labels as in figure 1.

Notes

The role of organic pollutants in the alteration of alkali silicate glasses

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Keywords: *alkali silicate glass, organic pollutants, alteration*

Introduction

Following the discovery of a widespread alteration in the National Museums glass collections in Edinburgh, a research was carried out to understand the effect of organic pollutants on the structure of the alkali silicate glasses and the reaction kinetics and mechanisms involved in the alteration. The paper will discuss the results from the analysis of museum objects and ageing experiments and the role of the difference organic pollutants in the alteration.

Abstract

When considering the storage and display of a glass artefact, the presence of organic pollutants is generally not taken into account and therefore not assessed. At the National Museums of Scotland (NMS), the combination of an unstable glass composition (mainly rich in sodium, poor in calcium), fluctuating humidity and high concentrations of organic pollutants emitted by the wooden showcases led to widespread deterioration of the 19th to 20th century glass collections. Many museums, aware or not, are affected by the same problem.

Research was carried out to understand the effect of the organic pollutants on the structure of the alkali silicate glasses and the reaction kinetics and mechanisms involved in the alteration [1]. Museum objects and artificially aged samples were examined using complementary techniques: elemental analysis by secondary ion mass spectrometry (SIMS) and electron microprobe; and molecular analysis by Raman spectroscopy.

The ageing experiments revealed that the organic pollutants influence the crystalline deposits formed at the glass surface as well as the chemical structure of the altered layer. These modifications could be directly related to the chemical and structural modification observed on the NMS historic glasses. Moreover, the experiments carried out on glass samples aged in ambient condition over one year threw light on the role played by these pollutants on the alteration mechanisms and kinetics [2].

The analytical results indicate that acidic pollutants (acetic and formic acids) greatly enhanced the alteration compared to an environment with similar relative humidity without the pollutants, and that formaldehyde has little effect on the glass deterioration. The research revealed that in a mixed pollutants environment, whatever the pollutant proportion or concentration, the pollutant with the highest acid-ionization constant, in that case formic acid, solely reacts with the glass. This phenomenon explained the dominance of formates in the crystalline deposits on the NMS glasses in atmospheres where acetic acid predominates. Finally, the experiments highlighted that the humidity and temperature fluctuations taking place in museums prevent the expected slowing down of the alteration and instead maintain a roughly linear progression of the alteration with time.

The research evidenced that the role of organic pollutants should not be neglected with glass objects and that storage of unstable glass in wooden cabinets or storage should be avoided.

References

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Notes

Monitoring of indoor air pollution in the stacks of the Swiss National Library

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Keywords: *indoor air, library; passive sample, Radiello, pollution, nitrogen dioxide, acetic acid, aldehydes*

Abstract

In 2008, we performed a survey of the air quality in the underground stacks of the Swiss National Library, including the surrounding working areas and two public areas. We measured a range of gases, both outdoor and indoor generated, with passive samplers [1]. The results were compared with the levels measured by active samplers and with the air corrosivity levels monitored on metal plates.
The interpretation of the results of this monitoring campaign is based on understanding the construction and the operational sequence of the air conditioning system present in the library. The levels of indoor air pollution are within the ranges set by the ASHRAE2007 Guidelines, but there was no significant difference between the NO_2 levels measured in areas with chemically filtered and not chemically filtered air. On the floor containing the newspaper collection the acetic acid level was 16 times (400 ppb) higher than on the other floors.
Due to the presence of tracer gases, the mixing of air between different floors could be followed. To explain these results, the functioning of the doors and the frequency of their opening have been investigated. The preliminary results of monitoring the air corrosivity levels by means of the OnGuard 2000-system will be presented as well.

Figure 1: The monitoring campaign in the Swiss National Libary.

Reference

[1] Radiello passive samplers, see http://www.radiello.com/.

Notes

Characterisation of fading behaviour of coloured papers during simulated display in anoxia

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Keywords: *anoxia, coloured paper, fading, pastels*

Abstract

Coloured papers, either as a primary support, collage material, or secondary support, can be found in most graphic art collections. They have been used by many artists including, Stanisław Ignacy Witkiewicz (Wikacy), Abraham Walkowitz, and Jackson Pollack. The relative impermanence to light of many of the materials used to produce the papers is well documented [1], and the resulting discolouration, due to yellowing of the lignocellulosic substrate and fading of the colorants, drastically changes the appearance of the objects and greatly affects the viewers' aesthetic experience. Anoxia has been proposed as a preventive conservation display technique for graphic materials [2] allowing for longer display of sensitive objects through the limitation of oxidative degradation and interaction with exogenous pollutants.

In this study a set of historic coloured papers, as well as modern equivalents, and 28 pastel drawings by Witkacy were characterised to identify constituent colorants and determine their optical permanence during anoxic display relative to standard museum display. The sample papers, both modern and historic, were subjected to accelerated photo-degradation under modified and standard atmospheres. The results of the study will be used to inform the future preservation and display of portraits by Witkacy and can be applied to objects prepared from similar coloured papers.

The historic paper samples used in this study were taken from sample books for paper dying, and represent the common "coal tar" dyes used by the paper industry in the early 20th century. These, as well as the samples of modern graphic arts papers, were mounted in sealed reactors and irradiated under a UV filtered xenon source under a constant flow of humidified nitrogen or a static standard atmosphere. The visible reflectance spectrum for each sample was recorded at periodic intervals, and the relative differences in colour and rates of colour change between nitrogen and standard atmospheres were noted.

The paper substrates and applied pastels of 28 portraits by Witkacy were characterized with XRF, RAMAN, FTIR and Vis spectroscopy with the goal of identifying the colorants. The identified colorants were noted and the potential applicability of anoxia for each was determined from literature sources [2] and/or from the above mentioned fading studies. The knowledge gained from this research will be used to inform future preservation and display practice in the National Museum in Krakow.

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Notes

Carbonyl vapors and their impact on paper degradation

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Keywords: *carbonyl, paper degradation, molar mass determination, pH, zero-span tensile strength*

Introduction

During ageing, paper produces a wide array of volatile organic compounds (VOCs) from the degradation of cellulose, hemicelluloses, lignin and other components. However, much is unknown - about how these VOCs can affect paper stability. When generated by a stack of paper in an archival container, these VOCs stay trapped and can build up in significant concentrations within the container. The VOCs with carbonyl and carboxyl functionalities are potentially harmful to paper by accelerating its degradation rate. The authors have previously established that acetic acid vapour can be detrimental to paper when present in its immediate environment [1].

Abstract

We have studied the impact of some of these VOCs on pure cellulose paper in real time. Acetaldehyde, acetic acid, formaldehyde, formic acid, furfural and hexanal were chosen, as they have been identified among the most abundant VOCs that paper produces during ageing. The paper samples were exposed to each VOC separately at an approximate concentration of 50 ppm for 52 days at ambient conditions. The VOC concentration in the vessels were generated by VOC/water/salt solutions. After VOC exposure, the paper samples were subjected to accelerated heat/humid ageing, in order to estimate their long term stability.
Aged and unaged paper samples were analyzed. Molar mass determinations as well as optical properties, pH and zero-span tensile strength measurements were performed in order to assess the impact of each VOC on paper degradation. Preliminary results for the unaged samples showed measurable degradation by the formic acid vapour. More results of this cooperative project will be presented.

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Notes

Volatile organic compounds in libraries' atmospheres: effects on the written and printed cultural heritage

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Keywords: *volatile organic compounds, sulphur, paper cellulose, photo activity test*

Abstract

If it has now been well established that outdoor atmospheric pollution, sulphur dioxide, ozone or nitrogen oxides in particular, has detrimental effects on library collections, that of indoor pollution is still underestimated by most written heritage keepers. But with the development of "airtight libraries", these effects become obvious. The National Library of France (BnF) was recently confronted with this issue [1,2]. Although most of the preservation parameters were taken into account when constructing its new building in 1996: scrupulous choice of the construction material, installation of outdoor air purification systems, a survey of air indoors revealed an evident contamination by sulphur pollutants, the source of which are in particular some kinds of boxes used for the conditioning of documents [3]. This survey clearly showed the disastrous consequences of these pollutants on indoor air quality and building materials. But the question of their contribution to the degradation of cellulose containing collections remains.

To answer this, a comparative laboratory study on different kinds of boxboards usually used for the conditioning of libraries and archive items was performed. The effects of the VOCs they emit on paper cellulose, measured by Size Exclusion Chromatography, were linked to their intrinsic composition. The results showed a particular correlation between the presence of calcium sulphate (gypsum) and the negative effect of boards on paper cellulose. But, if this criterion is important, it cannot explain all the phenomena. One should not underestimate the role of organic volatiles, aldehydes and acids in particular, which can also largely contribute to accelerate the degradation of paper cellulose.

This study gives a new insight into the quality of materials used for the preservation of cultural and in particular written and printed heritage. It shows that the criteria traditionally used to assess the cellulose containing preservation materials (pH, alkaline reserve, fibre quality) are largely inadequate because they do not take VOC emissions into account. The contribution of these VOCs in the degradation of museum artefacts, metal- containing ones in particular, has been largely demonstrated. We showed clearly that they can have an effect on paper cellulose. But the question of quality control still remains. What simple and sensitive method could be used to assess these preservation materials? We showed during this study that the results of the Photo Activity Test (PAT) correlate surprisingly with the effect of the VOCs emitted by the boxboards on the Degree of Polymerization (Dp) of paper cellulose. If this correlation is confirmed, this test could be used to assess materials used for the preservation of both photographic and cellulose containing artefacts.

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Notes

Volatile aldehydes in libraries and archives

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Keywords: *indoor air quality, VOC, indoor emission, paper degradation*

Introduction

Volatile aldehydes are well-known products of degradation of paper and other cellulose-based materials. This may result in their accumulation in archival and library repositories and thus a systematic study was implemented to investigate the concentration of these chemical species in various libraries and archives. In the frame of this study, passive sampling was carried out at 14 locations in 4 libraries and archives– the Nationaal Archief, The Hague (Netherlands), the National and University Library, Ljubljana (Slovenia), The National Archives, Kew (UK) and St Paul's Cathedral (UK).

Abstract

Sampling was carried out in repositories and also in archival boxes, using passive DNPH-based samplers to study formaldehyde, acetaldehyde, hexanal and furfural. Five members of the personnel at the Nationaal Archief were also provided with personal samplers. The time spent in repositories was reflected in a higher dose, nevertheless, all doses were found to be lower than even the most stringent work exposure limits [1].
At The National Archives, Kew, a further study was carried out to compare the concentrations of outdoor-generated and indoor-generated pollutants inside and outside repositories. It was evident that inside the repository and particularly inside archival boxes the concentrations of volatile organic compounds (VOCs) were significantly higher than the concentrations of outdoor-generated pollutants, though these are more commonly studied in connection with heritage materials [1]. This indicates that further work on the pro-degradative effect of VOCs on heritage materials, particularly in multi-pollutant situations, is essential and that monitoring of VOCs in heritage institutions should become more widespread.

Reference

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Notes

Volatile organic compounds in books after mass deacidification

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Keywords: *mass deacidification, VOCs, direct thermal desorption*

Introduction

Paper stability crucially depends on its acidity/alkalinity, and it is well known that acid paper degrades faster [1]. In order to prolong its lifetime, different deacidification treatments are available also on a large, "mass" scale. Some of these processes make use of organic solvents, which may remain in the deacidified material after treatment. Additional volatile organic compounds (VOCs) may be produced during neutralization reactions and emitted from deacidified paper material. Therefore, their determination is important as the emitted VOCs may be associated with health risks and risks to objects.

Abstract

Specific methods of sampling were developed in order to determine VOCs in model books after various deacidification treatments to determine the total amount of VOCs and the rate of their emission. We identified various remaining solvents, including alcohols as products of reactions taking place during deacidification. Direct thermal desorption and GC/MS analysis was performed to investigate the distribution of the remaining solvents and alcohols and 2D maps across a book page were plotted showing a higher concentration of volatiles in the middle of the page (see figure 1).

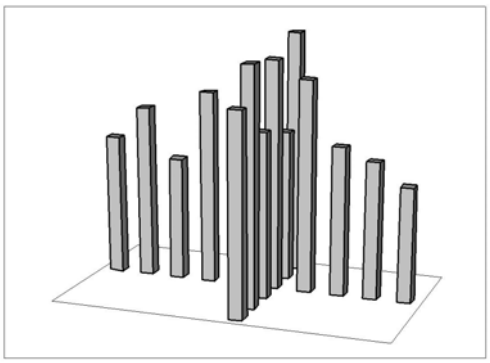

Figure 1: Typical 2D concentration map of the remaining volatiles across a model book page after mass deacidification.

Subsequently, the total amount of remaining VOCs was determined over time to determine the rate of emission. The remaining VOCs were analysed after two weeks, a month and three months of storage at room temperature. The amount of volatiles remaining in books after deacidification decreased to about 30% or less within 3-4 months.

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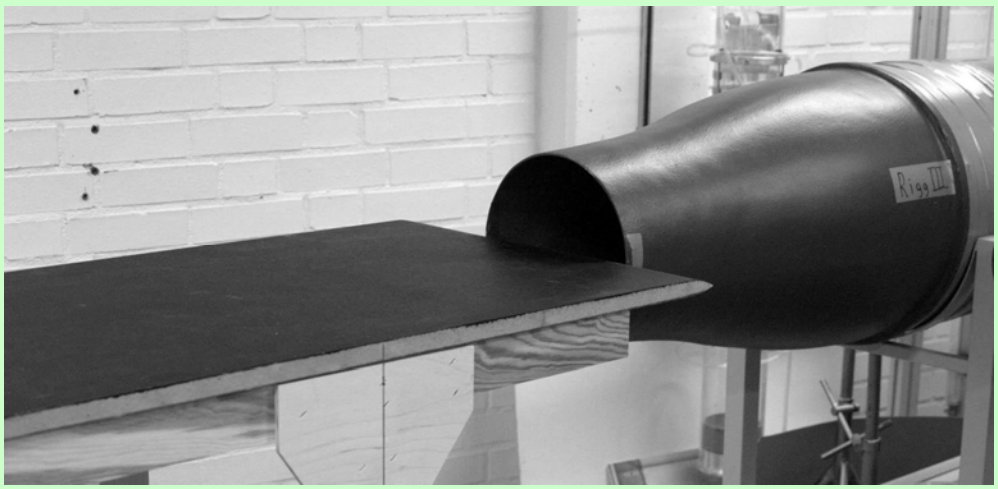
Analyis & Interaction of air pollutants and objects



Study of particle deposition on surfaces, © Sandberg

Notes

Understanding microclimates in museums, historic houses and churches and their impact on heritage materials

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***Keywords**: dosimeters, damage assessment, parchment, scanning probe microscopy*

Abstract

This paper will describe monitoring in museum environments and damage characterisation of selected heritage materials. Monitoring was directed at detection of volatile organic acids released from wood: in the PROPAINT project "Improved protection of Paintings during Exhibition, Storage and Transit", the aim was to monitor the air quality within microclimate frames, in the SENSORGAN project "Sensor System to Detect Harmful Environments" the aim was to develop a damage dosimeter based on the quartz crystal microbalance for continuous recording of the volatile organic acids generated by the wood of the windchest, and which have been shown to have a corrosive action on lead-based organ pipes. In both cases the factors to consider were the air exchange rate, and the type of wood used in the windchest, and in the micro-climate frames used to protect the paintings. Studies of the effect of environmental factors (inorganic pollutants) were made in the IDAP project "Improved Damage Assessment of Parchment" and of volatile organic acids on varnishes of paintings in frames in the PROPAINT project [1-3].
For monitoring, lead-based dosimeters were designed so that they could be used within organ pipes of selected historical organs and then with some modifications they were used within paint frames. In SENSORGAN the dosimeters were tested in the recently restored organ at St Botolph without Aldgate (London) and in Orgryte, Sweden, and high levels of dosimeter damage occurred in environments where acetic acid and RH values exceeded 0.5ppm and 60%RH respectively. The rate of change in the dosimeter values was found to be most useful parameter in ranking the quality of the microclimates within organ pipes and also in the laboratory accelerated aged studies. In frames the lead based dosimeters measured high levels of volatile organic acids (>0.5ppm) and significantly higher than in the rooms. Mitigating procedures for reduction of levels of volatile organic acids were also tested.
For studies of the impact of environmental parameters on materials, controlled environment dynamic mechanical analysis, spectroscopic (ATR-FTIR), and scanning probe microscopy (atomic force microscopy and nano-thermal analysis) were used. Damage ranking of parchment was based on the presence of intact D-banding of collagen in parchment and the mechanical response to RH. Damage ranking of vanishes was based on changes in glass transition temperature (Tg).
Questions such as "How do the microclimatic conditions in frames and the higher levels of volatile organic acids affect varnished surfaces of paintings?" and "How do varying levels of pollutants and damage to collagen in parchment affect the mechanical response" will be addressed.

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Notes

Preventive conservation of paintings in São Paulo (Brazil): assessment of damage risk by piezoelectric dosimeters

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Keywords: *microenvironments, damage risk, piezoelectric dosimetry, impact sensors*

Introduction

This paper describes the assembly and operation of an upgraded dosimeter based on piezoelectric quartz crystals modified with a thin film of mastic varnish. The difference in the ageing rates occurring in the films during exposure in a museum area and in a control chamber is recorded in terms of oscillation frequency of the crystals and used to assess the damage risk associated with the specific characteristics of the microenvironment of that room [1]. In these novel automatic devices the simultaneous measurement of T, RH and light intensity and type through on-board sensors is helpful to interpret the response of such *impact sensor* [2]. Here, their potentials are shown in field campaigns carried out in two of the most important museums of the city of São Paulo, Brazil: the Historical Museum of the University of São Paulo (*"HM"*) and the São Paulo State Plastic Arts Museum (*"AM"*), both located in the central urban area of the city of São Paulo, Brazil.

Abstract

An example of the response of two-month monitoring carried out in exhibition rooms and storage rooms of the two museums is shown in figure 1a: the exhibition rooms systematically exhibit higher degradation rates on account of the presence of natural or artificial light (storage rooms are kept in the dark). However, in the *HM* higher degradation rate compared to the *AM* (see figure 1b) indicates higher impact risk for that room. The correlation between light data and ageing rates in the early stage of exposure/degradation suggests that the use of fluorescent lamps and, especially, natural lightning is responsible for such behaviour (T and RH levels, though a little different, do not seem to affect significantly). Interestingly, in both storage rooms the degradation rate of mastic varnish is quite higher than in the control chamber, even if T and RH levels were only slightly better. This is likely to be associated with the absence of control in air quality: both museums exchange air with the external atmosphere of the city of São Paulo, a town that suffers from severe problems of photochemical smog pollution. The cross comparison of official ozone outdoor concentrations and dosimeters responses suggests that peak ozone episodes cause increase in mastic degradation.

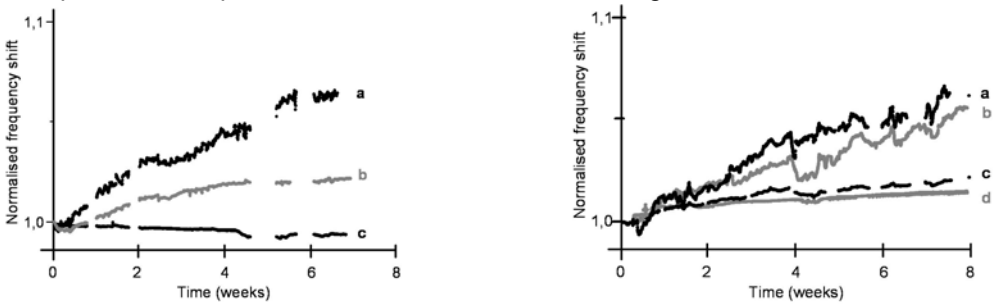

Figure 1: (left) Response of piezoelectric dosimeters exposed in the Exhibition (a) and in the Storage Room (b) of the *HM* and in the Control Chamber (c). (right) Response of piezoelectric dosimeters exposed in the Exhibition Rooms of the *HM* (a) and of the *AM* (b) and in the Storage Rooms (c and d, respectively).

Reference

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Notes

Survey on air quality control in cultural heritage institutions and development of automated corrosion sensors for real time monitoring

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Keywords: *atmospheric corrosion, monitoring, air corrosivity*

Introduction

Prototypes of loggers for continuous measurements of the corrosion rate of selected technical metals under atmospheric conditions were recently developed [1]. The electronic unit measures and records changes in the electrical resistance of a thin metal track applied on an insulating substrate. The developed concept offers several important advantages, such as on-line and real-time monitoring, small size, easy replaceable metal sensors, remote data access, and automatic data delivery via e-mail [2,3]. In 2009, a project that aimed at adjusting the monitoring system for highly-demanding application in the cultural heritage sphere has been launched [4].

Abstract

For use in low-polluted indoor premises where valuable objects are displayed or stored, ultra thin sensors by PVD technology will be developed. Highly sensitive means for corrosion monitoring will be available for steel, copper, lead, silver, zinc, and eventually metal alloys to more closely simulate the historical materials displayed in museums. Consequently, short response times will be obtained even in low-corrosivity indoor atmospheres with air quality control and the results will be available in days instead of months.

In addition, user-friendly software allowing for rapid interpretation of results and incorporating existing and proposed standards and recommendations will be created and the electronic logger and software will be adapted for single measurements on sensors exposed separately to lower the cost of monitoring.

A survey consisting of 22 questions was prepared to determine the current state of air quality control in cultural heritage institutions, as well as general and specific monitoring needs and desires. Respondents were asked to choose from a list of answers; multiple selections were possible for most questions. The responses on 80 surveys were tallied and will be presented.

Laboratory testing of new highly sensitive sensors for monitoring in indoor conditions has been started recently. A unique experimental setup for measurements in dry and humid air with low amounts of pollutants was developed and will be introduced. First results obtained in presence of traces of organic acids will be given.

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Notes

The factors deteriorating the historical textiles in the Museum of Faculty of Archaeology, Cairo University and approaches for their prevention

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Keywords: *museum textiles, improper environmental condition, deterioration features, prevention methods*

Introduction

This article presents a case study concerning the factors deteriorating historical textile objects in the Museum of Faculty of Archaeology, Cairo University and introducing approaches for the preservation of these textiles against the deterioration factors threatening them.

Abstract

The existing problems caused by environmental variables including temperature, relative humidity, light and air particulate pollutants have been monitored in the Museum of Faculty of Archaeology, Cairo University. The current study concluded that environmental conditions in the studied Museum are not properly monitored and controlled, and they fluctuate according to outdoor changes. This creates very poor environmental conditions which initiate various forms of damage and deterioration to the textile collection. Chemical, physical and biological deterioration features were noted in the textile objects in this museum. The analytical results showed that textile objects in the studied museum have extensive dirt deposits. The dirt accumulation is mainly due to air particles and pollutants coming from the display case environment. The study showed that the environmental condition and the air pollutants may promote the fungal deterioration of textiles. So other work was carried out to monitor the most dominant fungi on the textile collection in this museum. Different methods were used for isolating and identifying fungi on these textiles. The results obtained show that the fungal deterioration is one of the most serious problems in this museum. There is an excessive fungal infestation on textile objects in this museum. The most dominant fungi isolated from the textile collection belong to *Aspergillus, Penicillium, Chaetomium and Alternaria* species.

As the results show that there are combined problems in this museum that include the air pollution and fungal infestations, laboratory studies were done to evaluate the effect of using deacidifying agents to reduce or prevent the deterioration of ancient cellulosic textiles caused by air pollution in the studied museum. At the same time the role of these treatments in the preservation of textiles against fungal deterioration was studied. Textile samples were treated by 4 selected different alkaline deacidifying agents. The investigated alkaline deacidifying agents are commonly used materials in the storage and conservation of ancient cellulosic materials like paper as well as linen and cotton textiles. The ageing process of untreated and treated cellulosic textile samples was accelerated by different methods. Various methods were used to investigate the effect of deacidifying agents on the properties of cellulosic textiles before and after the ageing. This study reported that the tested alkaline deacidifying agents retarded the fungal deterioration of cellulosic textiles but did not prevent the deterioration. Treatment of ancient cellulosic textiles by alkaline deacidifying agents not only neutralises acidic degradation products, but also inhibits fungal deterioration and increases the lifetime of these textiles conserving them for future generations.

Finally this study established a strategic plan and introduced some guidelines for the control and prevention of the deterioration problems on textile objects in the Museum of Faculty of Archaeology, Cairo University.

Notes

The generation of indoor air pollution from surface reactions

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Keywords: *indoor air pollution, surface deposition, emission, organic acids, nitrous acid, nitric acid*

Introduction

Simple mass balances are typically used to model the deposition loss of outdoor pollutants to indoor surfaces.
For ozone this allows for a fairly close estimate to the amount of ozone molecules which react on the surface of, say, one museum object. However, for pollutants which are at the same time both generated and re-deposited on surfaces within the same room, such estimates are more difficult to make. This makes concentration measurements difficult to interpret as it is the flux of pollutants to a surface which is the main damage factor with regard to pollution related deterioration.

Abstract

Using two archive rooms, both located in central Copenhagen, it is demonstrated how it is possible to estimate the generation and deposition rates of organic acids on indoor surfaces by measuring the variations in the steady state concentration at different ventilation rates, and how the generation rate of nitric acid on surfaces can be estimated from concurrent measurements of nitrous acid in air.
The concentration of organic acids in air can easily be measured, but it is difficult on a room scale to estimate the rate of generation, or the deposition flux onto materials. However, if different steady-state concentrations are recorded for different air exchange rates, then the generation rate and the deposition loss (surface removal) can be computed by the use of a simple mass balance model. This was done for a 120m^3 archive room, which was tested at the air exchange 0.14h^{-1} (concentration 236μgm^{-3}) and 0.49h^{-1} (concentration 126μgm^{-3}).
From this the generation rate of organic acids for the archive was determined to 11000μgh^{-1}. The average deposition velocity for the re-deposition on surfaces was estimated to 0.002cms^{-1}. The total deposition loss was equal to what would be ventilated away at a quarter air exchange per hour.
In another archive room (1600m^3) the formation rate of nitric acid was investigated. It is known that reactions between nitrogen dioxide and surface moisture film will produce nitrous acid and nitric acid in molar equivalent amounts:

$$2NO_2 + H_2O/surface \rightarrow HONO + (H^+ + NO_3^-)$$

Nitrous acid will remain almost totally in the gas phase, while the nitric acid will exist as ions in surface water film.
While nitrous acid in itself poses little threat to materials its concentration in air indicates the concurrent production of the more harmful nitric acid on surfaces.
Measurements of nitrous acid inside the archive room and outdoor showed an indoor/outdoor concentration ratio of 6. When taking the ventilation rate and the volume room into account, the extra indoor generation of nitrous acid was calculated to 1700μgh^{-1} for the full room. This is mole equivalent to c. 2300μgh^{-1} of nitric acid, which will be formed on and left to react with hygroscopic surfaces, including those of books and other archival objects present in the room.

Notes

The assessment of air quality at the "Galleria dell'Accademia", Florence, Italy

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Keywords: *passive sampler, David, particulate matter, air pollution*

Introduction

The Galleria dell'Accademia in Florence contains the "David" by Michelangelo, one of the finest statues in the world. Previous studies of air quality within buildings housing cultural properties have shown that there is great variability for pollutants indoors due to air exchange with outdoors. In the light of this variability, techniques are needed to survey the area of interest for estimating air pollution in order to map the penetration of pollutants indoors.

Abstract

Diffusive samplers are an ideal tool for determining the pollutant distribution over a certain area and to assess integrated concentration levels over long period of time [1,2]. Diffusive sampling relies on a physical phenomenon (gas diffusion) that brings the pollutant into contact with the absorbing collector. Main advantages of the method, compared with the pump-dependent active sampling procedure, are cost effectiveness, simplicity and the potential for large-scale measurements. In addition, they are small, unobtrusive and noiseless, the last three features particularly favourable for indoor deployment in a museum. Three different locations of the Galleria dell'Accademia (one near the David, one at the entrance to the Gallery and one near one of the outlets of the air conditioning unit) were chosen as indicative of the air quality indoors for O_3, SO_2, NO_x, NO_2, HONO and HNO_3. Concomitant outdoor measurements on the roof of the Gallery were also carried out to investigate the penetration indoors. The exhibition hall which houses the David shares the same air volume as the site positioned near the air conditioning outlet. The remaining site chosen for the gaseous pollutants mentioned is separated from the space where the David is displayed. As far as the particulate matter component of indoor pollution is concerned, the measurement of PM10 was carried out by using a sampler in two locations, one of them in correspondence of the pedestal of the statue and the other at the make-up air entrance to the central HVAC. Furthermore, the distribution of particles was carried out using an optical counter at three levels namely at the basement of the statue and at 4 and 8 meters respectively. The conclusions reached in the present study were as follows. It was found that the critical factor influencing the deposition of gases and particles was the pollutant concentration in air, the transfer processes depending on turbulence and the presence of surface moisture. We also found evidences that HONO can be generated via indoor chemistry through thermal reaction of NO_2 with water on surfaces. Since indoor environments are characterised by high surface/volume ratios in comparison to those outdoors, the formation of HONO is highly favoured in the indoor environment.

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Notes

Long term prediction of marble erosion for the conservation of the statue of David by Michelangelo

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Keywords: *marble, erosion, particles, CFD*

Introduction

This article presents a study of the decay of a marble surface generated by solid particle impingement, in order to estimate the impact of a hypothetical harmful effect of the new hvac system, currently at the designing stage, for the protection of the statue of David by Michelangelo [1].
The system is composed of a curtain of air projected vertically from the floor, separating the statue environment from that occupied by visitors to obtain a low concentration of pollutants near the marble surfaces.
A very conservative simulation, with high air velocity and high particle concentration was performed using a CFD (Computational Fluid Dynamic) code, in order to estimate the effect of long term exposure to the aggressive phenomenon.

Abstract

The installation of hvac systems in museums needs an appropriate inquiry in order to predict every possible environmental modification, which could be detrimental to the sensitive materials of works of art.
The importance of the statue of David by Michelangelo in Florence (Italy), which in the last decades was submitted to more than 1.000.000 visitors per year, focused researchers' attention on the implementation of a kind of air ventilation solution for the preservation of the statue from the action of indoor pollutants. The proposal carried out is related to an air curtain protection system designed by CITERA of the Faculty of Architecture Valle Giulia in Rome [1] with the support of a CFD tool, in order to generate stable environmental conditions near the marble surfaces. The simulation results state that the injection from the bottom of the statue of air with low value of velocity (1m/s), with controlled relative humidity, and cleaned by a highly efficient filtering section, would not have any kind of decaying effect on the marble of the statue. Nevertheless at the suggestion of the Management of the Museum a study of long term decay phenomena on marble was undertaken in order to evaluate any new risk which might arise from the presence of pollutants in the air flux surrounding the surface of the statue.
A certain number of CFD simulations characterized by the Tulsa model of erosion are provided [2] in order to assess long term effects of the impingement on marble surfaces (see table 1).

Particle concentration (Kg/s)	ER average on front surface (kg/m^2s)	ER average on rear surface (kg/m^2s)
$1.500e^{-7}$	$5.85\ e^{-11}$	$6.86\ e^{-12}$
$0.750e^{-7}$	$3.01\ e^{-11}$	$1.64\ e^{-11}$
$0.325e^{-7}$	$1.47\ e^{-11}$	$6.87\ e^{-12}$

Table 1: Erosion generated by exposure to an airflow with different concentrations of pollutants.

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Notes

Different finishes of plasters - Importance for particle deposition

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Keywords: *plasters, friction velocity, particle deposition rate, churches*

Introduction

Soiling of surfaces in churches by deposition of particles is a common problem. Working the surface of a church wall can be done in different ways depending on the wanted appearance of the wall. It gives a certain visual structure to the plaster but the working on the surface will also generate a (geometrical) unevenness. The latter is important with respect to particle deposition. The degree of the unevenness of the surface is dependent on the tool used. It is known that with increasing roughness the particle deposition increases [1]. The degree of interaction between the surface and the flow is quantified by the so called friction velocity. There are theoretical models [2] that require only friction velocity to calculate particle deposition onto rough walls**.** This is the basis for the present work. The friction velocity is determined experimentally and then the deposition rate is assessed theoretically.

Abstract

Three samples of surfaces of lime plaster were prepared by a skilled masonry and were finished by three different methods; wood float finish, steel float finish and brushed finish. Each sample was placed on the table of the test rig (see figure 1).

Figure 1: Left; the table where the samples were placed. Right; the nozzle from which air was blown over the plastered surfaces.

The vertical velocity profile was recorded with a hot wire. The measurements started a few tenths of millimetres above the surface. Close to the surface the velocity profile is linear and from the slope of this part the friction velocity is obtained.
The properties of the different finishing methods were quantified qualitatively by taking photos with a Scanning Electron Microscopy instrument. The geometrical unevenness was also recorded.

The work is currently in progress.

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Problems and applications in practice & Preventive measures

Waldseemüller 1507 World Map encasement
at the Library of Congress, © France

Notes

Assessing and monitoring visual storage environments

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Keywords: *visual storage, environmental monitoring, anoxic, cultural heritage*

Abstract

Monitoring anoxic and controlled environments in visual storage encasements [1] to assess the environment and air quality poses new challenges for cultural heritage institutions. Since the mid 20th century cases with anoxic and relative humidity controlled microclimates have been utilized to retard the deterioration of artefacts. These include both active and passive systems in a range of cases: including the Getty Conservation Institute for the Royal Mummies Collection in Cairo; the US National Archives for the Charters of Freedom and Magna Carta [2]; and the Library of Congress for Top Treasures.

While there has been significant development of anoxic and hermetically sealed cases over the past 50 years sensor technology has advanced as a critical component, but these advances have not always been directly applicable to the needs of cultural heritage. Sensors measuring a variety of environmental parameters are critical for long-term monitoring of encasements to ensure stable conditions are maintained to preserve significant items of cultural heritage. Size appropriate, accurate and effective sensors for monitoring parameters are important factors in the design, development and fabrication of an effective visual storage system, and the challenges of locating and adapting the appropriate sensors needs to be more effectively integrated with encasement design and construction. Since the mid-1970s, there have been changes in many of the parameters associated with cases, including control of relative humidity and/or oxygen, gases utilized to create an anoxic environment, and advances and changes in case materials, design and construction. The development of monitoring technologies, sensors and their integration into information technology systems with system alerts and notifications require collaboration with a range of professionals outside the preservation community, including information management, software, communications, and security, not to mention building management and collection care.

An example of a recent anoxic visual display encasement cases is that of the large Waldseemüller 1507 World Map encasement at the Library of Congress. The encasement has been constantly monitored for two years in real-time for a range of environmental parameters critical to preservation of the map and maintenance of a well-controlled passive system. Extensive research went into the design, construction, leakage parameters and sustainability of the encasement for long-term exhibition. Just as critical was the development and operation of the monitors to ensure the integrity of the anoxic environment, the case and the map. Monitoring a variety of parameters over a period of two years has revealed an effective hermetic seal (with a potential lifespan of 150 years), stable case conditions, and also highlighted the challenges of integrating a sophisticated system into existing institutional IT systems and technology policy.

Decisions made in case construction, design and the materials chosen can have a dramatic impact on the properties of the encasement. Establishing protocols for sensors and the monitoring system are significant factors in the success and continued maintenance of a passive visual display system. The ability to monitor the operation of the case over time to determine the leakage rate and weaknesses is critical to understanding the effectiveness of the encasement in ensuring the required conditions are maintained. This requires effective integration with information systems to capitalize on the data available from the monitoring systems directly and remotely.

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Notes

Conservation design of a new storage building at ASTRA Museum in Sibiu, Romania

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Keywords: *storage, conservation design, preventive conservation, climate simulation*

Introduction

In April 2009 ASTRA Museum in Sibiu, Romania, received a grant of almost 3 million Euros through EEA Financial Mechanism in order to enhance the degree of heritage conservation, this including the building of new storages and conservation studios. The paper presents the development of the funding project and the preventive conservation aspects of the building design. Computer simulations of the climate in the designed storages were performed by the specialist team of the National Museum of Denmark, based on the climate monitoring performed by INOE in 2007-2009. Accordingly, if proposed building design is respected and the construction is airtight enough, temperature and relative humidity of the fully loaded storages will be within safe conservation limits for most of the year.

Abstract

ASTRA Museum in Sibiu, Romania, is responsible for about 60.000 objects and 300 vernacular monuments. Objects are spread in 7 different storage locations. Poor conditions in most of the storages resulted in the frequent need for treatment of the objects and were proved through the monitoring performed by INOE beginning with March 2007. The most promising solution for the problem was the design of a new storage building, which was first drafted in the final paper of arch. Silviu Popa, then further developed through a feasibility study by SC ARHIGRAF SRL architectural design office. This study served as the base of a successful funding project coordinated by Adriana Avram and submitted to EEA Financial Mechanism. In the risk assessment, cost-benefit analysis and in the conservation design of the building the preventive conservation events of year 2007 in Sibiu (ICCROM-ICN-CCI course: Reducing Risks to Collections, June 18-July 6; International Conference: Directions in Preventive Conservation, September 25-29) turned to be very helpful.
Building, climate, placement and traffic of objects, lighting, security, dehumidification and ventilation were all planned in order to best serve preventive conservation purposes of the hosted collections at sustainable costs.

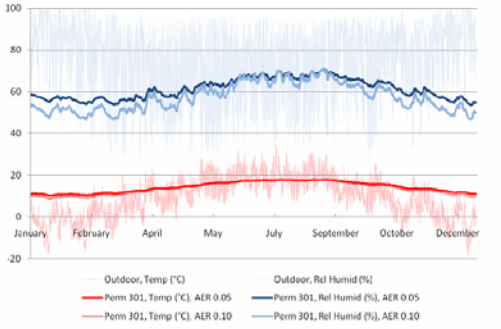

Figure 1: The simulated climate in the fully loaded permanent storage room at the air exchange rate 0.05 per hour and 0.1 per hour; in the background the monitored outdoor conditions [1].

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Notes

Indoor air quality survey in selected Jordanian museums, storages and archives

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Keywords: *indoor air quality, monitoring*

Introduction

This study seeks to identify suitable local environmental conditions for the objects displayed at selected museums in Jordan using the appropriate methods which will contribute to the stabilization of these objects.
In this study we selected eight museums, the main warehouse storage and the Department of Antiquities archive in Jordan, to examine how far these museums conform to recommended conditions and international standards for housing such valuable collections, through environmental reactivity monitoring method.

Abstract preparation

An air quality survey of ten museums, storages and archives in Jordan was performed over a period of seven months using Environmental Reactivity Coupons (ERCs) supplied by Purafil, Inc. (Doraville, Georgia, USA). The results will be used to determine the relative risk levels of the outdoor and indoor environments towards artwork, historical artefacts, books, archival materials, and other objects being exhibited or stored in these locations. Overall the results indicate that the outdoor air presents an extremely high risk to the collections from the introduction of gaseous pollutants. Indoor reactivity levels are lower, with some areas showing an elevated risk level due to the presence or active sulphur and/or inorganic chlorine contamination.

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Notes

Portable air cleaners in churches - efficiency and practicability

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Keywords: *air cleaner, precipitator, particles, churches*

Introduction

In many churches, indoor surface soiling due to deposition of airborne particles is of great concern. One way to diminish this problem might be to install portable air cleaners that reduce the particle concentration in the indoor air. Commercially available electrostatic air cleaners now exist that possibly are efficient and silent enough to be used in churches and similar buildings. A theoretical and practical investigation in this regard is presented here.

Abstract

Prior to testing air cleaners in a 19th century Swedish stone church, a theoretical calculation of required air cleaner capacity was performed in line with the theoretical background given by e.g. [1]. These calculations needed an estimate of the air change rate in the church. Previous tracer gas measurements during winter conditions yielded an air change rate of about 0.1h^{-1} in the church in question, which appears to be a realistic value for this kind of churches, being naturally ventilated through a variety of unintentional leakage interstices in the building envelope. The interior volume of the church is about 6500m^3. Using these data as input, the required Clean Air Delivery Rate (CADR) of air cleaners was calculated to be about 5200m^3/h in order to achieve an 80% reduction in indoor concentration of particles of about 0.1-1µm in size. For smaller and, especially, larger particles the reduction can be expected to be lower due to higher deposition rate of these particles.
In a previous study [2], portable electrostatic air cleaners were found to work well in classrooms, yielding good air cleaning and causing only little noise. Air cleaners of this kind is about to be tested also in the above mentioned church. These air cleaners are of size H×W×D = 1.3×0.5×0.5m and have a capacity of about CADR=650m^3/h each, suggesting a need for eight such air cleaners to achieve the desired 5200m^3/h. This indicates that the air cleaner capacity required to obtain significant air cleaning in churches is not unrealistic to realize in practice. The functioning in a real church is soon about to be tested, and the results will be presented in the final paper.

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Posters

List of posters

Topic 1 - Theme of the conference (research in IAQ put into practice?)

Main author(s)	Institution	Title
J. Havermans	Netherlands Organisation for Applied Scientific Research, Built Environment and Geosciences, Delft, NL	The COST D42 network: impact and challenges

Topic 2 - Analysis

Main author(s)	Institution	Title
L. Darchuk et al.	University of Antwerp, Department of Chemistry (MiTAC), BE	Dust in showcases: complementary study by EPMA and micro-Raman techniques in the Plantin-Moretus museum
M. Ferm and E. Bloom	IVL Swedish Environmental Research Institute, Gothenburg, SE	Use of diffusive sampling in museums and archives
Y-S. Kim et al.	University of Hanyang, Institute of Environmental and Industrial Medicine, Hanyang, KR	1. Identification of hazardous physical factors and chemical pollutants in museums 2. Distribution of concentration for airborne microorganisms in museums
B. Krupinska et al.	University of Antwerp, Antwerp, BE	Seasonal changes in particulate matter concentration and composition in the Plantin Moretus Museum in Antwerp, Belgium
S. Lopez-Aparicio et al.	Norwegian Institute for Air Research, Kjeller, NO	Indoor air quality in the Baroque Hall of the National Library in Prague – Preliminary results
M. Mattson et al.	University of Gävle, Department Technology and Built Environment, Gävle, SE	Tracer gas techniques for quantifying the air change rate in churches – field investigations
A.C. Pinheiro et al.	New University of Lisbon, Faculty of Sciences and Technology, Lisbon, PT	Indoor air quality in Portuguese archives: focus on fungi
M. Ryhl-Svendsen et al.	National Museum of Denmark, Lyngby,DK	The air quality inside the showcase containing the remains of the Danish King St. Knud the Holy (+AD 1086)
J. Smolik et al.	Institute of Chemical Process Fundamentals AS CR, Laboratory of Aerosol Chemistry and Physics, Prague, CZ	Airborne particles in the Baroque hall of the National Library in Prague
I. Spulber et al.	University College London, Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, UK	Wireless sensor networks for VOC monitoring in museum environments
M. Tsukada and J. Arslanoglu	The Metropolitan Museum of Art, Department of Scientific Research, New York, USA	Comparison of SPME fibers and Magic Chemisorber™ as the solid phase extraction component in VOC analysis in display cases

Topic 3 - Interaction of air pollutants and objects

Main author(s)	Institution	Title
A. Cavicchioli et al.	University of São Paulo, School of Arts, Sciences and Humanities, São Paulo, BZ	Simple and low-cost climatic chambers for studying the effect of microenvironments on cultural heritage materials

Topic 4 - Analysis & Interaction of air pollutants and objects

Main author(s)	Institution	Title
C. Santos et al.	University of Coimbra Chemistry Department, Coimbra, PT	Simple characterization of VOC's in storage cabinets of lead seals
M. Torge et al.	Federal Institute for Materials Research and Testing, Berlin, DE	Reduction of mercury emission from historic tin-mercury mirrors

Topic 5 - problems and applications in practice & preventive measures

Main author(s)	Institution	Title
R. Alghazawi et al.	University of Leiden, Faculty of Archaeology, Leiden, NL	Recent advances in museums environment
S. Della Ferrera et al.	University of Urbino Carlo Bo, Institute of Chemical Science, Urbino, I	The crypt of Saint Decenzio in Pesaro (11th century): indoor microclimate monitoring for conservation purposes
K. Doubravova et al.	Institute of Chemical Technology Prague, Prague, CZ	UV protective coating systems
G. Günes and Z. Dörtbudak	Koç University School of Nursing, Istanbul, TR	Occupational respiratory symptoms in museums, archives and library workers: A cross-sectional survey
S. Hong et al.	University College London, Centre for Sustainable Heritage, The Bartlett School of Graduate Studies, London, UK	Monitoring and modeling the storage environment at The National Archives, Kew, UK
J. Hutchings and K. Kollandsrud	University of Oslo, Conservation Studies, Museum of Cultural History, Oslo, NO	Assessing the impact of the museum environment on polychrome sculpture and frontals in the Museum of Cultural History (Oslo)
T-P. Nguyen et al.	National Library of France, Scientific and Technical Laboratory, Paris, FR	DECAGRAPH : Early detection of biological and chemical contaminants of paper based cultural heritage
M. Skrdlantova et al.	Institute of Chemical Technology Prague, Prague, CZ	Verification of conditions for appropriate storage of dyed cellulosic textiles

Notes:
- in the tables above, and when needed, the author attending IAQ2010 is underlined,
- in the following abstracts, and when needed, the corresponding author is underlined.

Notes

The COST D42 network: Impact and challenges

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Keywords: *networking, COST, indoor air quality*

Introduction

The conservation of cultural heritage is a duty for all nations for ethical reasons. Only very slowly are decision- makers starting to understand that caring about cultural heritage and especially about museum, library and archive collections is also a valuable long-term investment for their economy and is in the interest of their citizens. The quality of the indoor environment is crucial for the preservation of a collection. Sensitive materials displayed in an aggressive environment may suffer from chemical attack of pollutants, leading to irreversible damage within only a few weeks of inappropriate exposure. Environmental monitoring campaigns in storage rooms, galleries, display cases and libraries are performed, wherever skilled staff and sufficient resources are available. The interpretation of results on the impact of pollutants on the degradation of artefacts (in combination with other environmental parameters, such as humidity and temperature) and consequently, any appropriate measure to prevent damage requires a close collaboration between multidisciplinary key players: chemists concerned with environmental effects and material degradation, conservators, conservation scientists, art historians, curators, environmental engineers, display case manufacturers, and even politicians and decision makers concerned with international standards.

Abstract

Members of COST Action D42, ENVIART, explore chemical interactions between cultural artefacts and typical indoor environmental conditions through field studies and laboratory experiments and transfer the results into preventive conservation practice. The Action focuses on the chemical impact of pollutants on materials, thus also considering physical and environmental aspects, materials technology, chemical analysis, emission and harmonisation. Within the team there are 3 active working groups (WG): (1) on preservation (2) on Analysis and (3) on Guidelines. The last one cooperates with the European standardisation body CEN (TC346). WG 1 has two focus areas: degradation & stabilisation and prevention to understand changes in the chemistry of the object due to the environment. Since the strategic conference in Ohrid (2007), outdated experimental techniques have been improved. Subjects such as the role of light and indoor chemistry and how to evaluate materials were studied including modelling outdoor and indoor air. Improvements were established in the field of display cases and the role of microclimate and control methods as anoxic environments. Analysis (WG2) of heritage materials and environments is challenging as we are dealing with complex systems. COST has organized workshops and training schools to discuss indoor air chemistry and non-destructive characterization of material changes. The state-of-the-art was discussed at the recent workshop on NIR/chemometrics for cultural heritage and a Workshop on environmental analysis. It is important to mention the role of industry, as companies have been closely involved in the workshop on NIR/chemometrics for cultural heritage and have launched their products and services. Other innovative tools are being developed for the analysis of the chemical composition of indoor air and studies are being undertaken of the stability of inks used for labels in natural history collections and volatile degradation compounds and their role in long-term preservation and identification of heritage materials. The cooperation of WG3 on the harmonisation of methods and storage and health with CEN TC346 'WG4-Environment' is proving fruitful. Recently 2 prEN standards have been adopted to conclude: on measuring the air and surface temperature and on limitations of T and RH. And items on specification for light and lighting for exhibitions of art and artworks are under construction. Serious interest is being shown by non COST countries such as USA and Jordan. One important working item is the description of environmental conditions for storage and exhibition, as many materials do behave differently and this is being continued for at least another year. The impact of the ENVIART network will be shown by means of discussing case studies. A final conference will be organized in Dublin, 8-9 November 2010.

Acknowledgement

The European Commission, the European science foundation and COST office are acknowledged for making this network possible. All D42 members are acknowledged for their contribution.

Notes

Dust in showcases: complementary study by EPMA and micro-Raman techniques in the Plantin-Moretus museum

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Keywords: *pollutant particles, museum, EPMA, micro-Raman spectroscopy*

Introduction

Airborne pollutants have adverse effects on cultural heritage objects. Some of these pollutants encountered in indoor atmospheres have their main sources in the outdoor environment and enter the indoor environment mainly via air exchange. In contrast there are other pollutants mainly produced indoors.
The main subject of interest in this study was the influence of dry deposited particles on works of art exposed in exhibition galleries and in showcases. Analysis of indoor pollutant particles were carried out in the Plantin-Moretus museum in the city of Antwerp, Belgium. The museum owns precious collections of old printed books and historic typographical material and was put, in 2005, on the list of UNESCO World Heritage Sites.

Abstract

For the passive collection of dry deposited particles, Ag-substrate plates were used. The samples were placed in exhibition galleries and showcases for a period of 1 year. The elemental analysis was carried out by electron probe microanalysis (EPMA, JEOL 733, Tokyo, Japan, www.jeol.com) equipped with an ultra-thin window Si (Li) detector. To study the molecular composition of the pollutant particles micro-Raman spectroscopy (MRS) was applied: a continuous laser beam was focused on the sample via microscope objectives. MRS measurements were carried out with a Renishaw InVia micro-Raman spectrometer (Renishaw, Wotton-under-Edge, UK) coupled with a Peltier cooled CCD detector. Laser excitation at 785 nm, in the range between 100 and 3200cm^{-1} with a spectral resolution of 2cm^{-1} was used. The results obtained show that fine particulate matter is introduced into the museum by the outdoor air. It is also produced indoors by deterioration and maintaining of the building and visitors. Different types of particles were detected: quartz, calcite, sulphate-, nitrate- and Fe- containing particles (see figure 1).

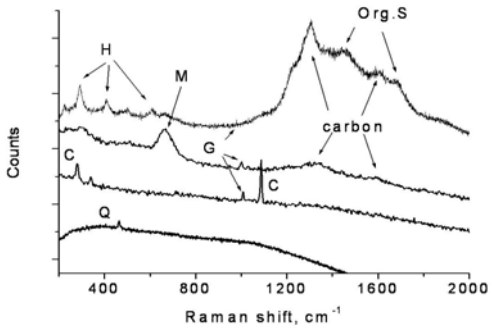

Figure 1: Raman spectra of the single particles.
H – haematite, M- magnetite, Q – quartz, C – calcite, G - gypsum, Org.S. – organic substances.

Some of these particles can be considered as threats to artworks as they are hygroscopic and water soluble.
The sampling of pollutant particles with Ag-substrate plates with subsequent micro-analysis of the samples gives valuable results for the assessment of the threatening of artworks by air pollutants. The chosen approach to combine various sampling and analytical methods for different components of the particulate matter seems to deliver a comprehensive picture concerning the pollutants in museum showcases.

Notes

Use of diffusive sampling in museums and archives

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Keywords: *diffusive sampling, indoor air quality*

Introduction

The Swedish Environmental Research Institute (IVL) has run networks using diffusive samplers in urban air since 1985 and in background air since 1990. The technique has many advantages such as, no electricity requirement, samplers are small and light-weight, no field calibration or technical personnel is needed at the sampling site, which avoids restrictions in the choice of sampling sites. Diffusive sampling is also ideal for indoor sampling especially in museums, because sampling is silent, and can be performed inconspicuously with discretion [1]. Long-term integrative techniques are advantageous for sampling around objects of cultural heritage. The time resolution needed for atmospheric corrosion data is almost always more than a month, often a year, and the use of sophisticated and expensive instruments for real-time measurements is therefore not necessary.

Abstract

IVLs badge type samplers are fully based on the theory which implies that experimentally determined uptake rates do not have to be used which is a great advantage [2]. IVL has developed samplers for NH_3, SO_2, HCl, Cl_2, HF, HCOOH, CH_3COOH, NO, NO_2, HNO_3, O_3 and Hg (see www.diffusivesampling.ivl.se).
Mould growth is an increasing problem in churches and cultural heritage buildings in Sweden. The renovation cost for one single church have in one instance reached beyond a staggering 2 million EUR. IVL Swedish Environmental Research Institute has initiated a research project funded by The Church of Sweden and The Swedish National Heritage Board. In the project the macro-and micro-climate around and in four churches in relation to building construction and physical properties are studied. In addition, mould damage in the church buildings are documented, and organic acids and their potential degradation effect measured.

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Notes

Identification of hazardous physical factors and chemical pollutants in museums

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Keywords: *cultural heritage, exhibit hall, storage, conservation environment*

Introduction

The purpose of this study is to identify hazardous physical factors and chemical air pollutants in museums in order to protect the cultural heritage.

Abstract

We collected and re-analyzed the articles that were published from 2006 to 2007 by the National Research Institute of Cultural Heritage for temperature, relative humidity and the level of pollutants (PM_{10}, CO_2, HCHO, CO, NO_2, Rn, TVOCs, O_3, SO_2) in exhibition hall and storage in museums. The pooled average level of temperature at exhibition and storage in museum was 23.5±1.4°C and 20.6±1.1°C, respectively. The range of temperature variation was 5.4°C for exhibition hall and 4.5°C for storage. The pooled average concentration of TVOCs in exhibition hall and storage in museum was 493.6±125.6μg/m^3 and 788.9±157.5μg/m^3 respectively. These exceeded 400μg/m^3 which is the guideline of national law for the Korean Ministry of Public Administration and Security (KMOPAS). Other surveyed pollutants were as per the guidelines of the national law for the Korean Ministry of Environment (KMOE) and the KMOPAS. Through the consideration of the physical and chemical properties and the result of meta-analysis for thermal environment and surveyed temperature, humidity, PM_{10}. NO_2, SO_2, O_3, TVOCs, and HCHO were the identified hazardous physical factors and chemical pollutants at exhibition halls and storages in museums.

References

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Notes

Distribution of concentration for airborne microorganisms in museums

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Keywords: *museum, exhibition hall, storage, bacteria, fungi*

Introduction

The aims of this study are to examine the concentration and identification of airborne organisms in exhibition halls and storage areas in museums and to provide fundamental data to protect cultural assets from damage.

Abstract

This study surveyed the concentration of airborne bacteria and fungi at exhibition halls and storage areas in museums located in 4 cities from July to October, 2007 and literature data on airborne microbes of museums in Korea that were published in relevant Korean journals. The concentrations of airborne bacteria and fungi were higher in exhibition areas than those in storage. The bacteria Pseudomonas spp. and Bacillus spp and fungi Aspergillus spp. and Penicillium spp. were occurred mainly in museums. The overall average concentration of airborne bacteria in museums was 34.2±10.1CFU/m^3 for exhibition halls and 17.2±10.0CFU/m^3 for storage areas respectively. The overall average concentration of airborne fungi in museums was 26.0±11.2 CFU/m^3 for exhibition halls and 16.6±11.0CFU/m^3 for storage areas, respectively.

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Notes

Seasonal changes in particulate matter concentration and composition in the Plantin Moretus Museum in Antwerp, Belgium

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Keywords: *indoor air quality, cultural heritage, particulate matter, XRF analysis*

Introduction

Officina Plantiniana was one of the first printing offices in Europe, nowadays turned into Plantin Moretus Museum in Antwerp, Belgium. Its rich collection of typographical material, old books and manuscripts is vulnerable to the atmospheric pollution and can be chemically damaged. The assessment of air quality inside the museum is thus necessary to reveal the main dangers during storing and exhibiting the objects.

Abstract

Four consecutive sampling campaigns were performed in 4 seasons during one year. Impactors of Harvard-type were used for collecting bulk particulate matter (PM2.5 and PM10) on Teflon® membrane filters for 24 hours, for a period of 7 consecutive days during each sampling campaign. Filters were weighed before and after use to determine the weight of collected matter, for further calculation of PM concentrations. The quantitative elemental bulk analysis was performed by energy dispersive X-ray fluorescence. The measurement procedure and the data quantification process are described elsewhere [1].
Concentrations of PM2.5 and PM10 (summarized in Table 1) were significantly lower inside than outside the museum, on average 40 to 60%. The averages of weekly concentrations inside the museum were comparable for all seasons, while the outdoor ones varied considerably, indicating that the indoor/outdoor air exchange differs strongly depending on the season. Additionally, the proportion of PM2.5 in the PM10 fraction was significantly lower outdoors, approximately 76%, while indoors it was 84%. The daily changes of the PM2.5 and PM10 showed a clear trend. The concentrations were found the lowest on Monday when the museum is closed and the highest from Tuesday till Thursday, when there are groups of visitors. The elemental concentrations were observed to be generally higher outside than inside the museum. However, the indoor PM2.5 concentration of four significant elements: aluminium, silicon, calcium and iron, in the autumn and winter, were very similar or even slightly higher than the outdoor PM2.5 concentrations. The contribution of sulphur in the PM2.5 compared to PM10 varies from 88% to 100%. The differences in the sulphur concentrations between outside and inside were very small, and therefore sulphur can be regarded as one of the most common elements in the museum.

Season	Outside		Printing room – ground floor		Rubens room – 1st floor	
	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10
Autumn 2008	24.0	32.7	12.8	15.6	13.3	15.8
Winter 2009	27.1	36.0	13.9	16.2	14.4	16.5
Spring 2009	30.3	37.7	12.0	14.1	12.7	14.9
Summer 2009	21.3	28.2	14.0	15.9	12.8	17.6

Table 1: Average PM concentrations in different locations and seasons [µg/m^3].

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Notes

Indoor air quality in the Baroque Hall of the National Library in Prague - Preliminary results

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Keywords: *library, air quality evaluation*

Introduction

Preliminary results from one year measurement campaign in the Baroque Hall of the National Library in Prague will be presented. The environmental characterization and assessment will focus in both outdoor and indoor generated pollutants in relation to the preservation of books and manuscripts.

Abstract

The object of interest is The Baroque Hall of the National Library in Prague (Clementinum Historical Complex), and in particular its environment and possible harmful agents therein. In order to assess the indoor environment concerning the preservation of books and manuscripts, a measurement campaign was designed and is currently ongoing. The measurements are performed during one year in two locations (indoors and outdoors) whereas four additional indoor locations were selected for sampling in two contrasting seasons, summer and winter. The environmental assessment will be based on the results obtained by dosimetry, pollutant concentrations obtained by passive gas samplers (NO_2, O_3, SO_2, acetic and formic acids, HNO_3, NH_3) and the chemical characterization of size-resolved particulate matter.
Preliminary results obtained by dosimetry and passive gas samplers for individual pollutants both indoors and outdoors will be presented and discussed. The results show high concentration of indoor generated pollutants such as acetic and formic acids in the Baroque Library Hall, and slightly high concentration of outdoor generated pollutants which are infiltrated into the library.

Acknowledgement

This study was made possible thanks to the financial support of “Norway Grants” (A/CZ0046/2/0001).

Notes

Tracer gas techniques for quantifying the air change rate in churches - field investigations

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Keywords: *tracer gas, air change rate, churches*

Introduction

The air change rate is a critical quantity as regards the air quality and energy consumption in buildings, including churches. Many churches belong to a category of buildings where, in addition, indoor surface soiling is of great concern, and the air change rate is crucial also in this regard; it determines the infiltration rate of soiling contaminants from outdoor air as well as the dilution rate of contaminants generated indoors. The air change rate can however be tricky to measure in ancient churches and similar large and naturally ventilated buildings, where the air inlets and outlets usually consist of a variety of accidental cracks in the building envelope. Often the only way to measure the air change rate is to use some kind of tracer gas technique. These techniques are relatively unproblematic if the injected tracer gas gets well mixed into a homogeneous concentration in the measured space. However it seems likely that this criterion often can not be met in churches, which constitute large volumes where the air movements are often slow. The present study deals with practical experience in this regard for two tracer gas techniques: the *decay method* (or tracer gas dilution method, [1]) and a *passive tracer gas method* [2]. Also the possibilities of using "natural" interior emissions of carbon dioxide, CO_2, as tracer gas are dealt with.

Abstract

Air change measurements were performed in fairly large 19th century Swedish stone churches. The churches were naturally ventilated and electrically heated by radiators along the walls as well as by bench heaters. By measuring at different times of the year, different heating situations were studied. For the decay method, a gas analyser (Brüel & Kjaer 1302) was used to measure the tracer gas concentration at, usually, six measuring points distributed both horizontally and vertically in the church space. As tracer gas, SF_6 and, occasionally, CO_2 were used. The SF_6 was distributed manually directly from a gas bottle, whereas the CO_2 was emitted by the visitors and candles burning during the service. In the passive method, two different tracer gas sources were placed at two different locations within the church, and three week integrated sampling gave long time average data.
The study is ongoing, but so far it seems that the air in the studied churches tends to be fairly well mixed when the churches are heated, presumably due to strong natural convection air currents occurring at the heat sources. It seems that both the decay and the passive method are fairly easy to apply when the church is heated. At such times it does not seem to matter much where the tracer gas is injected or where it is sampled. Preliminary data indicates that "naturally" emitted CO_2 can be used as a tracer gas when the church is heated thus further facilitating use of the decay technique. When no heating was in operation, however, spatial differences in tracer gas concentrations were observed, making tracer gas measurements more difficult to obtain.

References

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Notes

Indoor air quality in Portuguese archives: focus on fungi

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Keywords: *indoor air quality, archives, fungi*

Introduction

This project aims to assess the indoor air quality in archives with a particular emphasis on fungal development. Regarding fungal identification, the techniques used in this approach include both traditional culturing methods and modern molecular biology and, in this field, an especially recent system which allows the resolution of DNA from mixed populations - as those existing in an Archive environment and will include a chemical and physical parameters analysis of the environment surrounding both documents and workers.

Abstract

Fungi can pose a threat to both human and cultural heritage. In documents, fungi are considered responsible for the formation of foxing spots and the general degradation of written heritage. Nevertheless, the complete study of these fungal communities is still giving its first steps since only now molecular techniques are being used [1]. The main goal of this project is to develop a standard procedure for the identification of biological fungal communities present on the cultural written heritage stored in archives. To identify them a culture independent technique - DHPLC – is being perfected. This method allows separation of PCR products using an ion-pair reversed-phase high performance liquid chromatography and has offered exceptional advantages when it comes to the identification and isolation of bacteria and yeasts from complex microbial communities [2].

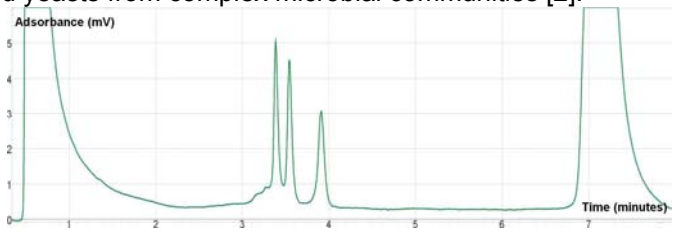

Figure 1: DHPLC chromatogram of a mixture of three fungi extracted and amplified. Conditions: DNASep Cartridge 0.9mL/min, wave optimized buffers A and B, gradient 59% at 57ºC.

DHPLC is applied to fungal communities in two types of samples: environmental samples collected from the air and surfaces in the archives and swabs collected from the documents. Collecting both types of samples enables to study the relation between the air quality of archives and the fungi strains found on documents and allowing also a risk assessment for the people who work in these settings, a study of epidemiological relevance. When compared to the traditional culturing methods, this technique also allows the identification of non-viable fungi, which may have caused the foxing in the past and may still be responsible for allergic reactions in those in contact with these documents. The air of the archives involving both documents and workers/readers will also be submitted to a chemical and physical analysis wherein the main contaminants will be measured and evaluated from a conservation and a public health point of view.

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Notes

The air quality inside the showcase containing the remains of the Danish King St. Knud (II) the Holy (+AD 1086)

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Keywords: *showcase, coffin, church, internal air pollution*

Abstract

King Canute was the last Danish king to plan a full scale invasion of England. After being killed by angry rebels in front of the altar of the church in Odense in AD 1086, the body of the king was interred in the graveyard together with several of his men. Here he rested for about 10 years. His bones were transferred to the church where they were placed in a wooden coffin decorated with precious stones and already in AD 1100 he was made a saint. At the time of the protestant reformation in Denmark in AD 1536 the wooden coffin holding the remains of the king was deposited in a hiding place in the choir. In 1833 the coffin was brought to light and displayed in the church. In 1874 the wooden coffin was placed inside a metal and glass showcase, where it has been kept to this day, i.e. some 135 years. It contains his bones as well as several textiles and the wooden 10th century coffin.
We have investigated the climate and air quality in the church and inside the showcase, by means of electronic temperature and relative humidity data loggers, and passive sampling of pollutants. The main pollutant component inside the showcase was acetic acid, which was found in excess of 1400µgm^{-3}. Monoterpenes and phenoxy derivatives were also detected. While the showcase contained internally generated compounds in high concentrations, at the same time it retarded external pollutants from entering as the showcase was fairly airtight. Ozone, which was present inside the church itself at about 5µgm^{-3}, was below the limit of detection (0.04µgm^{-3}) inside the showcase. The air exchange rate between the showcase and the church itself was 0.8 per day. The temperature inside the showcase largely followed room conditions; however, the relative humidity was stable as it was heavily buffered due to the large amount of wood in the coffin and the low air exchange rate of the showcase.
We find that a viable interpretation is that the acetic acid is derived from degassing of the oak tree from which the coffin was made, the monoterpenes from resin in pine wood, and the phenoxy derivatives from the deterioration of lignin. The acetic acid could pose a potential hazard to the textiles and the bones in the coffin.

Reference

Rasmussen K.L. et al. (1997). Integrity and characteristics of the bones of the Danish King St Knud (II) the Holy (+AD 1086), *Journal of Danish Archaeology*, 13, 161-170.

Notes

Airborne particles in the Baroque hall of the National Library in Prague

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Keywords: *indoor aerosol, outdoor aerosol, number size distribution*

Introduction

It is well known that in recent years mass tourism is on the increase. It contributes to the economy by favoring employment. On the other hand, the increasing number of visitors in museums, art galleries, libraries and archives can threaten exhibited artworks. Visitors can increase indoor air pollution through the transport of soil dust and textile fibers [1]. Particulate matter is particularly harmful to artworks because it may cause soiling and chemical damage, depending on its size and chemical composition [2]. The aim of this study was to determine whether and how much visitors influence aerosol concentration in the Baroque library hall.

Abstract

The measurements were carried out during 3 intensive campaigns at different seasons of the year (May 2008, March and July 2009). The measurements included particle number concentrations and size distributions determined by Scanning Mobility Particle Sizer (SMPS 3936, TSI, USA) and Aerodynamic Particle Sizer (APS 3321, TSI, USA). Both instruments sampled alternately from indoors and outdoors, covering the size range 14–20,000nm.
The monitoring of submicron particle concentration (≤ 1μm) versus time showed that visitors did not affect the fine particle concentration and that these particles came most probably from the outdoor environment. During tourist seasons, the indoor concentration of coarse particles (≥ 2.5μm) showed a periodical rise starting at the beginning of opening hours, with maximum achieved at the end of opening hours, followed by subsequent decrease to initial values (see figure 1).

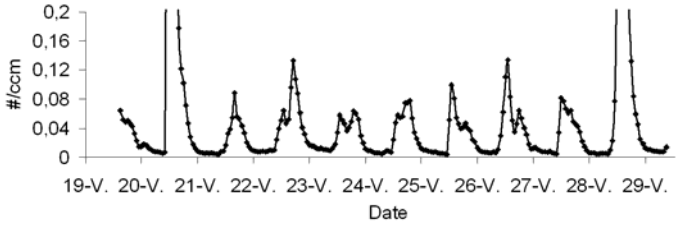

Figure 1: Indoor concentration of particles ≥ 2.5μm versus time, May 2008 campaign.

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Notes

Wireless sensor networks for VOC monitoring in museum environments

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Keywords: *real-time, wireless, formaldehyde, TVOCs*

Introduction

Controlling the levels of volatile organic components (VOCs) and other gaseous pollutants in display and storage environments has long been recognised as important for the preservation of cultural heritage objects, and the importance of monitoring as part of this process is increasingly being recognised. The presence of certain environmental pollutants at ppb (parts per billion) levels has been shown to present risks to artefacts and currently determining the concentrations of such components typically involves sampling and subsequent off-line laboratory-based analysis. This contribution reports on a novel application of a wireless sensor network tailored for continuous, real-time *in-situ* monitoring of formaldehyde and total volatile organic components content (TVOC) in a museum environment.
In this proof-of-concept study, commercially available sensors suitable both for measuring formaldehyde (HCHO) levels and TVOCs content in museum environments and for embedding onto the wireless network platform were identified. The chosen passive formaldehyde sensors and broadband photo ionisation detectors capable of sensing VOCs with ionisation potentials lower than 10.6eV have been successfully integrated onto the network nodes (the sensors complement each other as formaldehyde has a higher ionisation potential and thus is not detected by the TVOCs sensor).
Measurements were conducted at the British Museum in a variety of typical gallery and display case environments. A particular focus has been on display cases with a history of high levels of VOCs and formaldehyde linked to the use of pressed wood inserts used within the case which act as a primary internal source.

Abstract

Daily and weekly profiles of formaldehyde and TVOCs variations were obtained (based on measurements made at 60min intervals). A strong correlation between temperature and concentration was observed for both formaldehyde and TVOCs. Although at this proof-of-concept stage further work is required to fully calibrate and define the characteristics of the sensors, the cyclical nature of the recorded datasets suggests alternative generation and absorption of VOCs on a daily basis may be occurring, along with supply of VOCs by heating systems in winter. The development of discreet, flexible and wireless monitoring systems capable of providing real-time VOC concentrations offers the potential to study such mechanisms as well as a range of other reactions and processes important in the heritage sector. This study has shown that the wireless sensor network has the capacity to provide a valuable tool in monitoring both the short and long-term quality of the museum environments, and improving understanding of the generation and control of environmental pollutants damaging to cultural heritage objects.

Reference

[1] Heritage Intelligence project website: http://www.science4heritage.org/hi/ (accessed 18/01/2010).

Acknowledgement

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Notes

Comparison of SPME fibers and Magic Chemisorber™ as the solid phase extraction component in VOC analysis in display cases

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Keywords: *SPME, Magic Chemisorber™, VOC, thermal desorption GCMS*

Introduction

Solid phase micro-extraction (SPME) combined with GCMS analysis is drawing wide attention in various fields including preservation of cultural heritage, as a simple, quick and easy to operate method for the investigation of trace amounts of volatile organic compounds (VOC). SPME sampling systems are most commonly supplied as fibres coated with a polymeric extraction phase. Another solid phase extraction product, named Magic Chemisorber™ (MC), functions in a similar way as SPME fibres, but provides a thicker film or greater area of extraction phase. In this poster, the authors present a comparison of variously coated SPME fibres and MC as sampling elements for qualitative GCMS analysis of VOC in a museum display case.

Abstract

Commercially available SPME fibres are mostly incorporated in a syringe-type holder which can be introduced directly into a GC injection port where adsorbed samples are thermally desorbed and analyzed by GC or GCMS. The most common SPME fibres supplied by Supelco are 10mm in length and are available in different types of coatings and thicknesses (7-100µm). In contrast, MC, commercially developed by Frontier Laboratories, consists of a titanium tube on which polydimethylsiloxane (PDMS) is chemically bonded to the inner and outer surfaces. It is available in two lengths (6 and 30mm) and two coating thicknesses (100 and 500µm at the outer surface; inner surface coating is ca. 1µm). Thermal desorption of adsorbed samples and their introduction into the GC is suggested to be performed using Frontier Laboratories' pyrolyzer in thermal desorption mode.
In an occasion of air quality assessment within a display case in Metropolitan Museum of Art which presented a strong odour, these two types of sampling components were applied. The source of this odour was suspected to be the materials constructing the case such as wood, fabric and paint. To study the air quality within this display case, sampling with SPME and MC followed by thermal desorption and GCMS analysis was performed. The SPME coating types used were 65µm thick PDMS/divinylbenzene (PDMS/DVB), 85µm Carboxen™/PDMS (CAR/PDMS), 85µm polyacrylate (PA) and 50/30µm DVB-CAR/PDMS, and the MC types used were 6mm tube length with 500µm film thickness (MCS) and 30mm length with 100µm film (MCL100). As the sample extraction conditions and thermal desorption GCMS analysis conditions were different in each type of sampling component, the results were evaluated qualitatively.
Each SPME fibre coating is known to have specific selectivity and sensitivity [1] and the results of this investigation showed the same tendency. DVB-CAR/PDMS provided the largest variety of compounds ranging from various acids and esters to hydrocarbons and benzene derivatives. CAR/PDMS showed similar results to DVB-CAR/PDMS but some esters and ethers were lacking. PA trapped various acids with different carbon numbers, several of which were not detected with DVB-CAR/PDMS and CAR/PDMS. PDMS/DVB showed the least number of peaks, some of which could not be identified. In contrast, both MC which have PDMS as the extraction phase provided many peaks identified as various classes of compounds similarly to DVB-CAR/PDMS, however most of the identified compounds were of relatively apolar classes such as hydrocarbons and ethers. Most significantly many acids such as acetic acid and propionic acid were not detected. MCL100 which has thinner film but greater surface area showed larger abundance than MCS in most peaks, implying that the larger surface area of the coating is more effective in extraction of trace VOC than thicker film.

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Notes

Simple and low-cost climatic chambers for studying the effect of microenvironments on cultural heritage materials

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Keywords: *microenvironments, climatic chambers, automation, cultural heritage*

Introduction

The present contribution aims to describe the construction, operation, potentials and limitations of environmental chambers designed to study the action of temperature, humidity, UV and visible radiation and gaseous pollutants in the degradation of materials under controlled conditions. This apparatus is meant to be easily assembled using low-cost and directly accessible components and to be operated for long periods of time.

Abstract

The system comprises two stainless steel/PTFE compartments (approx. 9L each) whose temperature and relative humidity values are recorded and transmitted to a PC, which stores, plots in real time and continuously feedback heating and humidifying devices through logical signals in order to maintain desired T and RH levels. Designed to be installed in a room kept at, at least, 2-3°C below its set operating temperature, the chamber rapidly exchanges heat and maintains a stable thermal regime by means of heating pulses generated in its interior under software control. The atmosphere inside the chamber, including the content of water vapour and therefore RH, is controlled by a double stream of air that is mixed in a compartment placed before the chamber and kept at the same temperature: a dry and a H_2O-saturated flux, whose ratio is again controlled by the software which activates solenoid valves in the two air channel in response to the actually monitored level of RH, according to a set value. The former stream, coming from a FTIR Purge Gas Generator, should be purified beforehand and then, if required, can be enriched with a target gas (e.g. NOx, SO_2 etc.), e.g. by flowing in a thermostatted compartment containing a permeation tube. The latter is saturated with H_2O in the condensation column standing over a warm water bath (see figure 1). One of the key features of this system is that each independent compartment works under either stationary or cyclic conditions. A borosilicate, or quartz, window allows the irradiation inside the chamber from an external source, as needed.

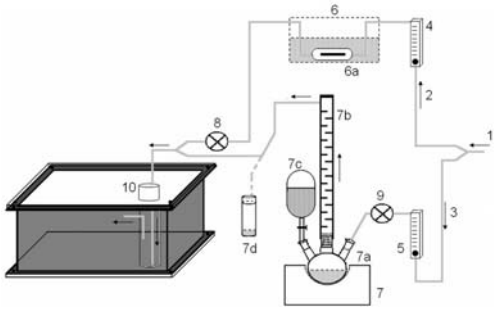

Figure 1: Schematic representation of one of the chambers. 1: dry air inlet; 2: dry air stream; 3: humid air stream; 4: dry air flowmeter; 5: humid air flowmeter; 6: thermostatted device for gas enrichment; 6a: housing for permeation tubes; 7: humidifying system; 7a: round bottom flask partially filled with deionised water and kept at 40 °C; 7b: condensing column; 7c: water replacement bottle; 7d: excess water drain; 8: 2-way solenoid valve for the dry air stream; 9: 2-way solenoid valve for the humid air stream; 10: mixing compartment.

Reference

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Notes

Simple characterization of VOC's in storage cabinets of lead seals

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Keywords: *archive's indoor air quality, characterization of VOC's, lead seals*

Introduction

The corrosion of lead seals appended to parchments is a problem found in many collections of Archives and Museums. The transformation of metallic lead into lead carbonates is the main root to the seal's complete destruction (see figure 1). Some of the reasons responsible for the progression of the corrosion process are known, namely the storage conditions of this type of collection. Typically the documents have been kept in wooden closets using inadequate wrapping papers for too long that promote this degradation. The presence of corrosive organic acids is reckoned as most prejudicial [1] and need to be effectively and quickly analyzed.

Abstract

The lead seals stored at the Archive of the University of Coimbra present different stages of corrosion. Lead is a very susceptible metal to corrosion which is deeply affected by the conditions of relative humidity and temperature. The storage cabinets, along with the document's paper folders emit volatile organic compounds which create microclimates inside the cabinets. Different drawers in the same cabinet have been examined where different levels of lead corrosion were observed. New storage conditions are being monitored in parallel.
The identification and characterization of volatile organic compounds in museum environments has been described in the literature before. The use of solid phase micro-extraction has proven to be a reliable, fast and economical sampling method. However most methods involve complicated sampling procedures [2]. In this work we exposed the fibre directly inside the cabinet's drawers for passive sampling. After the monitoring period inside the cabinet, the fibre was immediately treated and analyzed. The compounds were extracted by solid phase micro-extraction, using a 85µm CAR/PDMS fibre. The identification of the compounds was confirmed by comparison of the retention times of each composition with the pure standard and their characteristic fragmentation. The following parameters have been evaluated: time and temperature of adsorption and time and temperature of desorption. The most abundant volatile organic compounds found inside the wooden cabinets were acetic and formic acids. The identification, separation and quantification of the air components were obtained using gas chromatography (6890 Chromatograph Hewlett Packard (HP)) with mass spectrometry detection (Mass Selective Detector (MSD)).

Figure 1: Corroded lead seal.

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Notes

Reduction of mercury emission from historical tin-mercury mirrors

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Keywords: *mercury emissions, AFS, tin-mercury mirrors*

Introduction

The quantity of mercury emission from historical mirrors has been examined and a technique to decrease these emissions developed. In this abstract we give measurements of the mercury emission carried out under laboratory conditions. The released volatile mercury was trapped in a nitric acid absorption solution and its concentration was determined using cold vapour atomic fluorescence spectrometry (CV-AFS).

Abstract

The study of the mercury emission was performed under laboratory conditions on pieces of reproduced (modern) and historical amalgam mirrors (10 x 10cm^2). The tests took place in a desiccator under accelerated conditions in a climate test chamber at 40°C and a relative humidity of 50%. Mercury emitted by the mirror was absorbed in a 33% nitric acid solution [1]. The concentration of mercury in the nitric acid solution was determined by cold vapour atomic fluorescence spectrometry (CV-AFS). Compared to atomic absorption spectrometry (AAS), which is widely used for the determination of mercury, this analytical method offers a considerably lower detection limit and a larger linear measurement range [2]. Mercury emissions from "modern" tin amalgam mirrors were lower than the emissions from historical mirrors by a factor of approximately 10 under the selected test conditions. It is assumed that the damage provoked by aging processes and the associated corrosion of the tin amalgam layer lead to an increased release of mercury from historical mirrors. Different proposals have been made to decrease mercury emissions from historical and "modern" tin amalgam mirrors. Enclosing the back of the mirror with a layer impermeable to mercury vapour, for example glass, is one possibility. Another possible approach is to bind mercury vapour with an adsorbing material. The suitability and effectiveness of different adsorbents such as iodized activated carbon, Mercurisorb® and gold sputter-coated paper were tested.

Test	Flow rate [L/h]	Hg conc. in 100mL HNO_3[ng]	Hg conc. per litre of air pumped [ng/L]
M	28.0	406,8	2.9
H	30.60	3510.0	22.9
M Au	29.1	4.5	0.03
H Au	26.4	2.7	0.02
H Mer	31.6	13.9	0.09
H JC	31.4	96.9	0.6

M: modern, H: historic, Au: gold absorber, JC: iodized activated carbon, Mer: Mercurisorb®

Table 1: Tests results for mercury emissions from "modern" and historical tin amalgam mirrors with and without absorption materials. Results were obtained with cold vapour atomic fluorescence spectrometry (CV-AFS).

Modern and historical mercury mirrors are distinguished by different mercury emission. The results obtained indicate a deterioration of the amalgam layer of the mirrors under environmental conditions. The best way to reduce the emission rate of mercury into the environment is to use gold sputtered paper as adsorption material that is affixed to the back side of the mirror. A model mirror was produced as a sample for practical application in restoration practice.

References

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Notes

Recent advances in the environment of museums

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Keywords: *indoor environment, monitoring*

Introduction

As many archaeological objects recovered from excavations in Jordan eventually end up on display or in storage at Jordanian museums, it is of vital importance that these museums have the capability to both conserve and preserve these valuable artefacts. The valuable cultural legacy which these artefacts represent is best preserved by museums which correctly handle and properly display them. Therefore a fresh review of the available literature on museum environments could provide information which would further aid the successful development of Jordanian museums.

Abstract

Most museums hold countless artefacts in their custody, which they must curate as inexpensively and efficiently as possible. The importance of storing museum collections in appropriate conditions is reflected by the growth of the literature about museum environments. As more and more priceless artefacts are unearthed, more prevalence of museums world wide is in itself a motivator to exploit the literature review on museum environments. This poster reviews the different approaches to museum environments as a discipline. It also aims to analyze the extent to which Jordanian museums comply with international museum standards, so that they can provide a safe environment for the display and preservation of artefacts.
This study examines the extent to which Jordanian museums conform to recommended conditions and international standards for housing collections. It also looks at whether Jordanian museums have the adequate monitoring and control systems necessary to maintain a standard temperature and RH recommended by international standards.
While reviewing the literature on museum environments, particular attention was paid to articles which could have the greatest benefit for the Jordanian museum system. After taking stock of the present situation of museums in Jordan, several articles were found which described situations which closely resemble characteristics common in Jordan. Suggestions from these articles are deemed to have the greatest benefits for Jordanian museums. Most of the articles handled the topic of indoor environments in general, measuring the indoor relative humidity and temperature, and comparing it with the outside atmosphere to identify the extent to which museum buildings provide an environment suitable for hosting valuable materials within its walls.
Within the literature, the effects of ultraviolet light on organic based materials and the effects of a polluted outdoor environment upon the internal museum environment were under examined. However, it was still evident that most of the susceptible objects displayed in these museums face continuous threats of deterioration due to an uncontrolled environment.
It is recommended that samples of objects which have already deteriorated to some degree be analyzed for the causes of their respective deteriorations. These analyses would provide insight into the rate and severity of expected deterioration of similar objects, as well as methods which could be used to eliminate factors leading to accelerated deterioration.

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Notes

The crypt of Saint Decenzio in Pesaro (11th century): indoor microclimate monitoring for conservation purposes

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***Keywords**: San Decenzio, indoor microclimate monitoring, conservation*

Introduction

The oldest crypt of San Decenzio is located in the public cemetery area of Pesaro, below the Saints Decenzio and Germano church. The crypt was built using recycled Roman Age materials and it consists of four small aisles with eight granite columns and one red marble pillar. The groin vaults are decorated by mural paintings, dating back to the second half of the 11th c. AD. When they were discovered in 1752, the mural paintings were still in good condition. In the 19th c., following the opening of a window, the mural paintings began to fade away. In 1962 the Superintendence of the Urbino Galleries, decided to remove one part of the mural paintings (the Patron Saints Decenzio and Germano) as the plaster was completely wet and to place it in .the Civic Museums of Pesaro. An inspection in 2005 showed that brick walls and vaults were entirely covered by cement plaster which prevented the transpiration of the wall, leading to considerable salt flowering. In 2007 the crypt was restored through the consolidation of mural paintings and the removal of the cement plaster. Today, the crypt still suffers from a high level of relative humidity (RH) and capillary rising damp; this results in major problems to the fabric of the wall paintings some of which are crumbling and hardly readable. Probably the removal of a whitewash layer applied in 19th c. may have further contributed to the damage of the painting layers. In spring the crypt is wet, but historical records report that during the rainy seasons the crypt was completely flooded and for this reason in the 19th c. the floor was raised. Climate conditions have also worsened due to heating by an air-conditioned system and the continuous opening of the windows.

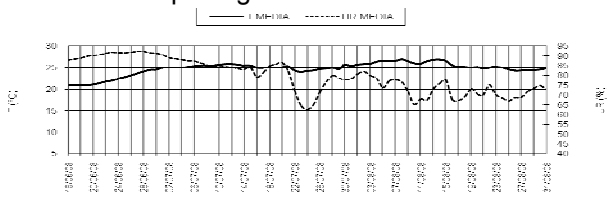

Figure 1: T & RH (UR) monitoring in summer.

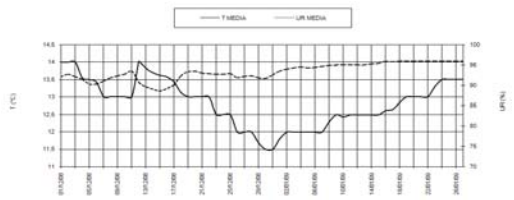

Figure 2: T & RH (UR) monitoring in winter.

Abstract

As a high level of humidity causes irreversible damage to the mural paintings, indoor microclimate monitoring (temperature (T) and RH) was carried out in the crypt from summer 2008 to spring 2009 in order to obtain information on the microclimate variations (T and RH). The data was collected using EasyLog Datalogger (EL-USB-2, RH/TEMP DATA LOGGER, Lascar), a portable measuring instrument set at 5 minute intervals for a total of 288 measurements a day, in order to investigate the seasonal trends and the daily ranges of T and RH.

The results of the microclimatic monitoring (see figures 1 and 2) confirm the critical situation of the indoor environment. In fact, all year long the average humidity is above 60% while the daily variations are over 10%. In particular, during the summer and autumn, daily fluctuations reach 20% while in spring and winter these are considerably lower. Sometimes the average RH is over 90%. The temperature is within the recommended range of minimum 6°C in winter and maximum 25°C in summer. The data have been compared with the D.M. 10/05/2001 (*Technical and scientific criteria and standard operations and development for museums*) which suggests a humidity of 45-60% for mural paintings, a minimum temperature of 6°C in winter and a maximum in summer of 25°C with a daily rise of 1.5°C/h.

The high level of RH registered during the whole monitoring period is closely-related to the contact of the walls with the ground as the crypt is located in the basement.

The microclimate data indicate that the indoor conditions of the crypt are not suitable for the conservation of mural paintings. This study represents the beginning of a preventive conservation campaign that will guarantee the most suitable environment for the oldest crypt in Pesaro and will provide useful data for the initial maintenance and restoration intervention.

Notes

UV protective coating systems

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Keywords: *UV radiation, polymer coatings, degradation*

Introduction

The project whose partial results are given in this poster, deals with the development of polymer protective coatings with an inbuilt UV absorber.

Abstract

The structure and properties of many artworks irreversibly change due to the surrounding environment (variations of temperature and relative humidity, presence of air pollutants, UV radiation etc.) and thus not only their aesthetic value, moreover, their existence are often significantly threatened [1]. In terms of preventive care of collection artefacts, it is therefore important to protect them against all existing adverse effects. One of the most damaging factors is UV radiation, which harms both the materials themselves and the protective surface coatings. This poster presents the results of a project where we studied the influence of UV radiation on the degradation of materials covered or not with new protective coatings. The coatings materials were made of acrylic copolymers with an UV absorber built in polymer macromolecules and a stabilizer as additive (marked A2, B and B2). A standard Paraloid B72 coating was used for comparison of the UV protective effect. Because of its high sensitivity to UV radiation, an epoxy resin was used as a model material to study the protective effect of the coatings. For the determination of the degradation degree the spectrophotometric measurement of the material colour change was used.
In Table 1 the changes of yellowing degree of the epoxy resin during the irradiation by UV light (intensity of irradiation $1Wm^{-2}$) expressed in db* (CIELAB colour space, difference between value b* of the sample before and after each irradiation time, positive values indicate yellowing) is clearly visible.

	db*				
irradiation time [h]	epoxy resin	epoxy resin and Paraloid B72	epoxy resin and sample A2	epoxy resin and sample B	epoxy resin and sample B2
47	16	8	1	3	2
166	26	17	1	4	3
378	32	25	2	8	4
785	36	34	2	7	4
1096	38	36	3	8	5
1432	39	37	3	7	5

Table 1: The results of the colour change measurement.

This work was supported as a grant project of Ministry of Industry and Trade of Czech Republic (2A-2TP1/070 "Functional UV Preservative Coating Systems").

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Notes

Occupational respiratory symptoms in museums, archives and library workers : a cross-sectional survey

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Keywords: *indoor air quality, respiratory symptoms, eye irritation, libraries*

Abstract

We have investigated indoor air quality related respiratory symptoms and job satisfaction in all 88 library, archives and museums in Turkey that have been operational for at least 25 years, with minimum 4 employees. The study sample meeting the selection criteria consisted of 21 institutions, 13 of which were in Istanbul. In a cross-sectional study, we mailed a total of 404 survey questionnaires, job satisfaction [1] and SF-36 Quality of life Scales [2]. Response rate was 66% (N=265). The survey questionnaire contained 70 questions consisting of standardized respiratory symptoms questions, existing disease, environmental factors, smoking, access to health services and demographic and job related information about the respondents. A physical environment evaluation form was also sent to each institution to assess air quality maintenance procedures, building characteristics, existence of mechanized clean air systems, if any, as well as the size and type of the collection. Only 6 out of 13 institutions reported having air conditioning. Humidity control was present in 2, dust control was valid for only 2. While all buildings reportedly had excess dust in shelves, working areas and reading halls, 12 institutions had routine cleaning services ranging from 1-7days per week. Mould and humidity was reportedly a constant problem in 2 buildings. 88 subjects reported eye irritation, 36 reported respiratory symptoms, 31 subjects reported skin irritation that they experienced in the working environment only. Half of the subjects reported nasal symptom in the absence of colds (128). Chi-square tests of the above listed symptoms with various building and work-related characteristics, job satisfaction and Quality of Life Scale points revealed no statistically significant associations with the symptoms; except nasal symptoms distribution among library and archives staff who spent <1 hour/day and those who worked more than 1 hour in the shelves, warehouse and restoration areas of the institutions. The latter experienced a statistically significant higher frequency of nasal symptoms ((χ^2=6.204, df=1, p=.013). The subjects who reported 'other work-related health problems' were found to have a lower job-satisfaction than others, and this difference was statistically significant (χ^2=6.998, df=2, p=.030).

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Notes

Monitoring and modeling the storage environment at The National Archives, Kew, UK

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Keywords: *archive, relative humidity, modeling*

Abstract

A computer based model is developed to accurately simulate the environmental conditions (temperature and relative humidity) inside The National Archives repository building (Kew, UK) which houses records of British history spanning over a thousand years. The model is used to understand the impact of the hygroscopic property of the archival records, which are mainly paper-based, in moderating the changes in relative humidity of the storage environment. The model is also used to examine options in maintaining an optimum preservation environment with reduced energy consumption in light of climate change predictions and to contribute to the development of appropriate standards and guidelines [1].
The need for the model to accurately simulate the hygrothermal behaviour inside the archive building led to the choice of *EnergyPlus* as the modelling software. All the modelling work in *EnergyPlus* was carried out under the Combined Heat and Moisture Transfer (HAMT) Model algorithm [2] which takes into account the movement and storage of heat and moisture to and from the repository environment and the surrounding physical elements.
The methods and assumptions used in developing the simulation model and how its performance was optimised by calibrating against the measured temperature and relative humidity of the repository environment are described. The model performance is compared to the actual repository environmental conditions and the preliminary simulation results from what-if scenarios are presented.

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Notes

Assessing the impact of the museum environment on polychrome sculpture and frontals in the Museum of Cultural History (Oslo)

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***Keywords**: environmental control, environmental monitoring, polychrome, pollution, dust*

Abstract

This poster presents the interim results of an ongoing research project into the preservation environment within the early medieval polychrome sculpture and frontals stores of the Museum of Cultural History (KHM), Oslo, Norway. The project is a partnership between Conservation Studies (IAKH) and the paintings & polychrome sculpture conservation section (KHM).
The Museum of Cultural History is responsible for the care of one of the most important collections of Northern European early medieval polychrome sculpture and frontals in the world. Whilst a large proportion of the collections are on display in an exhibition designed by the famous Norwegian architect, Sverre Fehn [1] a substantial part of the collection remains in storage. The project, started in autumn 2009, examines the long-term impact of a preservation environment that can be described as meeting “class I” [2] recommendations of for 95% of the time and well within “class II” for the remaining 5%. Although this can be described in museum terms as a good preservation environment minor damage has occurred, which given the importance of this collection, requires investigation.
So far the project has confirmed that the relative humidity and temperature fall within the desired limits of 55% ±5%. It has however also identified a surprisingly high mineral content within the dust samples collected and an atmosphere that causes lead coupons to rapidly tarnish. Whilst the current research tasks focus on these two phenomena, the poster also presents a broader summary of the project in order to give a representative picture of the investigation that has been undertaken.
Ultimately, this research is intended to identify events that have caused an alteration in the conservation status of the collection and assess their impact in terms of risk. It is hoped that the outcome of the research will allow decisions on the environment to be made in a more informed manner and the feasibility of the new standard [3] prEN 15757, which is due to be adopted within Norway in 2010, to be tested.
These broader goals will help to identify practical protocols for enforcing prEN 15757 based on:

- Low energy use and clearly identified passive measures of control,
- Environmental set points, daily variation limits, permissible rates of change in environmental conditions, annual drift in conditions based on external climate and the capacity of the building to act as an environmental buffer,
- Evaluation of the conditions that the collections have been exposed to in the past,
- New knowledge and research into the behaviour of materials.

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Notes

DECAGRAPH : Early detection of biological and chemical contaminants of paper based cultural heritage

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Abstract

Contamination by fungi in paper based collections storage facilities is a major and recurrent problem which concerns not only archives and libraries but every other institution in charge of the preservation of cellulose containing cultural heritage: engravings, maps, photographs, etc.
Unfortunately such contaminations can still only be detected when they become visibly obvious on the documents or the building materials. At this stage of the fungi development, it is often too late and the decontamination, long, difficult and costly. Moreover, unless using harmful chemicals, it is not always efficient.
The main aim of DECAGRAPH project is to apply a methodology already developed by the CSTB and the LRMH for dwelling houses [1,2] and historical buildings [3], to an early detection of biological contaminants specifically found on paper based collections.
Based on the detection of organic volatiles emitted by fungi in their early stage of development (VOCm), the results of this project will be used to parameterize a sensor for continuous monitoring of biological indoor air quality in paper based collections storage facilities.
This simple to use and low cost sensor will be equipped with a warning device. Thanks to it, the collection keepers could be warned about a contamination from its very beginning and take rapidly the actions necessary to prevent the contamination from being invasive and harmful to the documents.
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Notes

Verification of conditions for appropriate storage of dyed cellulosic textiles

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Abstract

The lifetime of textiles made from natural fibres is considerably influenced by storing conditions [1]. With this project we wanted to study whether dyed and undyed textiles react in the same way under identical storing conditions or if the dyed textiles require different storing conditions.
The evaluation of the influence of dyes and dyeing on the degradation of textile materials under different ageing conditions was based on the comparison of the degradation degree of the dyed and undyed textiles. The degradation degree of the vegetable textile material (linen) was evaluated on the basis of changes in the structure of cellulose which is its main constituent. The main measured characteristics were: the viscosimetric average polymerization degree of cellulose [2], the reducing power of cellulose (measured by the standard test method for copper number) [3] and the solubility in the alkali boiling [3]. These methods demonstrate the decrease of the polymerization degree and the oxidative damage of cellulose.
Undyed-and-unmordanted materials, undyed-and-mordanted materials as well as dyed-and-mordanted materials were compared. The comparison comprised unaged materials and materials after artificial ageing under heat-dry and heat-wet conditions and under UV/VIS radiation exposure. The dyes used were: Persian berries, galls, barberry root, turmeric, annatto, walnut, redwood, madder, cochineal and alkanna.
It appeared that the dyeing process itself leads to partial degradation of the dyed material. The presence of a mordant accelerates the degradation of the cellulose material compared to the undyed and dyed-and-mordanted materials. However, under the ageing conditions used in this study, the degradation rates of the undyed and dyed-and-mordanted materials were similar, with the exception of the gall-dyed materials.
Based on the current results, it is possible to conclude that we can store the dyed cellulose textiles under the same conditions as the undyed ones without a higher degradation risk.

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