

Effects of Friendly Heating system on human thermal comfort in the church

Sirkka Rissanen and Friendly Heating research group
Oulu Regional Institute of Occupational Health
Oulu, Finland

A new heating system (Friendly Heating, FHS) was installed to replace the hot air heating system in the church of Rocca Pietore in Italy. Instead of heating the entire room the heat generated by the new system is concentrated on the pew area where people stay, without causing a negative impact on artworks. The aim of this study was to assess thermal comfort of people in the church heated by FHS.

Thermophysiological measurements were carried out while the old hot air heating system was working and after the installation of different prototypes of the FHS in the church. Voluntary subjects participated in the measurements. They were either local people from Rocca Pietore or researchers from the project group. Their age varied between 25 and 78 years. They attended a simulated or actual service in the church. Duration of services was 45 to 60 min. Skin temperatures were measured and thermal sensation, thermal comfort and air movement intensity were asked during the service.

Air temperature varied between 5 - 10 °C and mean air velocity (\pm SD) was 0.2 ± 0.1 m·s⁻¹ at the height of a sitting person. Thermal insulation of clothing was 1.25 - 1.86 clo (mean 1.4 clo). Area weighted mean skin temperature increased from 30.5 °C (with old) to 31.5 °C (with the FHS). Finger and toe temperatures were 15 and 17 °C, respectively, at the end of the service while the old heating system was working. With FHS the temperatures were consequently 20 and 22 °C. Thermal sensation was rated "slightly cool" and "neutral" for old and FHS, respectively. Thermal sensation of fingers and feet were between "neutral" and "slightly cool" with FHS. Thermal comfort was "comfortable" except from fingers and toes with both heating systems. Draught caused uncomfortable sensation in the head with FHS.

In conclusion, progress in human thermal comfort has been achieved by the new FHS in the church. Whole body thermal sensation of the people is neutral or slightly cool and mean skin temperature varies between 31 and 32 °C. Although improvements have been achieved compared to the old heating system, feet, unclothed hands and head are still felt slightly uncomfortable. Forced vertical convection due to the radiative heating resulted in draught sensation especially in the head. People are most sensitive to draught in the unclothed parts of the body. According to ISO 7730 (1994) the limit for air velocity is less than 0.2 m·s⁻¹ but at the room temperatures of appr. 20 °C. Sensation of draught is known to be higher at sedentary activity and for people feeling cool/neutral instead of warm. Moreover draught-induced annoyance increases with lower air temperature. Some convective air movements might be unavoidable when radiant heating is used in churches. Work for reducing disadvantage of the air movements is going on.

This study is part of the project supported by EU Contract no. EVK4-CT-2001-00067.