SUMMARY

In Sweden, the traditional way of designing a freestall for dairy cows is either an insulated building (about 0.4 W/m²K) or a non-insulated low-cost building. This project deals with the possibility to design semi-insulated buildings, evaluating and creating design data. A semi-insulated building is defined as a building designed to an indoor temperature of 5°C during wintertime. The reason for building a semi-insulated building is lower building cost compared with a fully insulated building. Compared with a non-insulated low-cost building, the problems related to indoor temperatures below freezing point are solved and the solar heat load during summer is decreased.

Five freestall barns have been evaluated, during both winter and summer conditions, concerning the animal and human thermal environment and the aerial environment. In addition, the carbon dioxide and latent heat production from a dairy house with 42 tied dairy cattle at temperatures between 6 and 20 °C have been determined. Theoretical calculations about condensation, freezing of floors and solar heat load have been done for the five climate zones in Sweden. A semi-insulated freestall barn for each climate zone has been designed and the thermal environment in the buildings has been simulated. Finally, the building costs for the framework and claddings have been estimated.

The results show an acceptable animal thermal environment in semi-insulated freestall barns during wintertime. Compared with a fully insulated building, the air humidity and carbon dioxide concentration will be higher during wintertime. Compared with non-insulated freestalls, the semi-insulated ones have a lower freezing point and a lower indoor temperature during summer days.

An indoor temperature of 5°C instead of 12°C means lower latent heat production from the cows but also a lower capacity in the air to transport moisture out of the building. Thus, in spite of the lower heat production a higher air flow is needed.

Compared with a non-insulated freestall barn, the human thermal environment in a semi-insulated freestall barn is warmer during winter and cooler during summer. A large variation in thermal environment during a work cycle makes it difficult to dress appropriately. Generally, the dust concentration is low in cubicles.

Indoor temperatures about 5°C during wintertime affect the need of insulation to prevent condensation. Calculations show that in roof and wall at least 1.2 W/m² insulation is needed at 5°C and 85% relative humidity in the south of Sweden. In the north, at least 0.6W/m² is needed. A non-insulated concrete floor, at -24 °C outdoor temperature, does not freeze down to 4°C indoor temperature. In spite, the risk of cold leaking through the foundation motivates 30 mm insulation. More insulation in the roof decreases the solar heat load during summer. If the roof insulation is between 0.4 and 1.2 W/m²K the solar heat load is 10% to 30% of the heat load from the animals.

The building cost of a semi-insulated freestall barn, for the framework and claddings, are estimated to about 15% lower than a fully-insulated and 20% higher than a non-insulated cubicle.