HEAT LOSS DETERMINATION OF THE FUTURE BELGIAN POLAR STATION

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In 2004, the Belgian government commissioned the International Polar Foundation to design and construct a new research base in Antarctica, to become operational during the International Polar Year 2007. The station will be located in de Sor Rondan Mountains, on a snow-free granite ridge, elevated 16 m above the surrounding snow surface.

The main objective of this study is to develop a CFD methodology for heat transfer problems in building simulation with FLUENT. By using this methodology, heat losses related the future Belgian research base can be determined. The study is based on a square-based building which was considered during the conceptual design as the reference for parametric studies (orientation, positioning on the ridge, elevation etc).

The design wind speed of 70 m/s and design temperature of -60 ^{o}C drive the need for a more accurate heat loss determination than what has been obtained until now. FLUENT simulations were performed, using RANS turbulence modeling. The design of the station is almost frozen. However, it is important to know how much energy is exactly needed to heat the station.

In this study, first flow around the building for the model scale was modeled to investigate pressure distribution on the building as a function of pillar height varying from 1mm to 100 mm.

Secondly, heat transfer simulations were performed without taking into account radiation. The goal was to investigate the effect of windows on heat loss. It was observed that heat loss will increase about 27% proportional to windows surface area and the overall heat transfer coefficient since the outer surface temperature will be almost at the same temperature of the environment.

Afterward, heat transfer simulations were performed taking into account radiation effect. Although total heat transfer rate was almost the same as the previous simulations, heat loss by convection was reduced, compared with the previous simulations, because the outer surface temperature was decreased due to heat loss by radiation.

It is observed that heat loss determination using FLUENT and 1D model are in good agreement for both cases mentioned above.

Finally, heat loss from the building was estimated including solar radiation effect. In this case, heat loss is decreased about 14%. It is concluded that solar radiation can be effectively used as a passive heating system for the building. However, it could eventually lead to overheating if the building skin is not well designed.

Figure 1: A computer visualisation of the future Belgian research base