CHAM Limited

Pioneering CFD Software for Education & Industry

Natural convection flow in a Cask Storage Warehouse

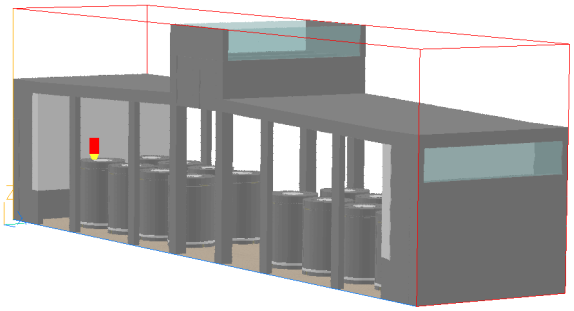
PHOENICS-3.5.1 Application by CHAM Japan

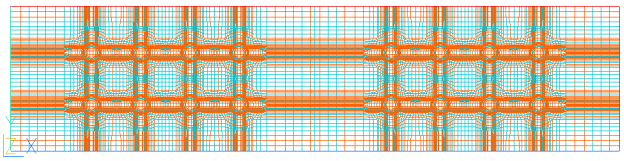
The following case forms part of a consulting project undertaken by CHAM Japan on behalf of Toyo Engineering. The case concerns the ventilation through natural convection of an underground nuclear waste storage depot. The primary purpose of the study was to establish the temperature distribution and the air flow rate within the storage facility.

The geometry of the warehouse was constructed using objects from the built-in library. A Body-Fitted Co-ordinate (BFC) mesh was applied to ensure a fine grid around the nuclear storage casks to capture the detailed heat dissipation and ventilation processes for each.

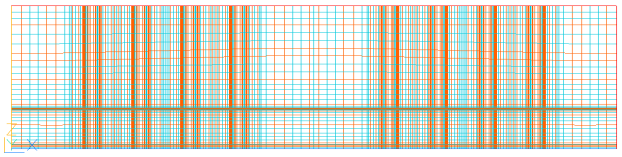
Case set-up details :

- BFC grid
- Three-Dimensional steady flow with heat transfer
- Buoyancy-influenced flow
- Surface to surface radiation included
- NX*NY*NZ=288*74*42=895,104

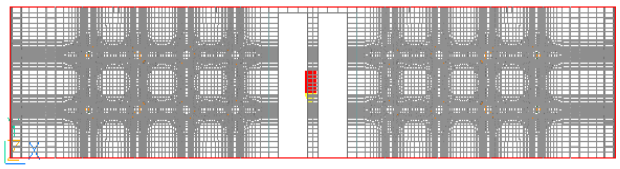


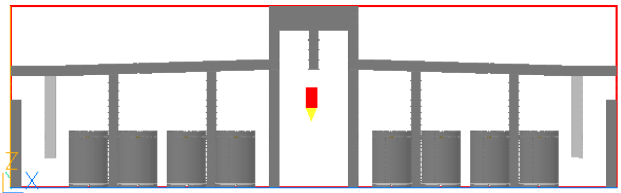


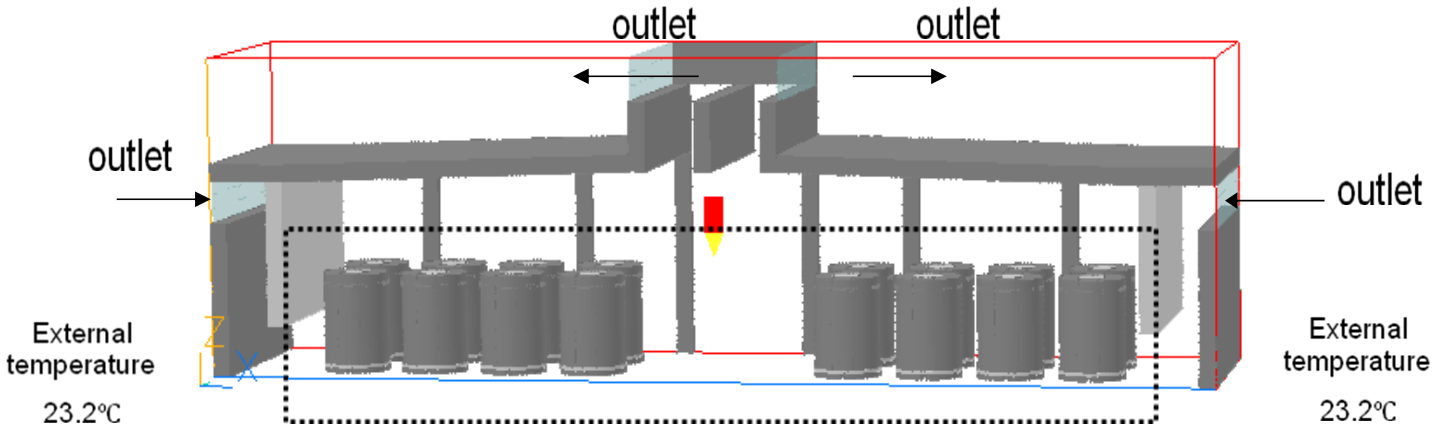
x-y plane
nx × ny=288×74



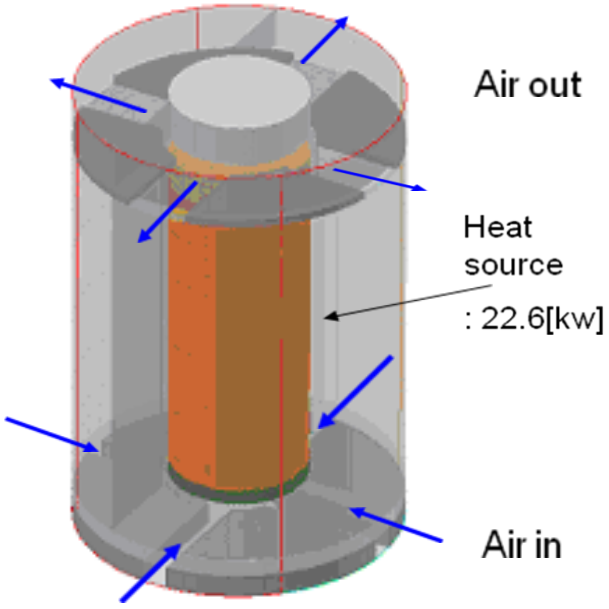
x-y plane
nx × nz=288×42







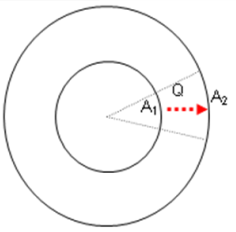
cask



Radiation model in the cask

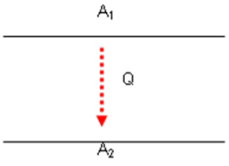
$A_1 \neq A_2$

$$Q_2 = \sigma(T_1^4 - T_2^4)A_1 \frac{A_2}{\frac{A_2}{\varepsilon_1} + \frac{A_1}{\varepsilon_2} - A_1}$$



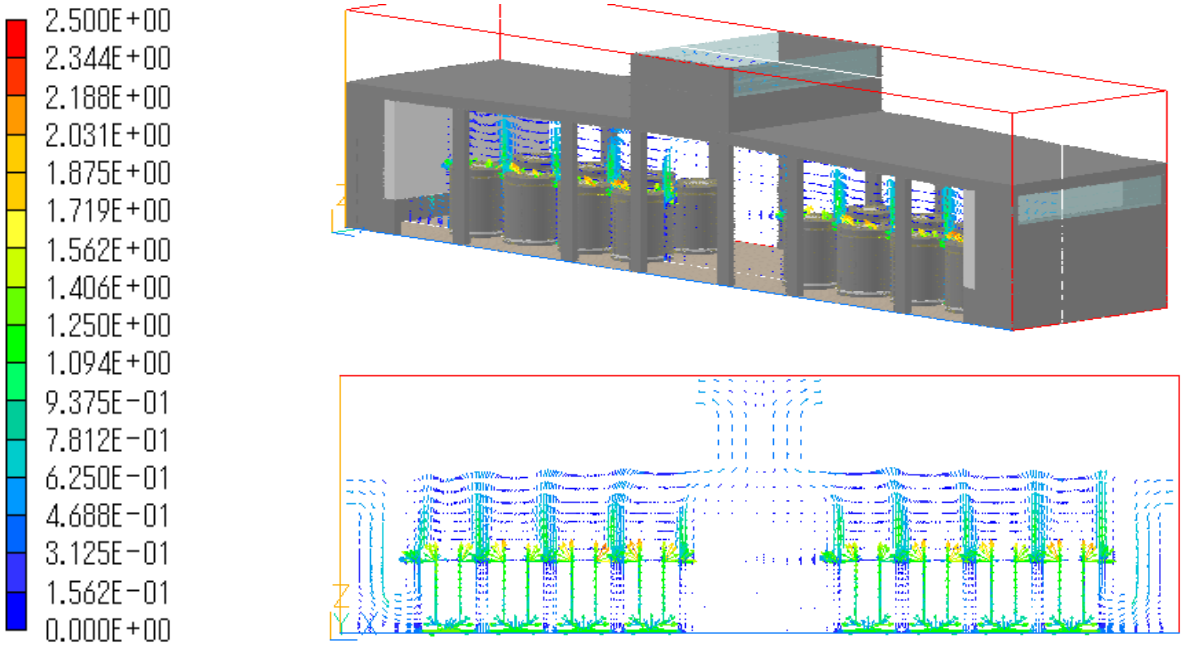
$A_1 = A_2$

$$Q_2 = \sigma(T_1^4 - T_2^4)A_1 \frac{A_2}{\frac{A_2}{\varepsilon_1} + \frac{A_1}{\varepsilon_2} - A_1}$$



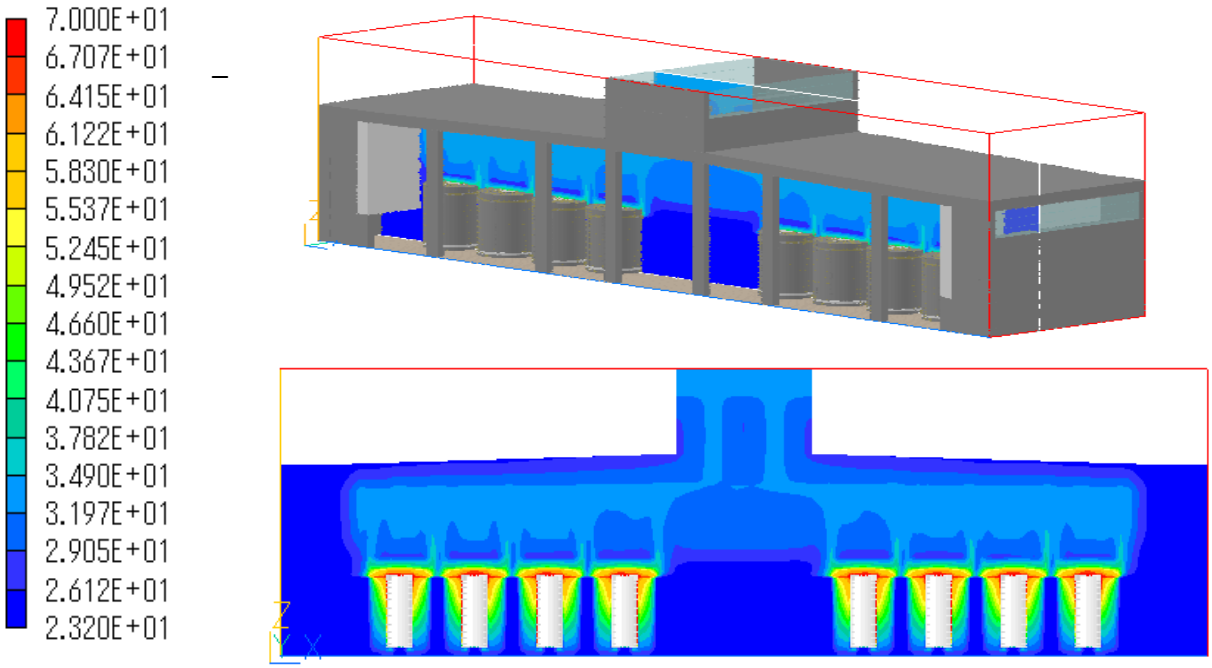
Geometry of the warehouse and configuration of cask ventilation and radiation sources.

Results



Velocity

FlowRate[m^3/s] per one cask - Experimental data = 0.28; PHOENICS result = 0.3



Temperature

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