Dust Dispersion
Client Confidential

Introduction

The encapsulation of legacy nuclear wastes in a cement grout will enable the safe decommissioning of redundant nuclear plants in the UK. MMI Engineering has been involved in a number of modelling studies of the encapsulation and separation caves for the proposed Sellafield Silos Direct Encapsulation Plant (SDP). An ANSYS CFD code was used to construct models of the building with sub-models of process equipment to examine the localised releases of hydrogen, heat, water vapour and dust.

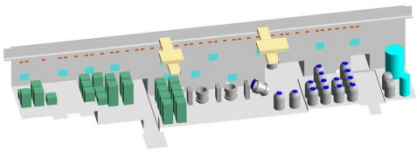

Figure 1: A proposed layout for the SDP. Iso-surfaces of air saturated with water vapour are shown in dark blue

Computational Models

The process starts with skips of waste retrieved from the legacy silos entering the SDP facility, where they are screened and tipped into a mixing vessel. The waste is then transferred to a mixing station, where it is combined with cement grout and water. The mixture is then tipped into liners and stacked while curing takes place.

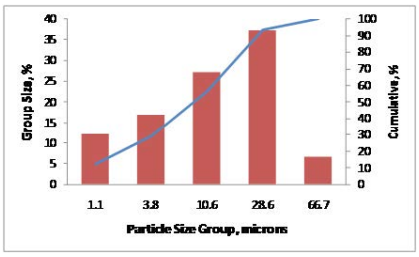

Figure 2: Cumulative PSD of the cement dust and % in each particle size group

Dust Releases

It is possible for cement dust to be released into the SDP cave-like environment during the mixing process. Dust accumulation, especially within areas presenting high moisture levels are, important for the long term planning of the SDP. Dust entrained into the ventilation extraction system and into the filters has to be processed. Quantifying this dust is therefore an important consideration.

CFD was used to calculate the distribution of dust within the SDP caves and the amount leaving through the extract system. Full models of the encapsulation and separation caves were produced and the influences of heat, humidity, hydrogen and extract flow rate were investigated.

A Particle Size Distribution (PSD) of the cement dust was discretised (Figure 2) into a number of size groups. These size groups were implemented in the model as scalars, each with a slip velocity based on the terminal velocity of the average particle size of that class. This enabled MMI to see which particle sizes were drawn into the extract system and which would readily settle.

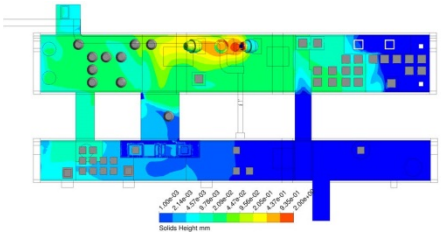

Figure 3: Dust deposition on the floor of the caves

Results

Contours of dust deposited on surfaces within the caves was produced (Figure 3) to highlight regions where dust would accumulate. These could be compared directly with areas of high humidity to gauge whether equipment could be affected. Quantities of dust entering the filters were calculated and the percentage of each particle size group reaching the filters was also calculated (Figure 4).

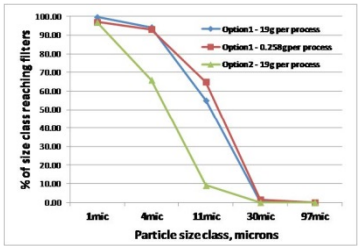

Figure 4: Percentage of dust size groups that reach the filters for different releasesp

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