Incinerator Analysis

Client Confidential

Introduction

During the operation of the Runcorn EVC incinerator, unacceptable levels of dioxins were detected in the stack. Two possible causes for this were considered, namely ‘breakthrough’, which is the passage of unburned material from delivery lance to stack, or ‘formation’, where unburned fuel causes soot deposition in the heat exchanger, which reacts and forms undesirable products.

Computational Fluid Dynamics (CFD) modelling was undertaken by MMI to investigate the combustion and flow within the furnace and to investigate the cause of the dioxins in the stack. Modifications to the furnace were investigated to eliminate the dioxin emissions.

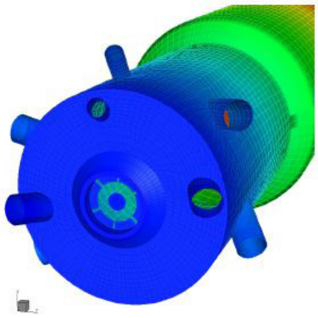

Figure 1: The central burner & fuel lances were modelled with a finite volume grid

Model & Design Modifications

The complex geometry of the central burner and fuel lances was modelled with a finite volume grid. The model was used to test the fuel time-temperature residence requirement of 1000°C for two seconds. The results showed the required temperatures were achieved through the furnace. Particle tracking was then used to produce residence time distributions and the results showed that some of the material was not experiencing the necessary residence time (Figure 2). Retrofit options were considered and the incinerator was modelled with a baffle wall at the expansion region between the combustion and residence zone.

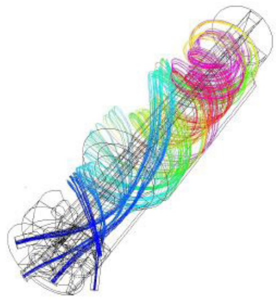

Figure 2: Traces from the delivery lances are coloured with time. Magenta is in excess of 2 seconds. Short circuiting is observed from 3 of the fuel lances

Results

The introduction of the baffle wall increased the residence time. Cumulative Residence Time Distributions (CRTD) were examined to see which option produced the steepest CRTD and therefore the best mixing. The baffle promoted better mixing and more complete fuel burnout, reducing the amount of soot formation and emissions. The modelling also showed that the introduction of the baffle did not significantly increase the pressure drop across the system. A number of wall baffles were compared and it was recommended to install a baffle wall of 400mm at the expansion region between the combustion and residence zones of the incinerator.

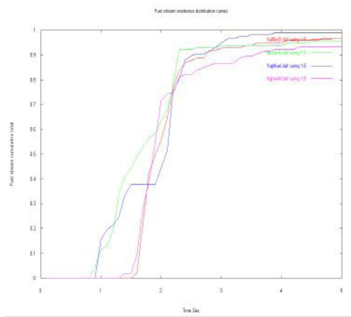

Figure 3. Particles below an exit time are summed and the result is plotted to the CRTD. The optimum condition is where all particles approach the hydraulic retention time of 2 seconds