Advanced CFD Engineering for DSI and ACI Systems

REACTION ANALYTIC SOLUTIONS CORP.

Overview

Reaction Analytic Solutions has significant modeling experience and strong capability in design and optimization of Dry Sorbent Injection (DSI) and Activated Carbon Injection (ACI) technology for pollutants removal from flue gas. In addition to Conventional CFD flow modeling, we have incorporated a number of our in-house proprietary sorbent chemistry sub-models.

Proprietary Chemistry Submodels

- Hydrated lime + SO_3
- Hydrated lime + HCl/SO_2
- Trona + HCl/SO_2
- Limestone + SO_2
- Activated carbon + $Hg/HgCl_2$

Benefits

The following table summarizes the advantages of chemistry-based Advanced CFD modeling versus flow-only (or non-chemistry) Conventional CFD modeling, in terms of CFD outlet and evaluation capabilities. Advanced CFD model provides "real-life" predictions, including not only the mixing and flow related output that a conventional CFD can provide, but also gas species concentration and reduction predictions. Advanced CFD model approach provides a much comprehensive and useful tool for evaluating a number of important design/operating parameters as well as sorbent properties.

	Conventional CFD Model (Flow-only)	Advanced CFD Model (Chemistry-Based)
CFD Output		
Particle Concentration Distribution	√	√
Particle Concentration RMS	√	√
Particle Trajectory	√	√
Pollutant Species Concentration	-	√
Pollutant Reduction	-	√
Evaluation Capability		
Impact of Injection Strategy	√	√
Impact of Residence Time	-	√
Impact of Flue Gas Temperature	-	√
Impact of Inlet Species Concentration	-	√
Impact of Sorbent Type	-	√
Impact of Sorbent Size	-	√
Impact of Sorbent Porosity	-	√
Impact of Sorbent Surface Area	-	√
Impact of Sorbent Flow Rate	-	√

Case Studies

As an example, Fig. 1 shows a case using SO_3 chemistry model to evaluate a DSI application at a 500 MWe coal-fired unit. Both sorbent dispersion and SO_3 species concentration and reduction are predicted by the model. Fig. 2 shows the CFD predicted SO_2 and HC concentration of DSI hydrated lime injection on a 200 MWe unit flue gas duct, using the chemistry model for hydrated lime reacting with SO_2/HCl. These models provide "real-life" results when optimizing injection systems.

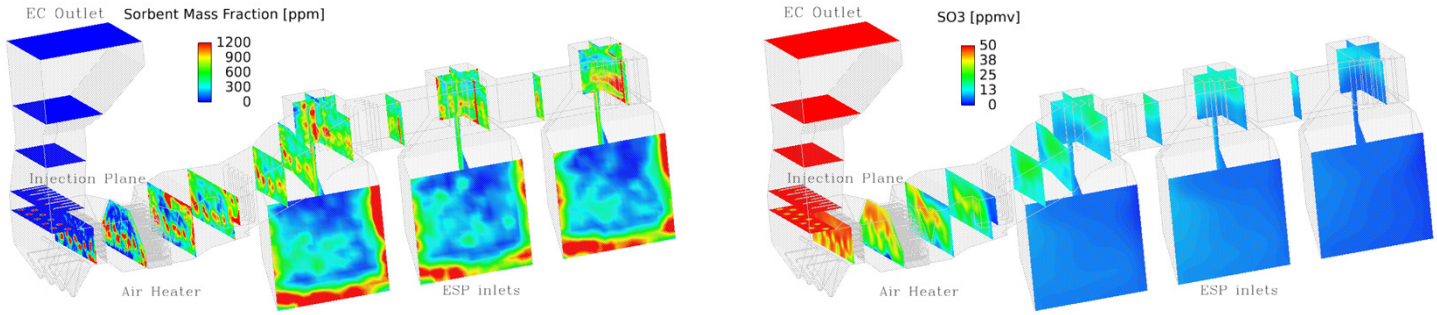

Fig. 1. CFD predictions of hydrate lime particle concentration (up) and SO_3 species concentration (low) for a DSI application on a 500-MWe unit flue gas duct. CFD Domain starting from economizer outlet to ESP inlet.

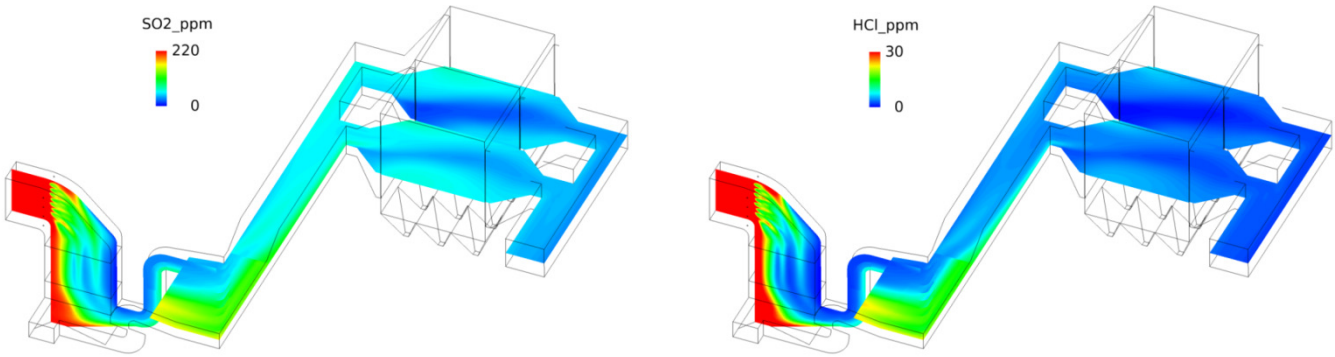

Fig. 2. CFD predictions of (left) SO_2 and (right) HCl species concentration a DSI hydrated lime injection on a 200-MWe unit.

About Reaction Analytic Solutions Corp.

Reaction Analytic Solutions (RAS) is a recently-established consulting service provider founded by a well-recognized CFD engineering specialist. RAS uses its unique CFD modelling service to support Air Pollution Control (APC) engineering projects for our clients. RAS's CFD engineer has modelled mixing and combustion of over 90 different units. We also have intensive experience in modeling sorbent injection technologies for flue gas pollutant reduction, including evaluating the sorbent injection system and optimization for mercury control, using our in-house proprietary chemistry kinetic submodels.

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