CFD Modelling of Power Station Boilers for the VerSi Project

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RECOM Services is a Spin-Off from Stuttgart University providing specialized combustion CFD modelling services to the power and process industry since 1999. A prerequisite for successful CFD Modelling of Power Station Boilers is the availability of a reliable CFD Modelling Software. RECOM-AIOLOS is an in-house developed combustion CFD code, based on the AIOLOS code originally developed at Stuttgart University. RECOM-AIOLOS is tailored for the description of gaseous-, liquid- and solid-fuel-fired industrial-scale combustion systems. All the relevant sub-models for turbulent fluid flow, multi-phase continuum mechanics, radiative/convective heat transfer and chemical reaction mechanisms to describe industrial scale combustion systems were developed using data of lab-scale and pilot-scale combustion experiments. The predictive quality of the code has been assessed thoroughly with full-scale experimental data of numerous measuring campaigns. A large number of velocity, temperature and concentration data from in-furnace measurements of full-scale systems has been used to validate RECOM-AIOLOS predictions against real data from the field. Many European power companies (e.g. E.ON, RWE Power, Vattenfall Europe, EnBW, Laborelec) have intensively supported this development by providing these measurements from full-scale power plants. RECOM-AIOLOS predictions are therefore highly trusted in the power industry, and it is therefore widely used to assess technical risks associated with operational, design and fuel changes in industrial firing systems.

Since slagging and fouling of the heating surfaces is one of the most severe phenomena in solid fuel fired systems, which strongly impacts plant availability and plant efficiency, the computational modelling of slagging and fouling processes has been a major field of research for many decades. Unfortunately, the detailed models produced as a result of these research efforts were computationally too demanding to be used directly within the framework of a CFD environment. Therefore, CFD models of industrial combustion systems were limited to simpler, mostly viscosity- or temperature-based approaches for the evaluation of the slagging and fouling situation in Power Station Boilers. However, the recent advances in computer technology and the availability of petascale supercomputing capabilities to industrial users are putting an end to these limitations today.

One part of the ongoing project “VerSi” funded by the German ministry of Economy and Energy (BMWE) that started in summer 2015 is therefore aiming at the utilization of detailed thermo-chemical equilibrium calculations together with high resolution CFD models ranging between 20-30 million grid points and tracking roughly a million solid particles for the description of the slagging and fouling situation in the full scale Power Station Boilers. For this purpose the thermo-chemical equilibrium calculations will be connected to the CFD-environment and optimized for an efficient execution on state-of-the-art multi-core and many-core systems. The capabilities of the extended model description will be validated with comprehensive full scale measurements conducted at a bituminous coal and a lignite fired Power Station Boiler. The introduction of virtual reality visualization techniques will finally enable the full exploration of the detailed information provided by the extended model description.

The presentation at the GTT user meeting is intended to provide more insight into the planned and already accomplished work on CFD Modelling of Power Station Boilers within the project.