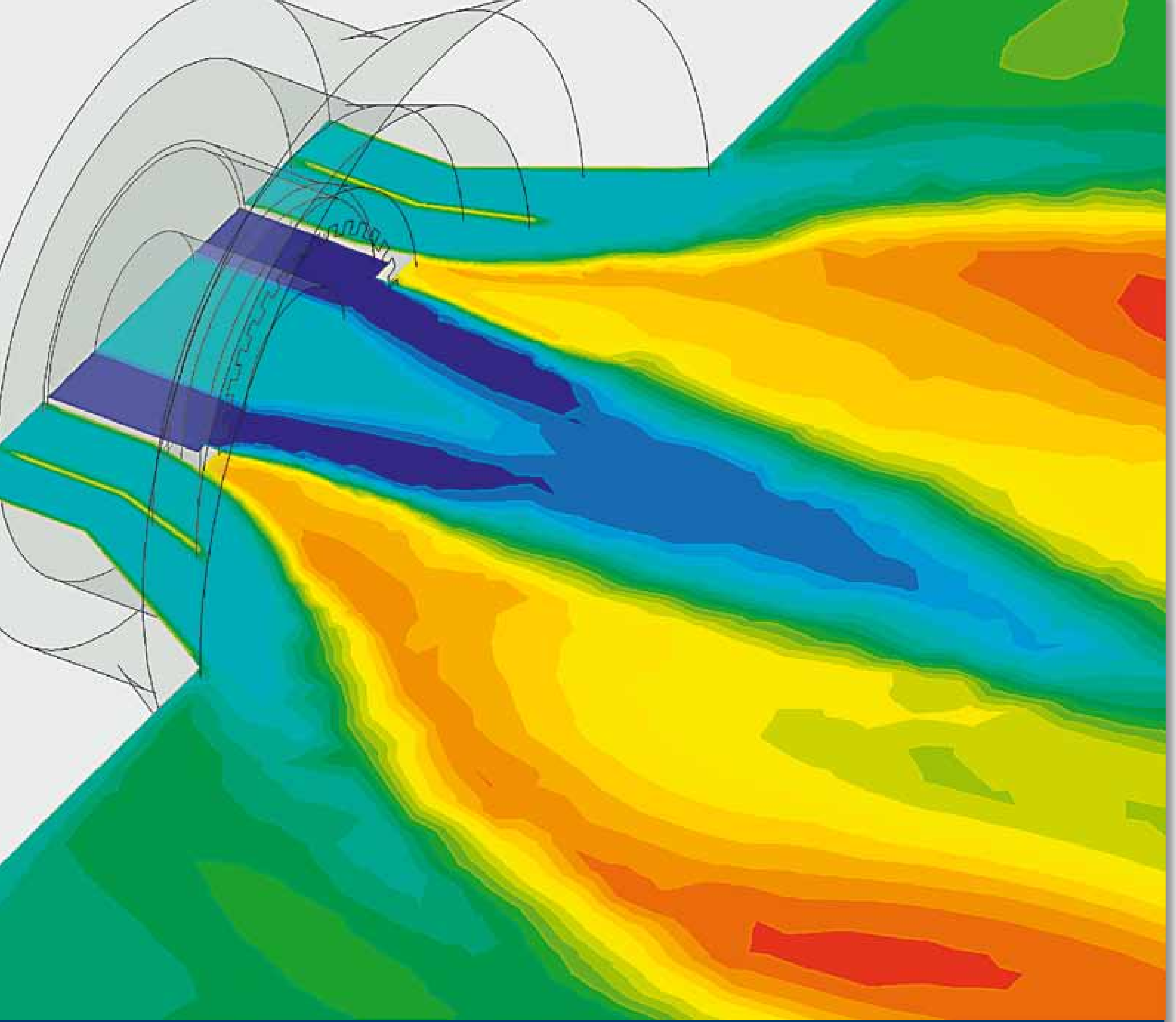

CFD calculations

Computer-based simulation of fluid flow, combustion, heat and mass transfer in power plants

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Heat removal from HAW casks in storage facilities

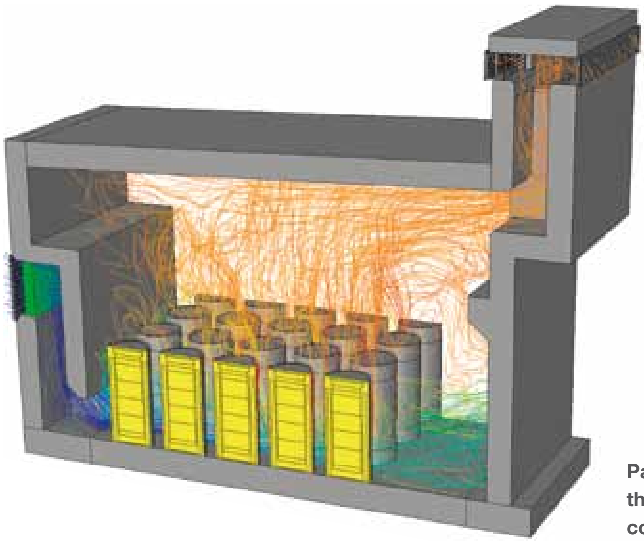
We perform calculations for heat removal from high level radioactive waste (HAW) casks in interim storage facilities. The calculations are performed in the scope of design and dimensioning of these facilities in order to meet thermal criteria. Similar calculations are carried out for high-level liquid radioactive waste (HLLW) vitrification facilities.

HAW casks stored in interim storage facilities generate thermal power due to radioactive decay. The heat removal from the facilities is realized by natural ventilation based on convective cooling mechanisms. Ambient air flows into the facility through inlets on the side of the building. The air is heated up by convective and radiative heat transfer that comes from the HAW casks and leaves the facility through air outlets located on the roof.

Based on numerical heat transfer models, calculations are performed in order to determine surface and air temperatures. In order to minimize occurring pressure losses, emphasis is placed on the dimensioning of built-in components in the inlet and outlet ducts, i.e. protective gratings, barriers and louvers. Additionally, concepts to optimize the storing position configuration of the HAW casks inside the storage facilities are evaluated.

Successfully completed projects have been carried out for various facilities in Germany and Switzerland:

- Interim storage facilities at Unterweser, Grohnde and Brokdorf Power Plant (E.ON)
- Interim storage facilities at Brunsbüttel and Kruemmel Power Plant (Vattenfall)
- Interim storage facilities at Lingen Power Plant (RWE)
- Interim storage facilities at Obrigheim Power Plant (EnBW)
- Central Swiss Storage Facility (ZWILAG)
- Karlsruhe HLLW Vitrification Plant (VEK)

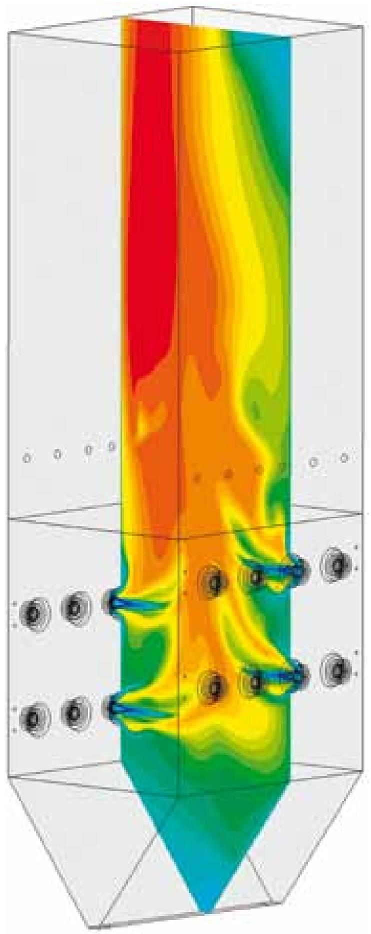


Pathlines of the convection-driven flow through an HAW interim storage facility, colored by temperature

In the Nuclear Technologies division of STEAG Energy Services, we perform CFD calculations for computer-based simulation of processes involving fluid flow, combustion, heat and mass transfer for nuclear facilities and fossil-fuel power plants.

Combustion calculations

In order to simulate the combustion mechanisms inside the furnaces of fossil-fuel power plants, we perform computer-based combustion calculations. In these calculations, the complex geometry of the combustion chamber, burners, air and fuel intakes as well as heat exchangers are modeled in detail.



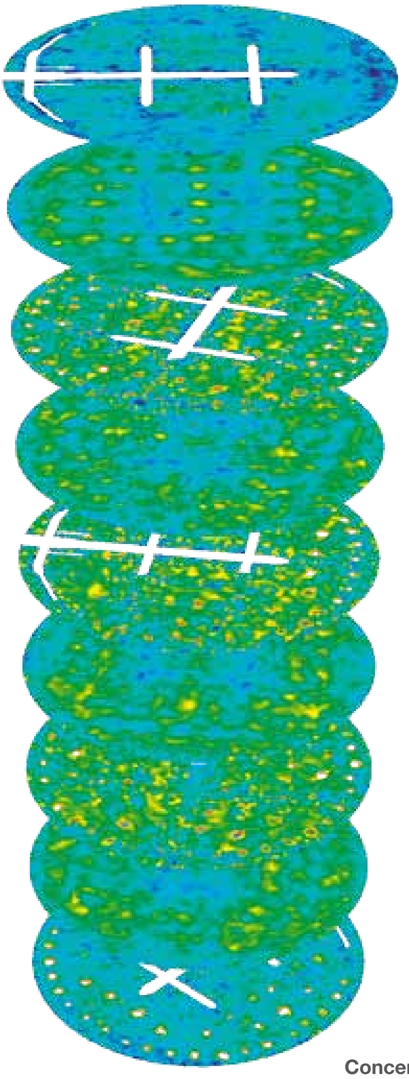
Temperature field inside the furnace at Walsum Power Plant

The detailed model of the burner geometry includes the fuel inlet as well as the primary, secondary and tertiary air inlets with regard to the twist angles of the incoming air and fuel. The composition and the thermal properties of the fuel are taken into account along with the most important chemical reactions occurring in the combustion process. In case of carbon dust combustion, such chemical reactions are taken into account along the trajectories of the injected particles.

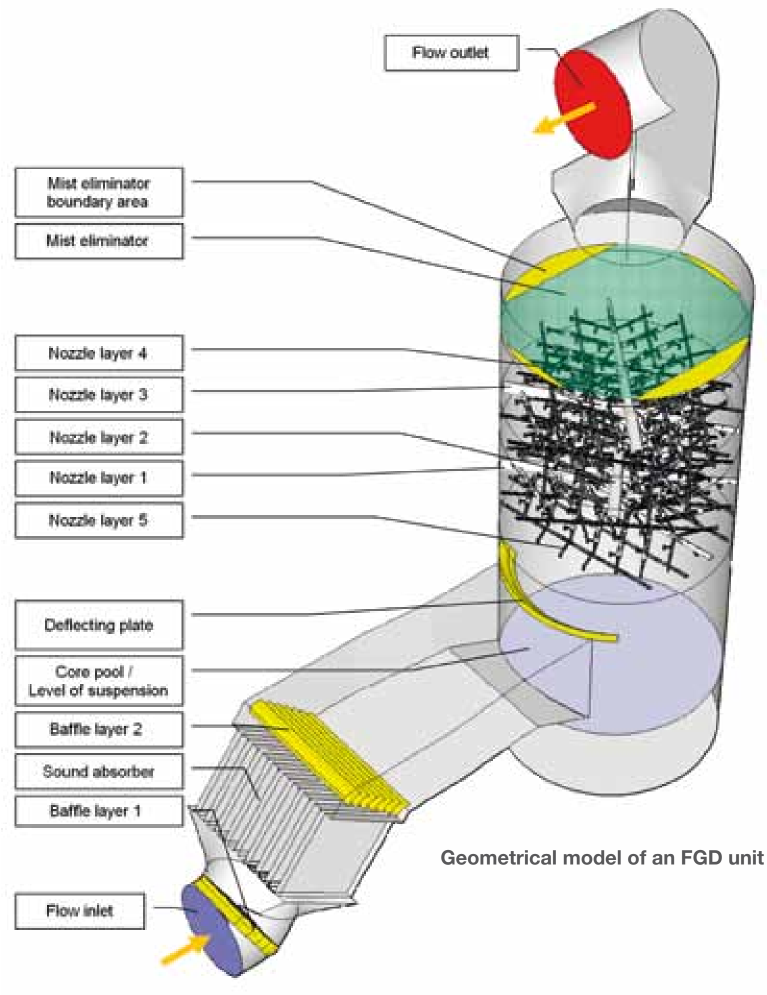
Results of combustion calculations include:

- The temperature field inside the furnace
- The thermal load on the furnace walls
- The species concentrations inside the furnace
- The oxygen concentration at the furnace walls (corrosion prevention)

Successfully completed projects have been carried out for STEAG's power plants in Walsum (Germany) and Iskenderun (Turkey).



Concentration of suspension droplets in the nozzle layers of the FGD unit at Bergkamen Power Plant



Geometrical model of an FGD unit

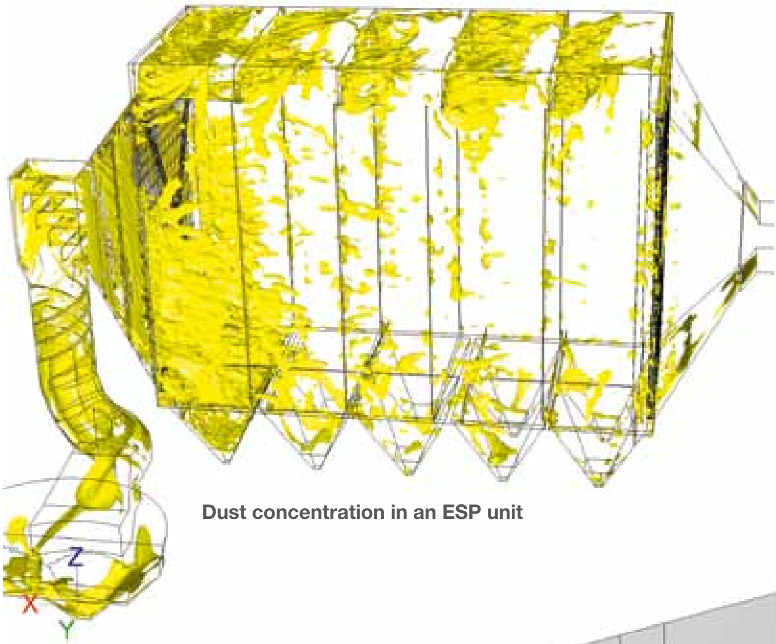
Optimization of flue gas desulfurization units

In the scope of flue gas desulfurization (FGD) unit optimization for fossil-fuel power plants, we perform numerical calculations in order to improve the fluid flow characteristics and the separation performance of the FGD units.

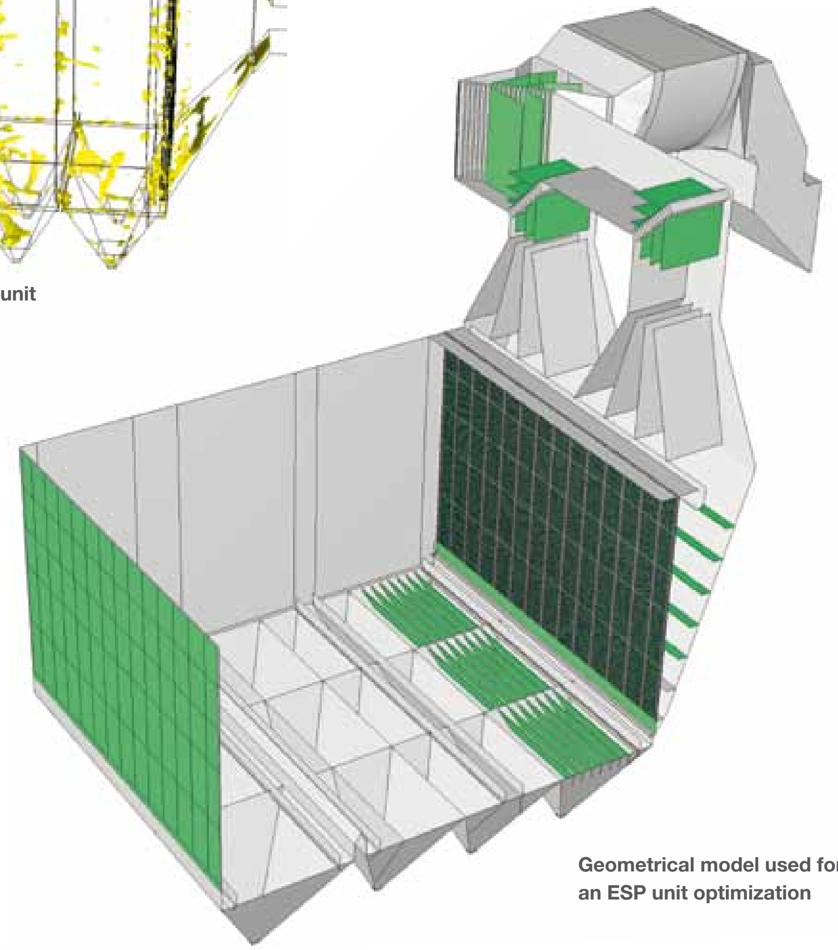
In the FGD optimization calculations, a numerical multi-phase model is used to determine the occurring heat and mass transfer phenomena between the suspension droplets and the flue gas. The goal of the computations is to homogenize the velocity and temperature fields as well as the suspension droplet concentration. Emphasis is placed on the suppression of flue gas inhomogenities and suspension wall effects.

An optimized FGD behavior can be obtained by geometrical modifications of built-in components such as spray nozzle layers and mist eliminators.

Successfully completed projects have been carried out for STEAG's power plants in Germany (Bergkamen, Lünen and Bexbach) and Turkey (Iskenderun).



Dust concentration in an ESP unit



Geometrical model used for an ESP unit optimization

Optimization of ESP units

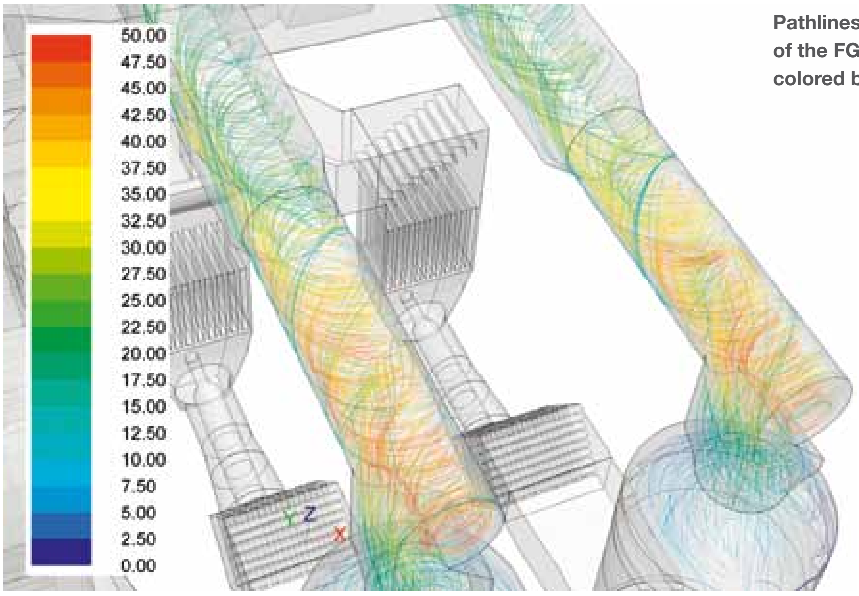
In the scope of electrostatic precipitator (ESP) unit optimization for fossil-fuel power plants, we perform numerical calculations in order to increase the performance of the ESP unit by optimizing the flue gas flow and dust concentration conditions.

Regarding ESP calculations, our focus lies on determining the optimization potential of fluid flow and dust concentration. Dust agglomerations can be eliminated by configuration and rearrangement of built-in components such as guiding vanes, flaps and gas distribution grids.

The concentration and distribution of dust particles inside the ESP unit is calculated using a two-phase flow model.

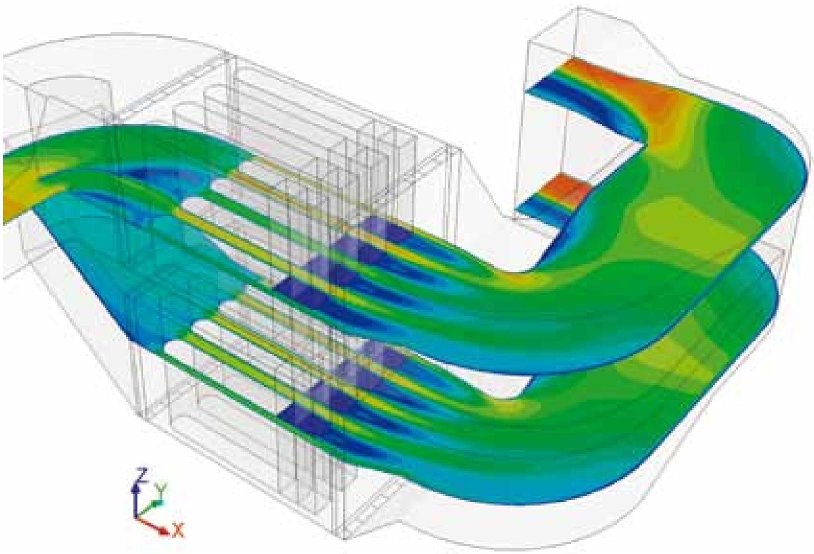
The amount of dust removal is calculated using the dust concentration and the Deutsch equation.

Successfully completed projects have been carried out for STEAG's power plants in Germany (Voerde, Lünen and Herne) and Turkey (Iskenderun).



Pathlines of the swirling flow downstream of the FGD units at Bergkamen Power Plant, colored by fluid flow velocity

Iso-contours of the fluid flow velocity in the flue gas treatment facility at Godorf Refinery Power Plant



Optimization of flue gas ducts

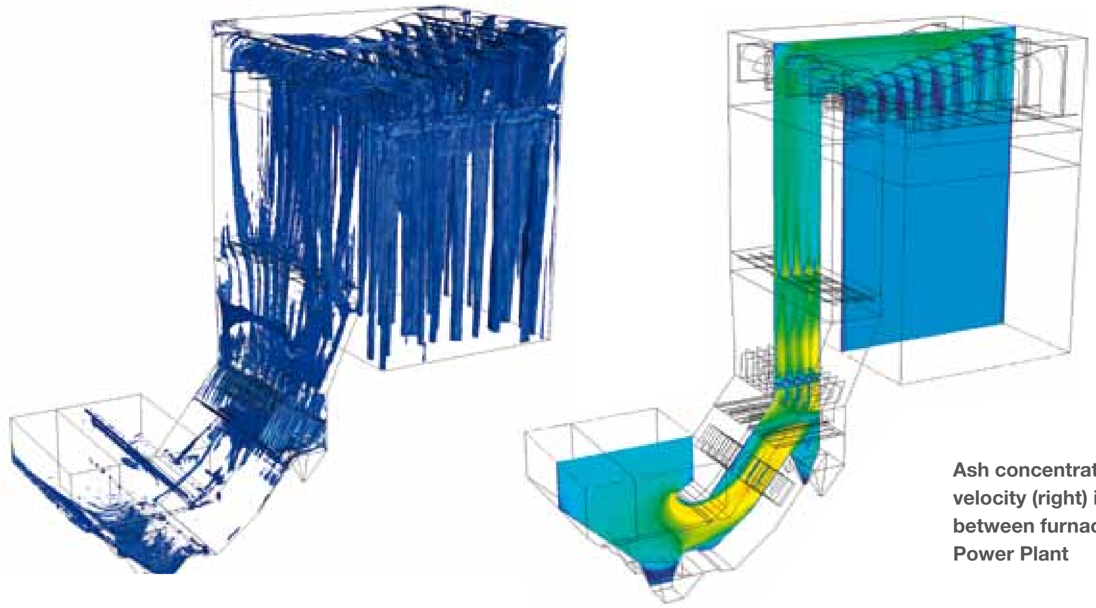
We have a large experience in optimizing the fluid flow conditions in flue gas ducts of fossil-fuel power plants. In the past, many projects have been carried out in the scope of numerical calculations for the optimization of flue gas ducts and its built-in components.

The optimization calculations for flue gas ducts mainly focus on the improvement of the fluid flow conditions and the determination of the according reduction of pressure losses. Geometrical modification measures are derived with these calculation results.

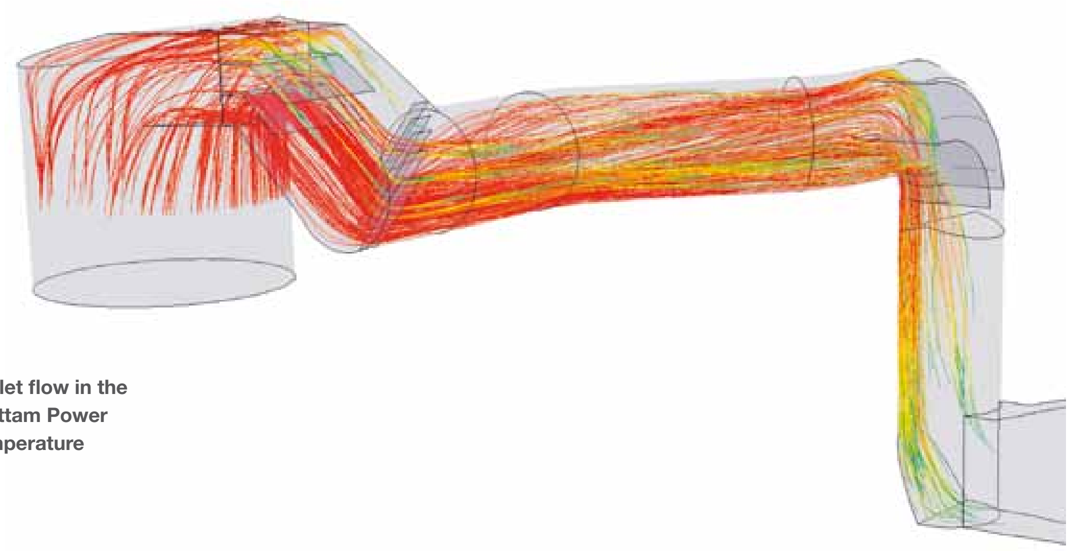
The chemical and thermal properties of the flue gas as well as the underlying thermodynamic effects (buoyancy, heat transfer, heat sources and sinks) are accounted for in the numerical models used for the calculations. In case of droplet flows, dispersion and evaporation effects are included in the model.

Successfully completed projects have been carried out for several power plants:

- Bergkamen Power Plant (RWE/STEAG, Germany)
- Godorf Refinery Power Plant (Shell/STEAG, Germany)
- Niederaußem Power Plant (RWE, Germany)
- Mainz Heating Plant (KMW, Germany)
- Cottam Power Plant (EDF Energy, United Kingdom)
- Iskenderun Power Plant (STEAG, Turkey)



Ash concentration (left) and fluid flow velocity (right) in the flue gas ducts between furnace and FGD unit at Gorgas Power Plant



Pathlines of the droplet flow in the clean gas duct at Cottam Power Plant, colored by temperature

Flow simulation with particles and droplets

We perform CFD calculations for two-phase flows with droplets and particles in the flue gas ducts of fossil-fuel power plants. The processes of interest include gas-liquid and gas-solid two-phase flows involving ash, dust or liquid particles.

Areas of application for two-phase flow models are ESP, FGD and SCR units of flue gas treatment facilities, in which the concentration of ash, dust and droplets is determined in order to increase the performance of those units.

Successfully completed projects including particle and droplet calculations as well as droplet evaporation have been carried out for several power plants:

- STEAG's power plants in Germany (Voerde, Lünen and Herne)
- Several power plants in the United States (Gorgas, Marion, Merom and Monroe)
- Marl Power Plant (Infracor, Germany)
- Cottam Power Plant (EDF Energy, United Kingdom)

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