Thesis proposal for grid dependency study in swirling flames

Background

CFD calculations have the last decades successfully been used in the power industry to analyze and optimize the performance of power and heat plants. The CFD simulations have mainly been used to predict trends in the furnace and superheater regions, and to evaluate modifications and changes in operating conditions for existing boilers.

In the last years development of a new generation of power plant technology with near zero- emissions of CO_2 have started. The concept is based on combustion of the fuel in a mixture of oxygen and recycled flue gas, so called O_2/CO_2 recycle combustion or oxyfuel combustion. CFD will be a useful tool in the development of this technology, however some of the submodels describing the heat transfer characteristics and the chemical reactions need to be adapted to the new combustion atmosphere. This is an ongoing work.

In industrial applications grid sizes and grid dependency are still critical issues, despite the fast development of computers, and it is today not realistic to get grid independent solutions for full scale boiler simulations. It is therefore necessary to create the mesh with great care and experience from earlier simulations to minimize the influence of the grid.

One of the new questions that arise for the oxyfuel technology which is suitable to investigate with CFD concerns the radiation heat transfer, and how the heat transfer to the furnace walls is changed, compared to combustion in air atmosphere. One of the most important things in order to correctly estimate the radiation heat transfer to the walls is to correctly estimate the peak temperatures in the flames. The temperature profiles are governed by the fluid flow (mixing) and combustion reactions in the flame. However to correctly estimate these quantities the resolution and type of grid will be important.

In this thesis a study of the grid dependency of one single flame will be performed, in order to try to find out how rough the mesh could be still giving acceptable estimations of temperatures, concentrations etc. The dependency of different mesh types will also be investigated.

Goal of the thesis

The purpose of the thesis is to study the grid dependence in CFD calculations of a swirling gas flame. The goal is to find a way to relate some characteristic burner dimension to the grid size, making it possible to transfer the results to other burners. The work also includes giving recommendations on choose of cell types in the grid (tetrahedral, hexahedral, polyhedral)

Preliminary outline

- Literature survey on mesh studies performed for similar applications.
- Definition of cases/meshes.
- Calculation of defined cases
- Analysis of results and definition of recommendations
- Write a detailed technical report

Suitable student background

Good knowledge of Computational Fluid Dynamics.

Starting date	**Number of students**
spring/summer 2006	one student

Scope

The duration of the study will be 20 weeks for one student and the work will be carried out at the Thermal Power/CFD group at Vattenfall Utveckling AB, Älvkarleby (25 km south of Gävle).

Contact persons

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