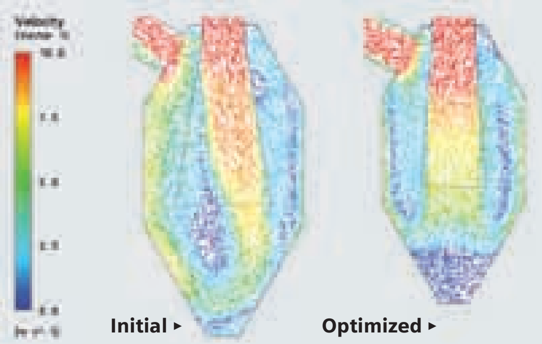
Application of advanced CFD and simulation tools allows equipment design to be optimized in a cost-efficient and effective manner

The Numbers Say It All

Over the last decade, computational power and software simulation technology have dramatically advanced. This has allowed computational fluid dynamics (CFD) to be practically applied as a powerful design and analysis tool in the iron and steel industry. A brief overview of several application examples is presented in the following.

CFD is a numerical analysis technique in which the flow of a gas or liquid is simulated by solving a large system of governing equations. Practical applications can range from simulations of gas flow through a ducting system up to combustion in a stove burner where chemical reactions, heat and mass transfer as well as gas flow are involved. Not only can performance be compared between different designs, but detailed visualization is possible, allowing a level of understanding not possible with a physical model.

In the course of hundreds of engineering projects implemented worldwide, specialists at Siemens VAI have acquired extensive in-house CFD analysis capabilities and are able to quickly and effectively evaluate new technologies, as well as diagnose and solve problems with existing equipment. For the blast-furnace area, recent examples include the optimization of dustcatcher internals, an assessment of convective cooling of an iron trough, and an investigation of the gas-flow distribution exiting a hot-blast bustle main.



Optimization of dustcatcher design applying CFD

Application examples

An efficient dustcatcher is critical in meeting emissions regulations for gas exiting a blast furnace in a cost-effective manner. Gas flow and collection performance for two designs were compared (see Figure). It can be clearly seen that the initial design produces an undesirable flow pattern where high-velocity gas sweeps the dust-collection area. A CFD analysis shows that by modifying the design of the dustcatcher, the poor flow pattern can be eliminated, collection performance increased, and equipment size decreased.

Convective cooling of an iron trough is another example of where CFD analysis can be applied to assess heat-transfer conditions. An investigation was performed on a new trough design to ensure that its thermal convection pattern and maximum metal temperature were close to that predicted for a proven existing design. This could be confirmed, showing that the new trough design was acceptable and safe for use.

Uniform distribution of hot blast exiting the bustle main is critical for maintaining stable blast-furnace operation. Gas-flow distribution predicted by CFD analysis and also by a one-dimensional mathematical model was compared with actual plant data. The effect of gas-flow redirection near the connection between the hot-blast main and the ring bustle was accounted for by the CFD analysis, but missed by the mathematical model. There was a local increase in pressure, resulting in more gas being passed through the first tuyere. After this was recognized, rectification measures could be undertaken. Although both design tools closely agree with each other, added insight was gained by performing a CFD analysis.

The examples above are by no means the extent of what is possible with CFD analyses. Siemens VAI is continually finding new applications and is keen to provide analysis services for new and existing plant equipment to optimize design criteria and performance. ■

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