PUMPING UP SUSTAINABILITY

Flow simulation optimizes the energy requirement of pumps.

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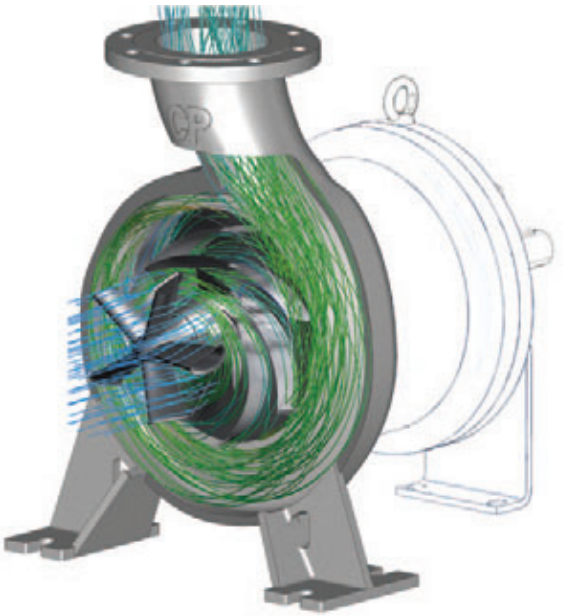
Process plant operators increasingly strive to reduce power consumption, achieve high efficiency and lower maintenance costs when investing in pumps. To gain an edge in this competitive marketplace, CP Pumpen (CP Pumps) in Switzerland, one of the industry's leading suppliers of premium quality centrifugal pumps, invested in engineering simulation software to improve its products.

The company has been helping its customers achieve sustainable improvements in fluid handling systems for many years. The power costs for operating a pump may comprise as much as 85 percent of its overall lifecycle cost. This provides the potential for huge savings by improving hydraulic performance and increasing overall efficiency, for example, thereby reducing power consumption.



ANSYS CFX simulation provides information on the discharge head, power consumption and efficiency; it also provides the designer with a view of the flow field inside the pump.

RAPID AND COST-EFFECTIVE DEVELOPMENT

Several years ago, CP Pumps needed to modify a legacy product family: a metallic chemical magnetic coupling pump (MKP). After initial attempts with in-house development tools, the team determined that the standard method of product development was far too time consuming and costly. The initial designs could be compared only based on experimental data, requiring prototypes to be individually produced and subsequently tested on the hydraulic test bench. In the search for alternatives, the company learned about ANSYS CFX and ANSYS BladeModeler software. BladeModeler allows CP Pumps engineers to quickly and easily model impeller geometries. This tool enables the user to design both the meridional flow path and the blade shape, including the blade-thickness distribution. Once blade geometry is specified, the software determines the cross-sectional area along the flow path to enable assessment of flow characteristics.

The engineers then can launch a CFX computational fluid dynamics (CFD) simulation from within the ANSYS Workbench platform. CFX calculates the complete three-dimensional flow field, including fluid pressure and velocity, which enables assessment of the impeller discharge head and efficiency. CP Pumps optimized multiple impeller designs for a particular pump size and subsequently tested them on the in-house pump test bench. The engineers developed an experimental testing method that allowed these prototypes to be used with the necessary metal connecting components (such as bearings or magnetic drive) and then tested them in existing spiral housings. Using simulation, the company rapidly and cost effectively created multiple designs, compared them with each other and validated them.

WORTHWHILE INVESTMENT

Many of the impellers designed using CFD dramatically improved the pump's hydraulic characteristics, as verified by the pump test rig. Other designs that

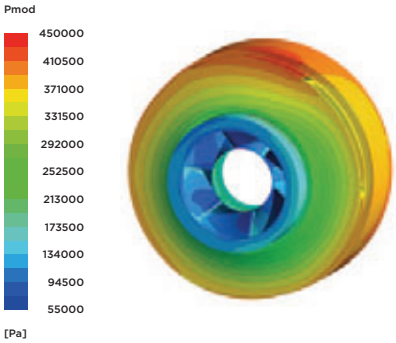
initially looked promising proved to be inadequate following CFD assessment, so prototype building (and accompanying costs) were avoided. Originally, the impeller was the focus of the new design. However, the development team quickly realized that the interaction between the spiral housing and the impeller was far more important than had been originally thought. It was not sufficient to simulate one part in isolation; instead, the team needed to include the whole unit in the simulation. Based on market research and this positive experience with ANSYS software, CP Pumps decided on systematic use of the simulation software for pump design.

Initially, the team calculated simulations on a steady-state basis since, at that time, the company did not have sufficient resources, including computing power to perform transient analysis. Transient calculations provide more detailed results but are more computationally intensive. To gain the benefits of a transient simulation, the company invested in a high-performance computer (HPC) cluster with multiple processors and a very large working memory along with multiple software licenses. The engineering group at first had to persuade management that this investment was worthwhile; when the first successful pump development left the test bench just a few months later, management was convinced. CP Pumps' hardware, software and personnel outlay for simulation with HPC is considerable. However, if the company develops only four pumps per year with CFD, the investment pays for itself because the pattern doesn't need to be altered for every pump size.

OPTIMIZED IN RECORD TIME

A further advantage of transient calculation is that, in addition to receiving hydraulic data (discharge head, power consumption and efficiency), the user also obtains information with regard to the transient pressure distribution inside the pump. With simulation, the company improved hydraulic performance in all 18 pump sizes of its MKP model; it also minimized the mechanical load on the impeller bearings, leading to improvements in the service life of the pumps. A further advantage of the hydraulic optimization is noise reduction for the pumps. Without CFD, it would have taken the company at least three times as long to develop equivalent products.

Completed pump



Pressure distribution around impeller

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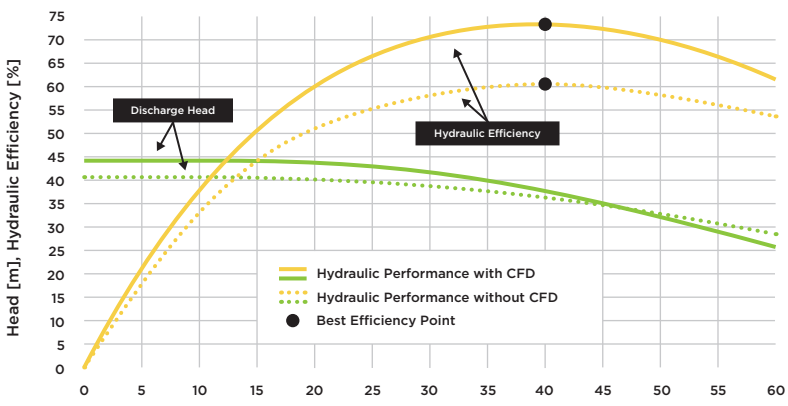
IMMEDIATE PAYBACK

Before modification, the pumps' efficiencies were acceptable, but today they are outstanding. In the final analysis, the use of fluid flow simulation has led to efficiency improvements of up to 50 percent. For customers, the pump consumes less power and requires less maintenance. "Last year, we had to replace two large heat exchanger oil pumps. The energy savings was so great that the investment paid for itself within a year," said Urs Wursch, chairman of CP Pumps. As the hydraulic efficiency of a pump increases, energy consumption declines correspondingly. This enables CP Pumps' customers to meet sustainability goals. The hydraulic components optimized with ANSYS CFX ensure high efficiencies and, in combination with special eddy-free can units, power savings of up to thousands of euros per year are possible.

Hydraulic performance improvement gained using CFD for MKP pump 65–40–160



The illustrated data was measured in February 2008 at the pump test rig of CP Pumps in Zofingen in accordance with EN ISO 9906 An.A. The details apply for operation with water at 20 C. Selected pump: MKP 65-40-160 with impeller diameter 180 mm at 2930 mi n-1.