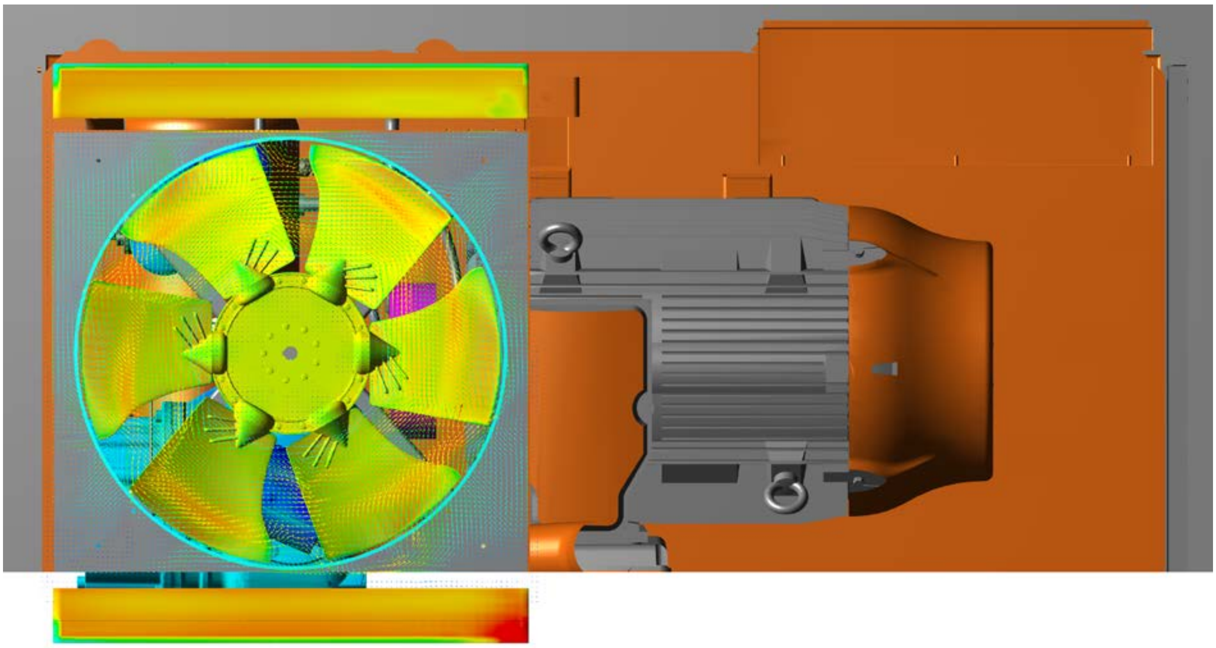
Success Story about Optimizing Energy Consumption and Noise Emission of the Cooling Airflow for Compressors

Partners: BOGE
CapVidia
Arctur



Noise emission and energy consumption are two decisive factors for worker safety as well as human-compliant workplaces and resource-efficient factories, respectively. This CloudFlow application experiment aims at minimizing energy consumption and noise emissions created by the fan and the cooling airflow for the reference case of compressors. This goal is achieved by introducing simulation, more specifically computational fluid dynamics (CFD) to the design and development process at BOGE and derive acoustics information from the flow simulation results to influence fan selection and noise-reducing enclosure design. The resource-demanding CFD simulations have been carried out with FlowVision from CapVidia which has been cloudified and adapted to the CloudFlow Infrastructure within the course of the experiment.

The experiment was an opportunity for BOGE to gain experience with CFD simulations and to introduce them to their development process that – so far – was based on building physical mock-ups and experimentation taking approx. 3-5 months of development time for one design variant of an enclosure-fan combination.

The goals of the experiment are:

- product innovation: improving the 'quality' of the compressor–enclosure–fan combination based on the simulation results, quality here means:
    - optimized design for the shape of the enclosure
    - cooling-fan with lowest possible noise emission and power consumption
- reducing development time from 3-5 months to 1-2 months
- lowering costs due to shortened development cycles

These noise reduction levels have been validated by physical experiments and measurements.

Technical impact

The cloudified CFD software FlowVision by CapVidia enabled BOGE to economically predict the effects of enclosure design and fan selection more accurately than with the physical experimentally-based approach formerly used. Some of the quantifiable technical/physical improvements are:

- reduced fan power consumption from 4 kWel to 2,75 kWel (> 30 %)
- reduced fan noise (just fan, without compressor block) from 82,1 dB(A) to 75 dB(A) (almost 10)
- reduced noise of the whole compressor by 0,9 dB(A) (15 % reduction of noise energy)
- reduction for electrical fan power consumption by 30 %

These improvements have been possible due to the efficient HPC/Cloud-based simulations which have provided insight into physical effects (air pressure, air flow) which is invisible in physical experiments. These insights revealed that some of the measures taken in the past to reduce noise of compressors where actually only addressing the symptoms, negatively affecting other performance parameters, instead of tackling the cause, e.g. noise reduction was compromising energy efficiency making the compressor less environmental-friendly than possible now after he experiment.

Simulation time could have been reduced by a factor close to 4 by using HPC resources. and affordability of the HPC resources and simulation services could have been improved by a factor close to 4, too, in the reference case due to a pay-per-use model.

This all contributes to reduced design and engineering time and costs. Yet alone, the design and layout of the splitter-type silencer can be calculated within hours instead of days that were needed before for the physical mock-up and experiment. This allows for simulating more alternatives than physical ones can be built economically, finding better solutions for the product more likely.

Putting it all together, the design cycle can be accelerated by a factor of 5 roughly, because not only individual experiments can be accelerated by virtualising them, e.g. the splitter-type silencer from a week to a few hours, but also some of the physical mock-ups can be rendered superfluous by replacing them with digital ones on which virtual simulations can be performed. Thus, the experiment also contributes to better time-to-market.

Economic impact

Predicting noise emission and power consumption of a compressor more accurately in the development phase thereby avoiding physical validation steps has considerable economic advantages for BOGE in terms of development cost and time-to -market. Furthermore and based on the current number of delivered compressor systems existing BOGE clients will save electricity cost that amounts to about 350.000€ per year. Finally, the important noise and power consumption reduction offers potential to increase the BOGE market share in particular in those markets in which either very silent or ultra-energy-efficient compressors are required. Taking the development cost reduction and the competitive advantage through better products and a faster time-to market into account, it is conservatively estimated that BOGE can increase their revenues by about 2 M€ over the next 5 years.

Having demonstrated the successful application of its FlowVision CFD analysis software, CapVidia expects a twofold economic impact of the experiments results. Using the software using cloud HPC resources on a pay-per-use base makes CFD and therefore this software attractive and affordable for many more companies. This will increase the sales of SW licences considerably. Moreover, the combination of the CFD specific knowledge of CapVidia with HPC resources in a package provides the company with a new business model selling all-inclusive CFD simulation services where customers get a turn-key simulation result for a fixed price in a given short time. CapVidia expects to increase revenues by 5 M€ over the next 5 years thanks to the experiments results.

The successful collaboration with CapVidia and a reference end-user company provides the HPC centre Arctur with additional customers from industry.