

CONSUMER PRODUCTS AND RETAIL

FIME

Using Simcenter STAR-CCM+ and HEEDS to help deliver comfortable, efficient heating to homes

Product

Simcenter

Business challenges

Improve outputs with less fuel

Enhance product safety by making sure the exhaust gases are safe

Improve product reliability to avoid costly recalls

Keys to success

Use Simcenter STAR-CCM+ to enhance accuracy of performance prediction

Use HEEDS to explore multiple designs quickly and automatically

Deliver a seamless process with the design tools communicating effectively

Results

Exceeded the industry standard by three-fold for boiler modulation ratio from 5:1 to 15:1

Vastly improved heating efficiency and cost-effectiveness of boilers

Made homes more comfortable than ever before

Siemens solutions enable FIME to surpass industry standard by three-fold for boiler modulation ratio

Achieving better domestic heating

Elica Corporation is the world's leading manufacturer of extraction hoods, with a turnover of over 470 million euros and 4,000 employees worldwide. Elica makes fans and motors for both their own brands and for household names in consumer goods such as Whirlpool, Samsung and Electrolux. FIME, an Elica brand, produces motors for domestic heating boilers, as well as pumps for domestic heating and ventilation and fans and motors for white goods.

Already a leader in Europe for motors for household appliances and boilers, FIME is always striving to improve the efficiency of its products to deliver continuous improvement, its core design principle. The household heating segment is predominantly dominated by two main requirements – comfort and efficiency. With an eye on delivering improved heating performance and increased energy savings for the customer, FIME put together a project to improve the ventilating system inside a domestic heating boiler. As suppliers of over 20 million heating pumps per year, even a small improvement in efficiency would have a big impact on domestic heating bills and overall emissions.



The numbers behind a comfortable, energy-efficient home

The level of comfort delivered by a domestic boiler hinges on a little known number – the modulation ratio. This is the ratio of the maximum to minimum output. The industry standard for modulation ratio is between 5:1 and 6:1. For example, a boiler with a maximum output of 120 kilowatts (kW) and modulation ratio of 5 has a minimum output of 24 kW. In modern homes with good insulation, the minimum heating demand will often be lower than the minimum output of the boiler. For the boiler mentioned above, if the minimum heating demand is less than 24 kW, the boiler will provide the heating required and switch off until the next heating cycle. Constant switching on/off of a boiler results in inefficient use of fuel and wear-and-tear on components.

The single integrated interface of Simcenter STAR-CCM+ enabled a seamless setup of the CFD simulation to analyze the performance of the venturi mixer inside the blower.



Figure 1. FIME's ventilating system inside a domestic boiler (right) and the venturi mixer (left).

For modern homes, a high modulation ratio is critical to customers as this improves the boiler longevity and efficiency while reducing constant on/off cycling, energy bills and wear-and-tear on components. Moreover, the higher the ratio, the more stable the heating delivered to the house, an important factor to avoid a boiler switching off during operation (no one likes it when the shower gets too hot or too cold due to boiler fluctuations).

FIME set its sights on achieving a much higher modulation ratio and deployed computational fluid dynamics (CFD) simulation and design optimization on its pump design to understand how that might be achieved.

Optimizing the mixer design in a boiler

FIME set out to optimize the venturi mixer design to balance the gas and air intake for optimal output. The venturi mixer is a static mixer that provides the right amount of air and methane to the gas blower. In particular, the mixer affects the modulation ratio. A good mixer design provides enough flow rate at high power while maintaining high pressure at lower power outputs. This allows the boiler to sustain combustion at higher and lower power outputs while subsequently exhausting the gas. This increases the gap between the power outputs, thereby increasing the modulation ratio.

Using Simcenter STAR-CCM+ to find the best design

The overall objective of the project was to improve the modulation range beyond the industry standard of 6 to 8. FIME needed to identify a new static mixer design capable of achieving the high ratio while ensuring complete combustion and reliable power delivery. Prototyping and testing multiple designs would have been costly and time-consuming with no guarantee of achieving the best possible mixer design. The engineers at FIME instead turned to CFD simulation and design optimization. The design optimization process with Simcenter™ STAR-CCM+™ software, which is part of the Siemens Xcelerator business platform of software, hardware and services, included the following steps:

- Input design variables, constraints and objectives to the model
- Parameterize the 3D computer-aided design (CAD) geometry
- Use HEEDS™ software to deliver CAD robustness for CFD simulation
- Use Simcenter STAR-CCM+ to run CFD analysis
- Simulate, analyze and explore multiple designs driven by HEEDS
- FIME engineers interpret results and identify the best design

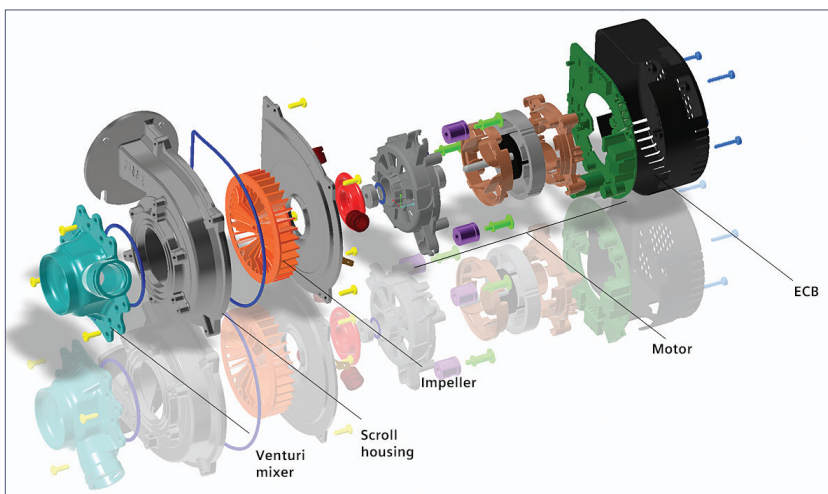


Figure 2. Exploded view of the FIME ventilating system.

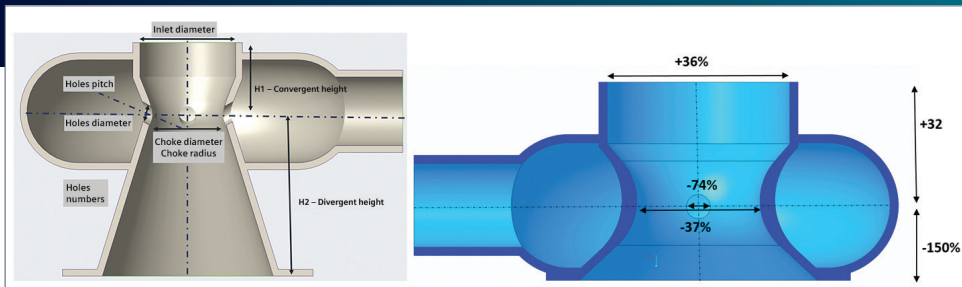


Figure 3. Initial design of the static mixer (left) showing design variables and optimization (right).

The single integrated interface of Simcenter STAR-CCM+ enabled a seamless setup of the CFD simulation to analyze the performance of the venturi mixer inside the blower. The validated simulation methodology delivered performance characteristics like mass flow rate of the air and gas and the thermal power output from the blower.

HEEDS was used in the optimization stage to consider eight geometry variables, including air inlet diameter, choke and hole diameter. In an entirely automated process, HEEDS was used to create 160 mixer designs. The performance was analyzed in Simcenter STAR-CCM+ to find the optimum design. All designs had to meet two performance constraints, ensuring adequate thermal power output and air/fuel ratio. The fully automated design exploration process delivered a design with a modulation ratio of 10, which was confirmed by a heating boiler test on a prototype.

Extending the process to a dynamic venturi mixer, 155 more designs were evaluated with Simcenter. The engineers at FIME achieved an optimal design delivering a modulation range of around 15, which is much better than the best available static mixer on the market.

A heated boiler test on the new design validated the simulation results, helping FIME digitally improve the product at the same design and cost.

Francesco Trabalzi, mechanical design Leader at FIME, states, "Using Simcenter STAR-CCM+ and HEEDS, we found an

optimized design that is able to maximize the modulation range and increase the quality of combustion without exceeding the production cost of the device."

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FIME

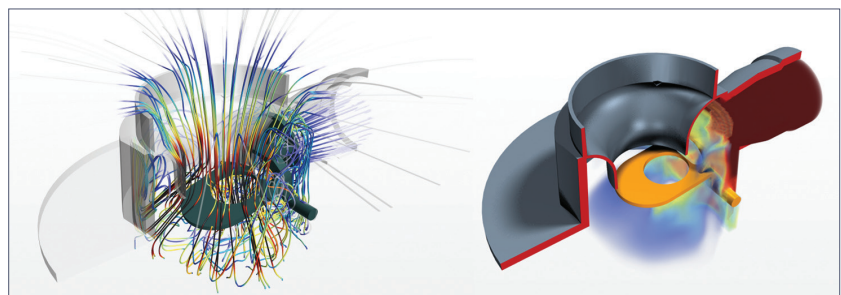


Figure 4. Flow streamlines (left) and volume-rendered flow (right) from CFD simulation through the optimized dynamic mixer design.

Solutions/Services

Simcenter STAR-CCM+
[siemens.com/simcenterccm](https://www.siemens.com/simcenterccm)
HEEDS
[siemens.com/simcenter](https://www.siemens.com/simcenter)

Customer's primary business

FIME is an Elica brand that has more than 40 years of experience in the design and production of electric motors and plays a leading role in the international market. FIME's products have been chosen by the major industrial groups, such as Vaillant, BSH, Viessmann, Ariston Thermo, Miele, Whirlpool and Electrolux.
www.elica.com/corporation/en

Customer location

Castelfidardo
Italy

The team at Elica has now set its sights on the desirable value of 20 by using Simcenter STAR-CCM+ and HEEDS to evaluate more design parameters.

Better boilers for a better home

Today, the market for heating boilers is focusing on the modulation range that represents the capability of the boiler to work to high and low thermal power values.

This project aimed to maximize the modulation range reachable by means of a static mixer with a view to bettering the industry standard (6 to 8). By using Simcenter STAR-CCM+ for CFD simulations and HEEDS for design optimization, the FINE engineers delivered a modulation range of 10 for a static venturi mixer. However, the most important improvement is using a dynamic mixer that ensures a narrow air/gas passage section for low thermal power and higher passage for high thermal power. The first optimization run, validated by experimental test, has brought the modulation range to the value of around 15.

The team at Elica has now set its sights on the desirable value of 20 by using Simcenter STAR-CCM+ and HEEDS to evaluate more design parameters.

The use of a simulation-based approach has helped FIME and Elica engineer innovation in the domestic heating boiler design to improve performance beyond today's market standards. For the average consumer, a domestic heating boiler driven by Elica's motors now delivers a longer lifetime, fewer breakdowns, better fuel efficiency and a more stable heating experience. With Simcenter STAR-CCM+ and HEEDS, FIME and Elica are making our homes even more comfortable than ever before.

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