Facts

Challenge

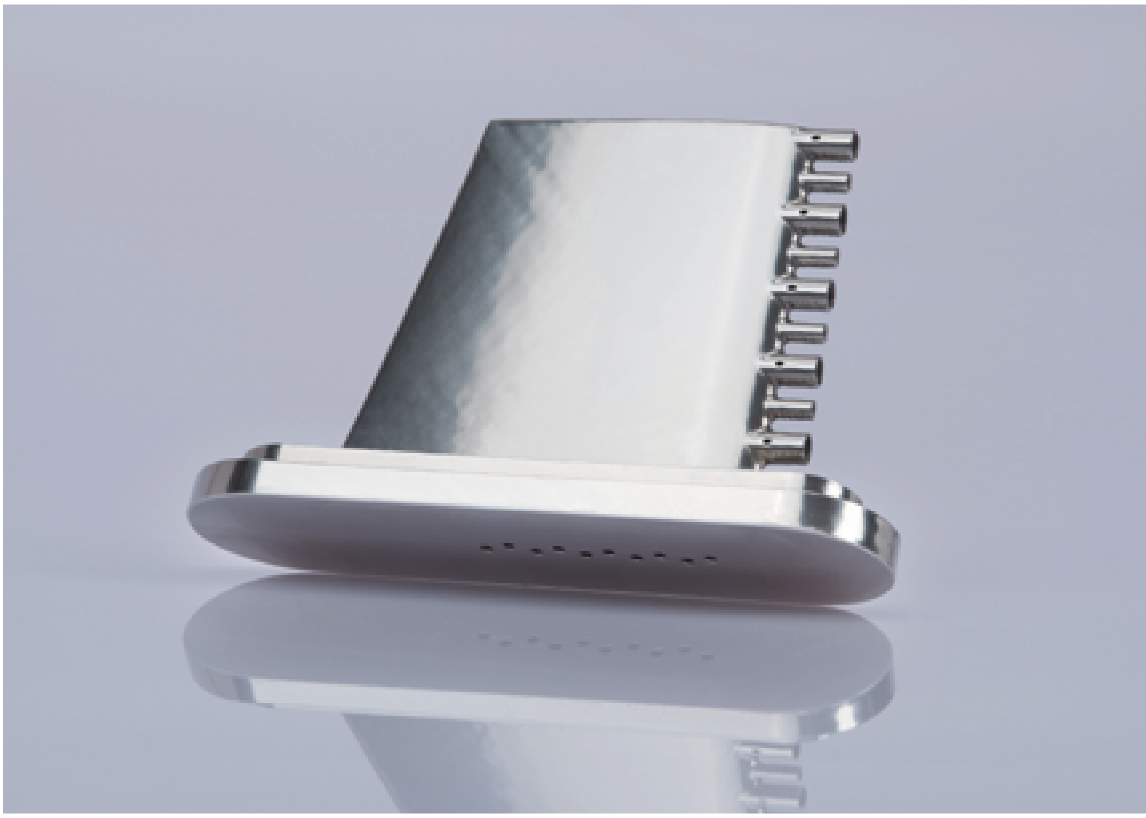
To produce robust probes for measuring speed and temperature in turbo engines.

Solution

Additive manufacture of extremely robust and at the same time thin probes featuring a long service life and precise measurements.

Results

- Flexible: freedom of design in terms of form, material and size
- Robust: components are up to 150% sturdier than those made by conventional manufacturing
- Low-maintenance: extended service periods with reduced maintenance overhead
- Fast: product development in just 1/3 of the usual project duration



Extremely rigid and durable: this compact flow measurement probe was made in one piece using industrial 3D printing (source: EOS GmbH, Vectoflow).

Durable up to the Sound Barrier and Beyond

Flow measurement probes from Vectoflow—highly robust thanks to additive manufacturing and EOS

Short profile
Vectoflow GmbH is a company operating in the field of fluid-dynamic metrology engineering. Its combination of innovative processes enables it to supply measuring technology in as yet unparaleled quality.

Further information
www.vectoflow.de

Flow measurement probes are the components responsible for gauging the speed and angle of attack of an airflow and are used in particular in aircraft and turbo-machinery design. The speed and angle of attack are determined from the inflowing air. While they may seem relatively small and fragile, these systems have to withstand extreme stresses and continue to function reliably at all times. Vectoflow specialises in developing and manufacturing complex flow measurement probes. It uses EOS additive manufacturing technology to achieve an ideal design with maximum endurance.

Challenge

Speed is a major factor in aircraft—firstly to give it its decisive advantage over other forms of transport and secondly, it is a critical factor, since if the speed is too low, the airflow can stop abruptly causing the aircraft to crash. Too much speed, on the other hand, places too much stress on the components. So-called flow measurement probes are used in aviation to constantly measure relevant speeds. As the air flows through them, the speed is determined based on the pressure. This might, for example, be the flight/air speed or the speed at which air flows through the engines, thus providing propulsion.

Considering the high Mach numbers that are frequently encountered nowadays in both subsonic and supersonic ranges, it is of no doubt that the probes are subjected to severe stress. This is all the more so when functionality has to be guaranteed at large angles of attack, i.e. when the nose of the aircraft points sharply upwards or downwards. High forces and irregular air inflows also occur in certain installation configurations in a jet engine, for example when the probes are located at an angle to the airflow. This is where our Kiel probes, an enhanced development based on traditional flow measurement probes, are a solution. They enable accurate measurements to be taken, for example, during extreme flying manoeuvres or when engines are in a banked position. However, the stresses on the component then increase even further. This is especially the case in the engine, due to the higher thermal loads.

KKiel tubes are used to measure the total pressure in the engine. (source: Vectoflow)

Vectoflow specialises in developing such probes. Right from the start, the specialist team has used additive manufacturing to meet the aforementioned challenges. One special case shows just how great the potential of this technology is. The engineers were given the task of producing a group of probes with a particularly aerodynamic design a so-called rake. In plain terms, this meant having to produce instruments in a very small and optimised form in order not to disrupt the airflow. At the same time, they had to be able to withstand temperatures of 1,000 degrees Celsius over prolonged periods.

Solution

"Our customer, a European research company in the aerospace industry, experienced ongoing problems with probes fracturing because they were made up of multiple parts, which made them unstable. "We manufacture our probes in a single piece in order to avoid this type of problem," explains Katharina Kreitz, Engineer and Director at Vectoflow GmbH. "Additive manufacturing allows us to produce Kiel probes in a single piece, and the special Kiel architecture is only possible using EOS technology. This enables us to implement special functionally integrated designs and attain very small channel and overall sizes."

When modelling the components, Vectoflow also attaches great importance to minimizing the number of possible disruptive factors and their effects, for example the development of undesirable secondary noise, as acoustics measurement was also part of the remit in this case. The engineers also found effective solutions relating to thermal load capacity thanks to the nature of the layered production with the EOS M 290. The thermal elements measure the temperature of the respective measuring units. The nickel-chromium alloy is even able to withstand high temperatures of up to the required 1,000 degrees Celsius and continue to be fully functional at twice the speed of sound.

Vectoflow also subjected the components to extensive post-production treatment, to optimize the product quality. Specially developed processes give the probes their extremely smooth surfaces and perfect finish. This optimises the aerodynamic quality of the probe such that their functions—measuring pressures and temperatures in the boundary layer of the air flowing from the jet engine—are not impaired.

Results

The customer was impressed with the Vectoflow team's approach, as Katharina Kreitz confirms, "We received very positive feedback. Unlike probes manufactured using the traditional machining process, our sample was impressively robust. Our component is 150 per cent more rigid than conventionally made parts. Moreover, the extremely low thickness, improved aerodynamic design and post-treatment played a major role in allowing the user to obtain very precise measurements." Formerly frequent component fracturing is now a thing of the past.

And there are further benefits too. For example, the user is now able to enjoy significantly extended component maintenance intervals , and he can perform any work required with the part in situ, which, depending on where the part is installed, can save days. This factor has an immediate positive effect on costs and reflects the considerable robustness and high level of safety. What is more, additive manufacturing makes it possible to achieve short production lead times and in turn, rapid delivery. Vectoflow was able to cut its overall production time—from the initial draft to the finished part—to about one third of time it originally needed.

Once again, additive manufacturing shows what it is capable of—maximum flexibility in design, size and material, coupled with fast production and delivery, resulting in precise and reliable components with a long service life. This makes the process ideal for use in aerospace engineering, where maximum safety standards go hand in hand with extreme stresses—at the supersonic speeds.

"Our team has many years of experience in fluid-dynamic development as well as in the industry. We are driven by an entrepreneurial spirit that results in the continuous improvement and expansion of our product range, with innovative production methods playing a key role. We are absolutely convinced by EOS technology. It is revolutionary."

Katharina Kreitz,
Vectoflow GmbH

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