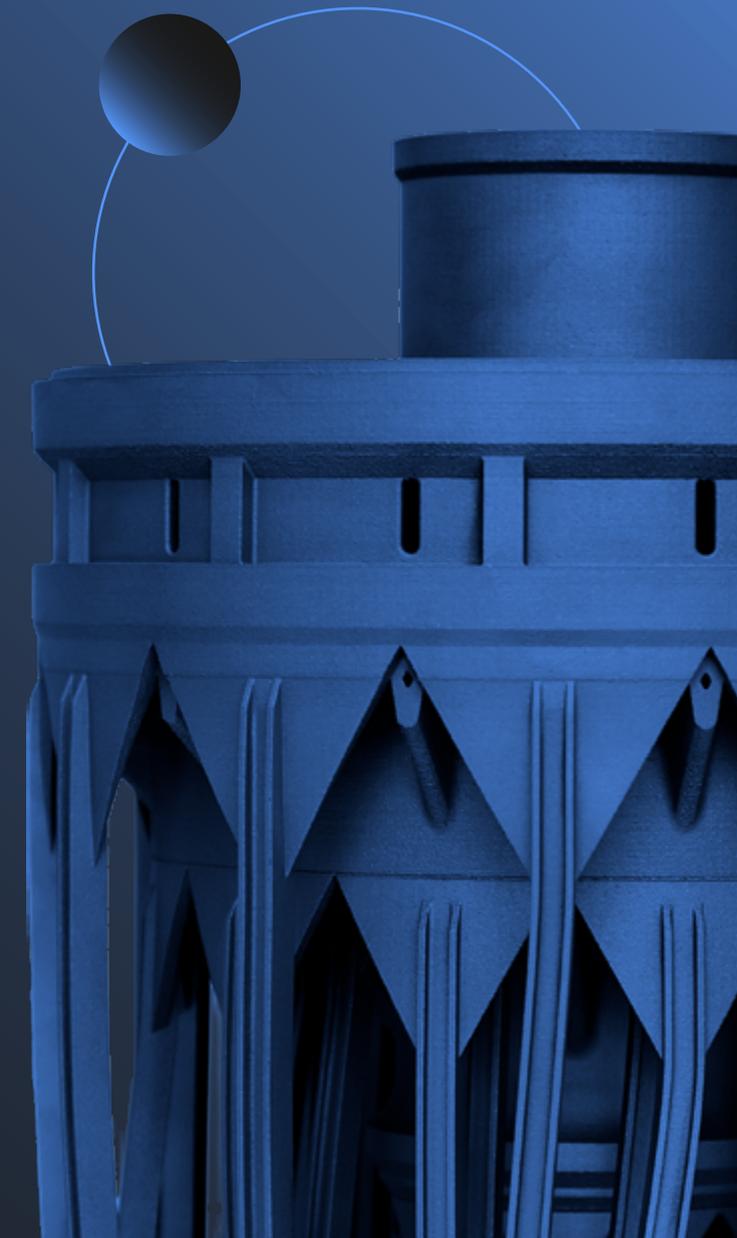


DOOSAN ACHIEVES UNMATCHED EFFICIENCY IN GAS TURBINE PARTS

WITH EOS 3D PRINTING



INTRODUCTION

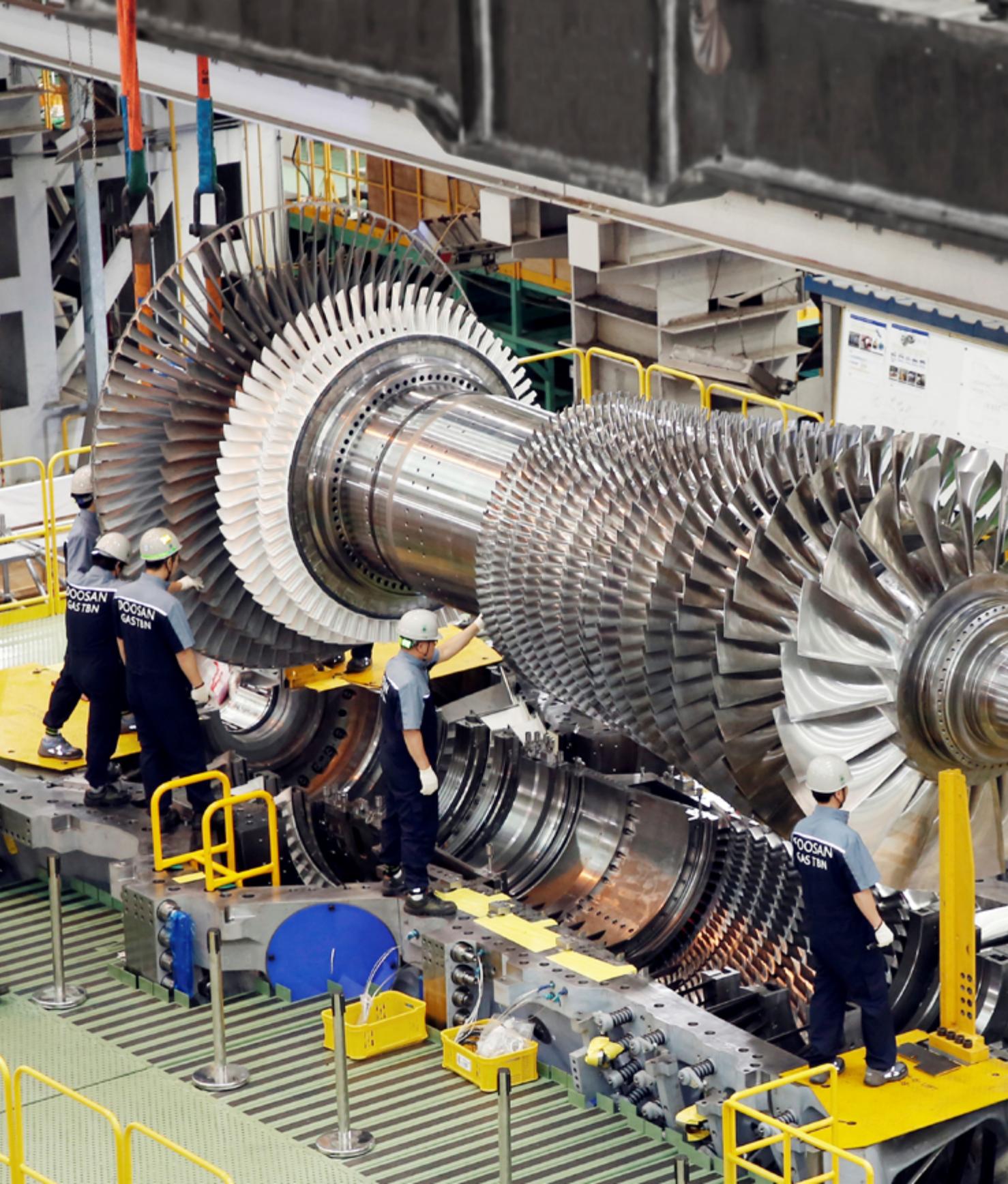
Doosan Enerbility, a South Korea-based global leader in energy industries, faced a problem all too common in gas turbine manufacturing. They were trying to lower their turbines' CO and NOx emissions while maintaining efficiency and power output, but conventional means of manufacturing didn't allow for the design complexity needed.

As part of their environmental strategy, many regions are moving toward gas turbines because they produce fewer exhaust gases than external combustion plants and even use excess exhaust gas heat for so-called combined cycle power generation. However, that often introduces the new problem of CO and NOx emissions which must be limited in urban areas, thus affecting the turbines' application possibilities.

Doosan does business in a highly competitive market and time to find a solution was pressing, they went off the beaten track, integrating additive manufacturing (AM) solutions.

By building the critical part additively, Doosan dramatically lowered the amount of unmixed fuel in combustion by 68%, leading to highly reduced emissions at a high efficiency level.





THE CLIENT AND THE PROJECT

As a global corporation, Doosan offers everything from equipment and services to utility-plant EPC, but no matter how much experience, the challenges in turbomachinery are well described and apply to everybody.

To work at optimal combustion temperature while minimizing CO and NOx emissions, the temperature needs to be precisely regulated through the mixing of gas and air. A suboptimal mixing scheme will result in cold and hot spots and therefore higher emissions. Not to mention your turbines work less efficiently because the hot spots that add the most to NOx emissions don't benefit the actual power production.

To make matters worse, all of this mixing has to happen in a very limited space, pushing traditional manufacturing methods like CNC to their limits.

Doosan clearly felt this problem while trying to establish an ecosystem of independent domestically produced gas turbines for distribution throughout the country.

Due to the public's evolving interest in alternative energy sources, the government was eager to begin transitioning from traditional power plants to gas turbines, among other solutions. However, Doosan kept running into challenges which prevented them from meeting target emissions and achieving performance objectives.

THE CHALLENGE

Compared to traditional means of energy production such as coal, gas power plants emit less fine particulate matter, making gas turbines a cleaner source of energy, relatively speaking.

The key ingredient to this better emission profile lies in the gas turbine's combustor, more specifically, the combustor's nozzle and pre-mixer. To meet the government's emission regulations, the combustion needs to remain under a predetermined emissions threshold, which requires a complex design. The mixer's and nozzle's internal channels need to allow for the right composition of air and fuel to be delivered to the combustion for optimum output.

However, with casting, molding or CNC manufacturing, it's challenging to fabricate a part with the appropriate internal channel design. With most processes, the only option would be to produce multiple pieces that are ultimately combined into the final component. This poses several problems.

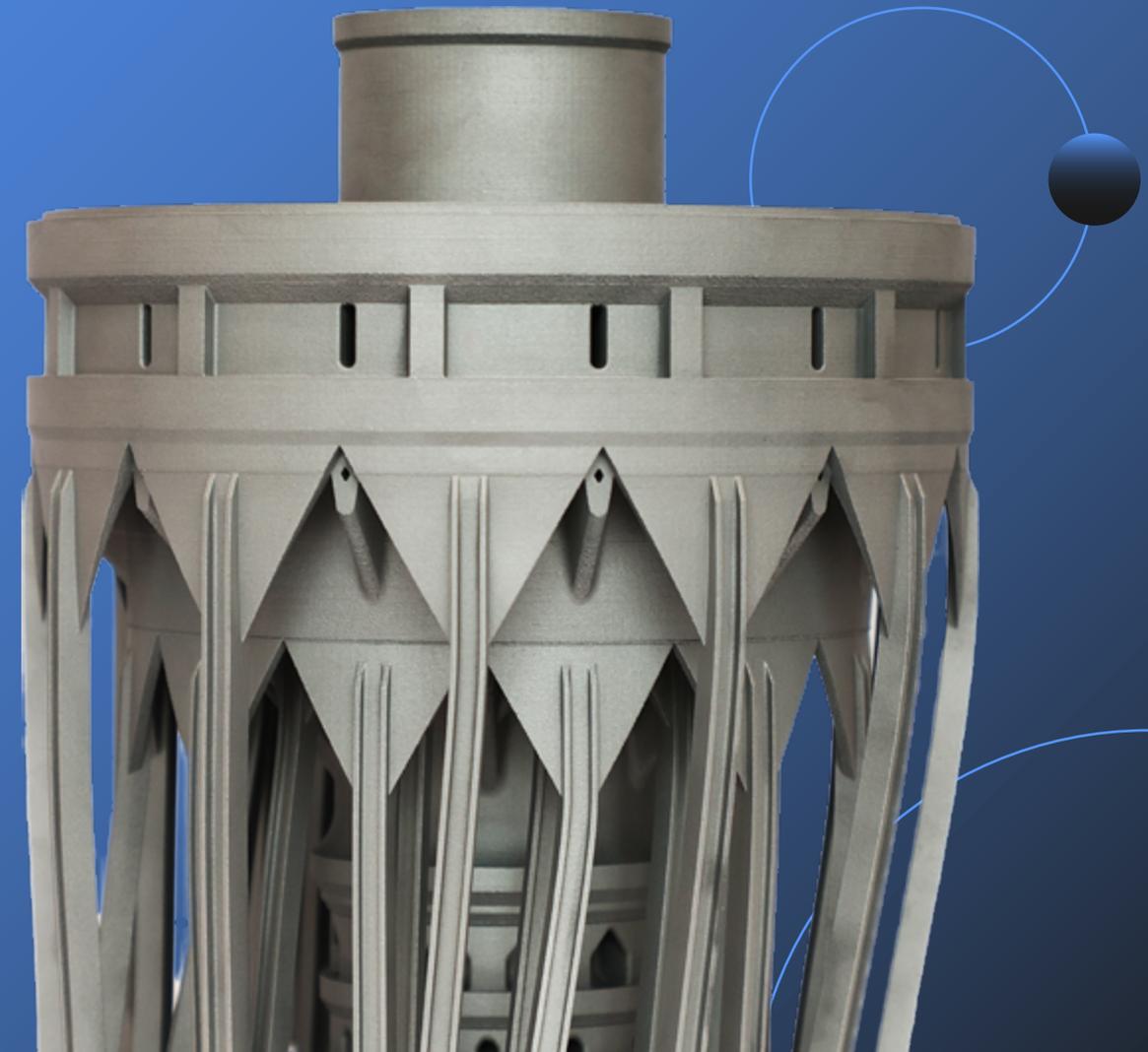
Producing multiple parts drives up costs. In addition, the produced parts usually have a larger footprint to reach given performance goals. In cases where the performance isn't realized within the combustion process, the need for post-treatment equipment can increase costs even further while reducing overall efficiency.

THE SOLUTION

The Doosan development team realized early on that traditional manufacturing methods like CNC weren't capable enough for their plans. Since the company already operates South Korea's largest 3D printing facility, they could rely on several EOS 3D printing systems to solve their production problem.

For their needs in high performance and flexibility, they found the four-laser setup and double re-coating capabilities of the EOS M 400-4 to be ideal. They manufactured the nozzle using STS 321, a specific stainless steel that is often preferred for applications in high temperatures, preventing intergranular corrosion.

While the choice of production means and material already gave them significant advantages over traditional manufacturing processes, the question of control standards was yet to be solved. To ensure build quality and repeatability, Doosan used EOS MeltPool and Exposure OT optical tomography solutions. EOS offered field service and technical support at the facilities in South Korea to guarantee production output that met the government's and Doosan's standards.



THE RESULTS

By its nature, AM inherently allows for more freedom of design than other methods like CNC manufacturing. With EOS systems, Doosan engineers were able to produce the high-performance mixer / nozzle they needed. Rather than compromising on efficiency or emissions, they developed the internal channel structure that could facilitate perfect mixing, regardless of the design's complexity.

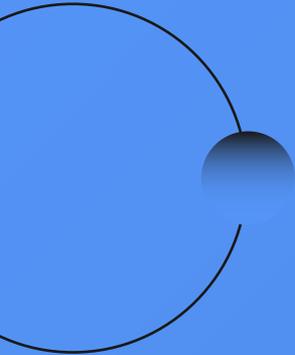
Aside from the manufacturing benefits, the engineering team deeply appreciated the EOS M 400-4's intuitive user interface and variable laser scanning patterns, as they helped to make the actual build easier and more efficient.

50% LEAD TIME REDUCTION

Doosan was able to reduce nozzle production lead time by 50% as a result of a single AM process, compared to a combination of component manufacturing, assembly and welding.

Most importantly, the complex internal channel design enabled them to lower the level of unmixed fuel by 68%, thus ensuring that their gas turbines didn't exceed the government's emissions limit. Thanks to AM, they were able to lower NOx emissions to as low as 15 ppm and CO emissions to 10 ppm, less than a third the emissions seen in existing coal power generation.

Due to EOS' technology leadership and the great innovations that allowed for more sustainable and efficient solutions, Doosan plans to make EOS 3D printing solutions an integral part of their endeavors. Their additively manufactured hydrogen turbine, currently in development, will help lower carbon emissions by about 50,000 tons per year. They're also developing additional turbine parts, including blades and vanes, with the help of EOS technology, once again showing how AM can solve known manufacturing problems while lowering costs from product design to production and maintenance.



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Thanks to EOS for creating such an outstanding product! With the exceptional EOS M 400-4, we've been able to expand our AM service business across various industries, including gas turbine parts, defense, aviation, space, automobiles, and semiconductors. The high productivity and utilization of the EOS M 400-4 have led to remarkable customer satisfaction, thanks to its quality, reliability, the use of optical tomography and excellent technical support provided, such as field service and technology downloads. These efforts by your company have truly elevated our business to the next level.

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All team members of Doosan Enerbility AM business team

DOOSAN

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