CASE STUDY

Industrial 3D-Printed Parts for Oil & Gas Field Service Applications

Velo3D teams with IMI Critical Engineering to provide a major O&G operator with additively manufactured components.

IMI Critical Engineering

CHALLENGE:

Provide O&G operator with key replacement parts reliably and quickly

INDUSTRY:

Energy

KEY BENEFITS:

- No redesign or Design for Additive Manufacturing (DfAM) required
- Improved part performance
- Improved maintenance and supply chain scalability

IMI Critical Engineering knows the challenges facing the Oil & Gas industry. The company operates a global service network, with manufacturing facilities in 12 countries and employs over 3,400 talented people across a range of disciplines, and its products are at the heart of complex energy and production processes for some of the largest O&G operators around the globe.

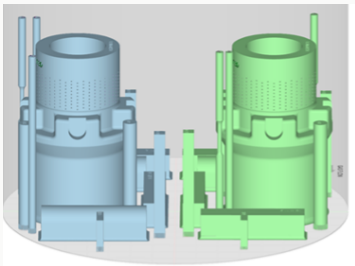
Challenge

Although many of the parts produced for the O&G industry control the flow of steam, gas, and liquids in harsh environments, and are designed to withstand temperature and pressure extremes—as well as intensely abrasive or corrosive cyclical operations—keeping oil and gas production facilities running smoothly is never easy.

Critical process-control components inevitability fail under these severe service conditions. To rapidly respond to these failures, and due to long conventional manufacturing lead times, O&G operators have historically been forced to maintain high-volume inventory programs. But these programs are both costly and inefficient.

Often, the parts placed in inventory are the same ones from when the facility was first designed. Even worse, replacements may be unavailable from the manufacturer. Opportunities to upgrade a component's design or materials as operating requirements change, or next-generation designs are introduced, are limited at best.

Thus, O&G operators need a way to provide key replacement parts reliably and quickly to facilities in distant corners of the world without having to stockpile expensive inventory of existing parts at every location or redesign and qualify a new part from scratch.



Two choke valves optimized with IMI's DRAG technology, pictured in a Velo3D Flow™ software build file.

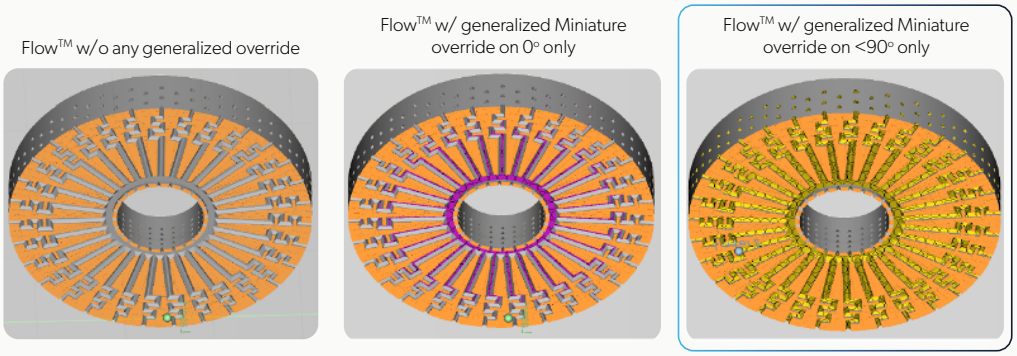
Solution

To overcome these operational challenges and determine the feasibility of on-demand part replacement as an industry standard, IMI Critical conducted a trial project that explored the use of advanced additive manufacturing (AM) technology. The test project involved producing a commonly installed choke valve cage to demonstrate proof of digital inventory viability with an AM printed part that meets all quality and performance standards.

IMI Critical turned to Velo3D, known for its advanced end-to-end metal AM solution, which includes automated pre-build system calibration and end-to-end build-quality monitoring and reporting. The test parts, which also meet draft API20S requirements, were printed on a Velo3D Sapphire® metal AM system operated by contract manufacturer Knust-Godwin.

To achieve the desired part without any design compromise, unlike conventional AM solutions, Velo3D's Flow™ print-preparation software automatically responds to a part's geometry without any complex part-specific parameter development. Flow™ does this by intelligently applying a generalized set of recipes based on the design's native CAD geometry and user-defined inputs relating to surfaces of importance.

This allows design engineers to focus on their desired end-part functionality without the need for complex, pre-print parameter manipulation. The designer can also use the software to easily apply and test different surface-refining sub-processes to choose the best one.



Three surface finish test conditions using Velo3D's Flow™ Software

Image 4a & b. (a. Top) Two choke valves, optimized with IMI's DRAG technology, shown on the build plate after being 3D printed with Velo3D's Sapphire® system, and **(b. Bottom)** the two valves after finishing.

This not only resulted in a quick transition into the first-article section of the project, but it also created a standardized framework to further ease setting up future builds to meet IMI Critical's specific surface finish and flow characteristic requirements. Velo3D's ability to manufacture internal channels and overhangs at well-below 45-degree angles (even down to zero in the case of IMI Critical's DRAG technology) helped enhance the application of DRAG to optimize legacy designs and simplify workflows.

With API20S requirements top of mind during the printing of part, the automation provided by Velo3D 's internal quality-control software, Assure™, compiled the data along with a tremendous amount of information collected throughout the build, layer by layer, which then automatically generated a build report containing important information for compliance. The raw data and height-mapper images generated by the software were also useful for evaluating and assessing critical areas of the part for future production.

In conjunction with the Flow™ software and the easy one-click pre-print calibration of each machine, Velo3D uniquely allows the same generated print file, to be printed on any Velo3D system regardless of its location in the world and with the same expected end-part quality. These capabilities of advanced AM, such as Velo3D's end-to-end solution, make digital warehousing and on-demand high-quality part replacement achievable.

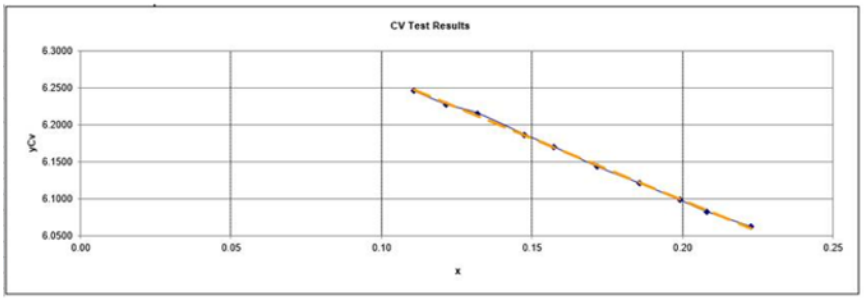
Outcome

With Velo3D, IMI Critical was able to successfully print the choke valve cage using Velo3D's advanced metal AM solution. Moreover, they were able to print this part with no design, quality, or performance compromise, or redesign for AM.

This outcome aligns with the long-term goal of the joint project, which is to build a compendium of measured field data that will support the path towards certification of production parts for AM as well as the future establishment of more exact specifications for material properties and test methods.

The valves were then machined to final finish while specimens were testedin accordance with API20S, which showed compliance to IMI Critical's materials specification.

The valves were then tested at IMI Critical before being delivered to the O&G operator for use in upcoming field trials. "This was the first production valve produced using Velo3D technology and the Flow™ test results were a profound demonstration of the consistency of the generalized processes," says Steve Freitas, R&D Director, IMI Critical Engineering.



Completed choke valves Flow™ tested at IMI Critical's facility.

With initial testing and analysis has already deemed successful, these versions are in transit to be run in the field by the O&G operator in extreme conditions. Additional field testing will also be performed to collect more operational data. The result will be production-ready components, adhering to current API20S draft objectives.

"The unique abilities of Velo3D's next generation technologies will allow us to minimize the re-design of our products for additive while also reducing the barriers associated with traditional metal additive systems on the build setup, maintenance, and supply chain scalability," Freitas says.

By using Velo3D's end-to-end metal AM solution to deliver DRAG-optimized parts at the quality and performance required in less time than traditional manufacturing methods, IMI Critical can provide its customers with significantly shorter lead times and a simplified supply chain.

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