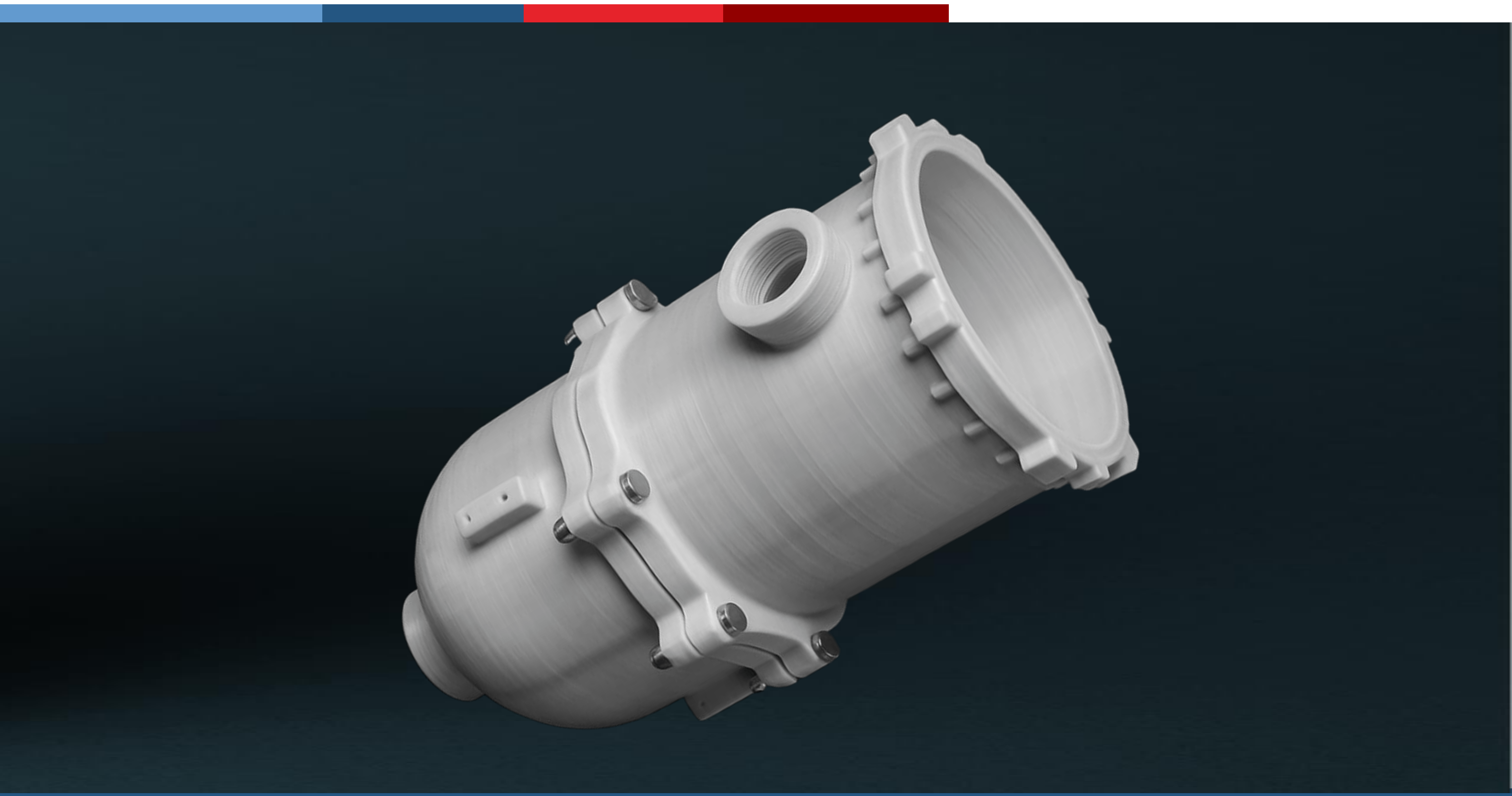
CASE STUDY

From Leaks to Reliability: Additive Manufacturing of a Replacement Bag Filter Housing for Offshore Desalination



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1. Introduction

Filter bag systems are filtration devices that use replaceable fabric bags to capture and remove particles from liquids or gases, ensuring efficient separation and maintaining process quality. These systems are designed for high flow rates and high sediment holding capacity. They provide filtration solutions for a broad variety of fluid applications in the process industry.

The filter bag housing is a critical component of filter bag systems. It provides a sealed environment where liquid or gas passes through the filter bag, trapping contaminants and ensuring efficient filtration. These housings are typically made from materials like stainless steel, carbon steel, or plastic to withstand various industrial conditions.

In offshore applications, bag filter systems are used in seawater desalination systems to pre-filter seawater, removing sediments and particulates before the reverse osmosis process to produce freshwater for industrial and potable use.

2. Problem Statement

Our customer reported that the existing unplasticized polyvinyl chloride (UPVC) filter bag housing required replacement due to leakage during operation, which compromised its effectiveness and posed a contamination risk. The frequent occurrence of cracks in the UPVC housing led to operational failures, resulting in unplanned downtime and disruptions to the freshwater supply, which is critical for offshore potable water needs. Figure 1 shows the leakages and crack present in the failed filter bag housing.

To address these challenges, the customer emphasized the need for a more robust, leak-proof housing solution that ensures long-term reliability, enhances operational efficiency, and minimizes maintenance costs in their desalination processes.

Figure 1: Leakage stains and cracks present on the failed filter bag housing

3. Our Solution

Based on our evaluation, we observed the following:

1. The cracks at the upper and lower sections of the filter bag housing likely resulted from material limitations under offshore seawater desalination conditions. UPVC's susceptibility to stress cracking under high salinity, fluctuating pressures, and prolonged exposure to UV radiation might have compromised its structural integrity, leading to leakage during service.
2. We observed excessive leakage from the adhesive-bonded joints of the three-part housing, compromising performance.
3. The openings at the joints of the housing presented a significant risk of water contamination, as they allowed external particles, debris, and microorganisms to infiltrate the system during operation. This compromised the integrity of the filtered water, potentially impacting its quality and suitability for potable or industrial use.

After a thorough evaluation of the key design constraints and performance requirements, we implemented our solution in a systematic and structured manner to ensure optimal functionality and long-term reliability.

To achieve this, we selected ULTEM 9085 for the enclosure due to its superior corrosion resistance, strength-to-weight ratio, and long-term durability in offshore and seawater environments. While all polymers face challenges in prolonged seawater exposure, the material's properties provided a suitable solution for this replacement component.

The redesigned housing was strategically engineered to eliminate potential leakage points by addressing two critical factors. First, it mitigated the effects of turbulent inflow, ensuring a stable and consistent water flow while preventing upward displacement within the system. Second, the new design significantly reduced the number of joints and seams, minimizing the risk of structural weaknesses and enhancing the overall integrity of the housing.

The assembled unit underwent pressure testing based on the customer's operational requirements to verify integrity and performance. The testing protocol was designed to confirm the housing's suitability for the specific seawater filtration application in question. A 3D model of the improved filter bag housing is shown in Figure 2.

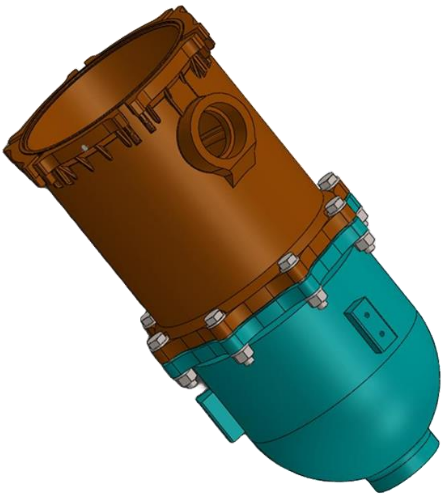

Figure 2: A 3D model of the redesigned housing

To manufacture the filter housing, we utilised Fused Filament Fabrication (FFF), a widely adopted additive manufacturing method selected for its material flexibility and cost-effective production of large-format components. The manufacturing process used optimized print parameters, including controlled raster orientation and elevated build chamber temperatures to enhance interlayer adhesion. Potential permeability concerns were mitigated through the use of fine nozzle diameters, reduced layer heights, and dense infill patterns. These measures, combined with precise geometric control, resulted in a dimensionally accurate and mechanically robust component, well-suited to withstand the operational demands of its intended filtration environment.

4. The Result

The successful completion of the project delivered a robust, leak-proof housing that exceeded the customer’s expectations, enhancing operational efficiency and ensuring reliable performance. The enclosure was produced and delivered within just 14 days from design approval, a significantly shorter timeframe than conventional manufacturing and international sourcing options, which would typically require about 8-10 weeks. By optimizing material selection and adopting a two-part assembly approach, we not only met the required performance criteria but also enhanced the sustainability of operations.

Figure 3: The result

5. Sustainability Impact

The adoption of additive manufacturing for this filter bag housing replacement offers meaningful sustainability benefits tailored to this specific application. By utilizing Fused Filament Fabrication (FFF) with ULTEM 9085, we addressed several sustainability challenges inherent in replacing legacy components for offshore operations.

A primary advantage of this approach lies in enabling local, on-demand production. Manufacturing the replacement housing in the same country as the end user eliminated the carbon footprint associated with international shipping while reducing lead times. This localized production strategy is particularly valuable for legacy components that would otherwise require costly retooling of injection molding equipment or maintaining extensive spare parts inventories.

The redesigned housing, with its reduced number of joints, directly addresses the failure mode evident in the original component where leakage occurred at connection points between sections. By minimizing these potential failure points, the new design extends the operational lifespan of the component, reducing the frequency of replacements and the associated material consumption over time. Additionally, the additive manufacturing process eliminated the need for manufacturing tooling typically required for injection-molded components. The absence of mold creation represents a significant reduction in embedded carbon, especially valuable for low-volume replacement parts.

While the ULTEM 9085 housing may require more material by weight than the original UPVC design, this trade-off is justified by the improved durability and reliability in harsh offshore conditions, ultimately reducing the total material consumption over the system's operational lifetime.

These focused sustainability benefits—localized production, extended service life, and elimination of tooling requirements, demonstrate how advanced manufacturing techniques can contribute to more sustainable industrial practices in maintaining and replacing legacy components for critical offshore applications.

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