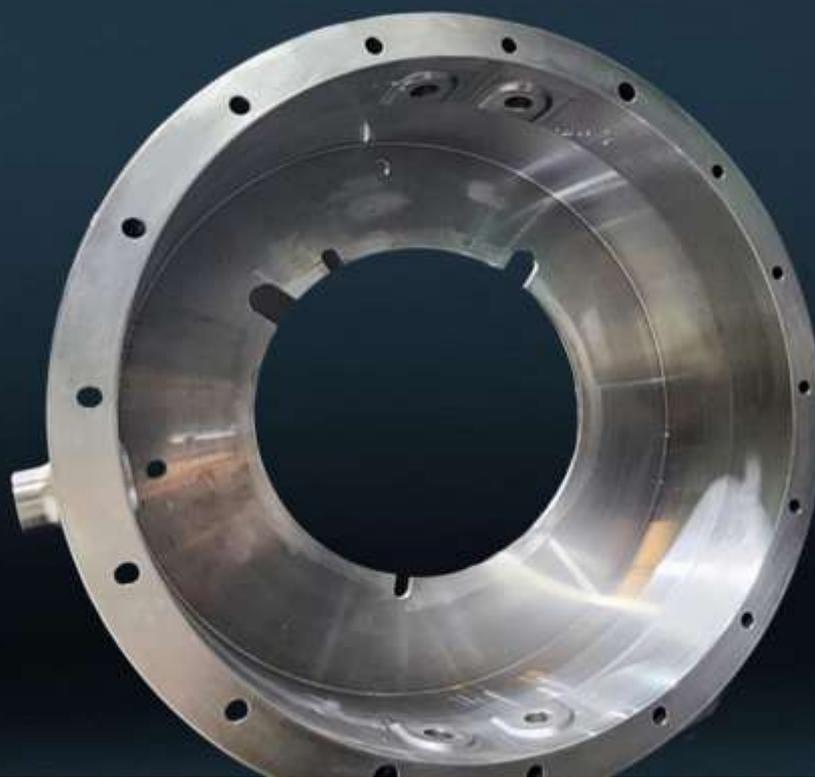


Additive Manufacturing of a Replacement Compressor Coupling for Offshore Operations



Contents

1. Introduction
2. Problem Statement
3. Our Solution
4. Sustainability Impact

Introduction

A rigid flange compressor coupling is a precision-machined mechanical component used to connect the shafts of a motor or turbine directly to a compressor, enabling reliable transmission of torque and rotational motion. The coupling consists of two flanged hubs that bolt together, creating a solid mechanical interface between the driver and the driven equipment. Unlike flexible couplings, this rigid design does not accommodate shaft misalignment, so precise alignment during installation is critical. When properly installed, it provides direct power transmission while protecting both the compressor and the driving motor from premature wear.

In offshore oil and gas assets, compressor systems are critical for gas compression, reinjection, and processing operations. A reliable coupling is therefore essential to maintain continuous operations, reduce unplanned downtime, and enhance operational safety in harsh marine environments. These couplings are typically manufactured from high-strength materials such as stainless steel 316 or 316L, duplex stainless steel grades, or carbon alloy steels to provide superior mechanical strength, corrosion resistance, and fatigue performance under demanding offshore conditions.

Problem Statement

The customer experienced a compressor system failure when a rotating component damaged the coupling beyond serviceability, causing equipment downtime. With no replacement available locally and OEM procurement requiring four to six months due to supply chain constraints, the customer engaged RusselSmith to reverse-engineer and additively manufacture a replacement coupling in Nigeria.

This approach leveraged RusselSmith's additive manufacturing capabilities to bypass international supply chain delays and return the compressor to service within weeks rather than months, significantly reducing downtime and associated costs.



Figure 1: Failed Compressor Coupling

Our Solution

A comprehensive failure analysis was first conducted to determine the root cause of the damage to the compressor coupling. This was followed by a detailed material analysis to identify the elemental composition and alloy type, as the component was aged, with no OEM datasheet available for reference. The analysis confirmed that the original coupling was manufactured from C-Mn steel. To enhance performance and reliability, a higher-grade low-alloy steel was selected to improve fatigue resistance and corrosion performance compared to the original C-Mn steel.

To ensure an accurate and reliable model, the failed component was transported to RusselSmith's Advanced Manufacturing facility for 3D laser scanning and reverse engineering. The resulting model was then modified to enhance both structural integrity and functional performance. The customer reviewed and formally approved all proposed modifications before production began.

Prior to full-scale production, test blocks were printed, and test coupons were extracted to perform both non-destructive testing (NDT) and destructive testing (DT). The NDT included surface inspection using Dye Penetrant Testing and volumetric inspection using Ultrasonic Testing. The DT comprised hardness, impact, and tensile tests to confirm mechanical performance. Additionally, compositional analysis was carried out to ensure full transparency and traceability of the replacement part.

RusselSmith leveraged Submerged-Arc Additive Manufacturing (SAAM) to print the replacement coupling using EM12K wire and BA-S2Si as the flux, as it met the dimensional and performance requirements while significantly reducing lead time.

This solution was completed within 5 weeks, enabling rapid deployment and minimising machine downtime.

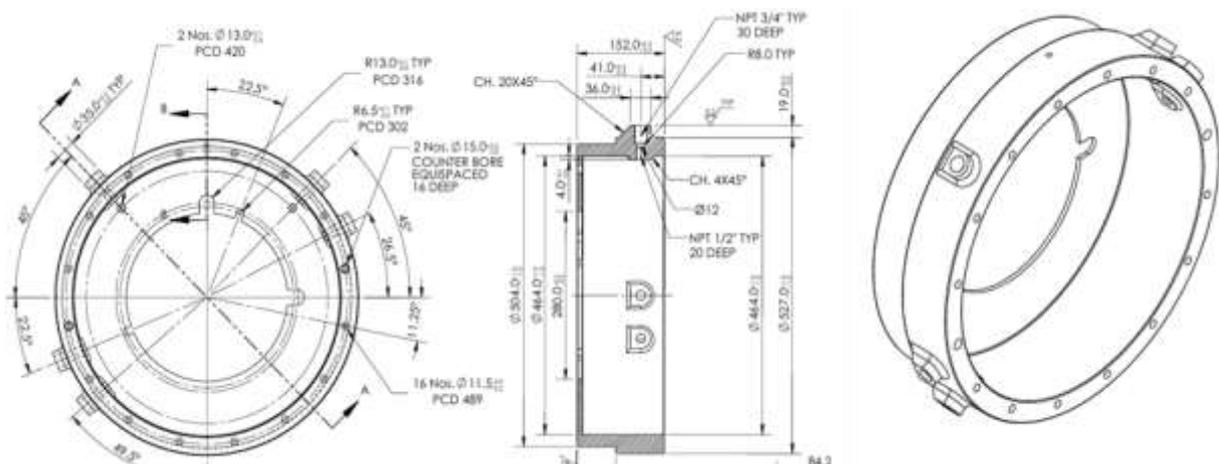


Figure 2: Drawing and 3D Model of the Modified Compressor Coupling



Figure 3: Additively Manufactured (As-printed) Compressor Coupling using the SAAM technique



Figure 4: Top and Bottom Views of the 3D-Printed Compressor Coupling (after post-processing)

Sustainability Impact

Additive manufacturing offers potential sustainability benefits through more efficient material utilisation compared to conventional machining from oversized stock. By building the component near-net-shape and minimising bulk material removal, SAAM reduced raw material requirements for this project. The localized manufacturing approach also eliminated international shipping, reducing the project's logistical footprint.

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