CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE

CASE STUDY

DEVELOPING A WEAR-RESISTANT COATING FOR DRILLING COMPONENTS

Project duration

2022-2023

Partners

Centre de métallurgie du Québec (CMQ), MBI Global (VersaDrill Canada), and Forage André Roy Inc.

Materials

TEKAD®1000 (metal) on 1026 steel substrate

Processes

DED (Directed Energy Deposition), Optomec LENS process (Laser Engineered Net Shaping)

Application fields

Seal bushing for the drilling industry; pump, motor and energy applications.

OBJECTIVES

To develop a coating characterized by its physical and mechanical properties to prevent seal bushing abrasion in drilling operations.

BACKGROUND

Seal bushings are used in mining exploration to prevent water from penetrating the drilling head. Inserted between the rotating mandrel (1026 steel) and the gasket (urethane), these 6.5-inch diameter parts undergo a rotation of 1,000 RPM for 14 to 16 hours a day. Friction generated in drilling operations causes a great deal of abrasion, despite the 0.002", 60 HRC chromium layer applied to the bushings by electroplating. After six to eight months of use, the contact area retracts the seal bushing, the chromium coating is completely worn away and the steel is chiselled off, despite the chromium protection. Water begins to penetrate the drilling rod, causing several components to break at a cost that can easily reach $4,000 to $8,000.

THE CHALLENGE

Seal bushings can be replaced according to current practices, but replacements can take upwards of two to three hours of work, while the cost of the operation can rise quickly to $1,200. Thus, our hypothesis seeks to replace chromium with a material that has shown its wear resistance under extreme operating conditions.

To resolve this challenge and to reconcile material properties with the seal bushing's mechanical requirements (resistance, durability), TEKAD Industries Inc., along with the *Centre de métallurgie du Québec (CMQ)*, MBI Global (VersaDrill Canada), and *Forage André Roy Inc.*, used their expertise to test materials that form chromium micro-carbides during the additive manufacturing process (laser cladding). For this, the focus was set on martensitic stainless steel with high carbon content. The project was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the National Research Council of Canada (NRC), and *Groupe MISA*.

DEVELOPING A WEAR-RESISTANT COATING FOR DRILLING COMPONENTS

CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE

Seal bushing - TEKAD 1000 coating - DED process

Seal bushing (after tests)

THE SOLUTION

The solution sought by the team at TEKAD Industries Inc. involved the replacement of the chromium layer with a TEKAD®1000 coating. This material is characterized by high matrix hardness and, among other things, a significantly high chromium micro-carbides content (70 HRC). The deposit was achieved through Directed Energy Deposition (DED) technology. This process allowed for the use of a short, 1026 steel segment, along with a thin layer of coating, to increase wear and corrosion resistance without compromising the toughness of the base material. The approach helped reduce costs and created a part with outstanding mechanical properties, none of which could have been achieved through traditional processes. After applying the coating, the part was ground and polished to a surface roughness of Ra 16 µm; an ideal surface finish for joints.

The success of this project stems from the collaboration of various partners. The CMQ, a Quebec pioneer in the field of DED additive manufacturing, developed the metallurgical experimental design and conducted several laboratory tests to analyze the material properties before producing the deposits. For its part, MBI Global shared its technical knowledge of bushings. *Forage André Roy Inc.* conducted the field tests.

BENEFITS/RESULTS

The DED process helped develop a wear and corrosion-resistant coating that could not have been achieved through other technologies. The results were validated through an intensive phase of on-site drilling tests. After six months of use, the seal bushing showed no signs of wear; our hypotheses predict two to three years of durability. In summary, replacing and applying the coating material by DED created a two to fivefold increase in the seal bushing's service life, as compared to standard practices. The impact on costs is systemic. In this particular case, maintenance costs fell by $2,400 per year (material and labour), not to mention the fact that the drilling head components (ball bearings, for example) will undergo less wear and fewer replacements over the long term. Considering all of these factors, increasing the service life of seal bushings correlates with greater productivity, since the downtime required to replace parts is reduced and, in some cases, eliminated altogether.

CONTACT

TEKAD Industries Inc.
2375 Jules Vachon Street, Trois-Rivières (Quebec) G9A 5E1
Philippe Laplante, B. Eng, M. Sc, President of TEKAD Industries Inc.
1 819 691-4244