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Mixer Seal Gets Major Makeover

BY VIC LUNDBERG

Sealing the agitator shaft entry point in a tank used for high temperature mixing of titanium tetrachloride (TiCl4) at its Henderson, Nev., plant was a crucial worker-safety issue for Titanium Metals Corp. (Timet). TiCl4 is an aggressive chemical that has a tendency to flash off to form a potentially noxious vapor and toxic white cloud. In addition, when the chemical comes into contact with water, it can become hazardous.

In late 2010, Timet sought out the engineering team at Quadna to advise the best way to seal the mixer shaft entry point. We faced two major challenges in developing an effective solution.

The first was to determine how to maintain a strong positive seal. The seal design was of paramount importance and there were critical metallurgy issues as well. Previously, the system employed a double mechanical seal with a mineral-oil barrier fluid that provided lubrication between the inboard and outboard faces.

Timet wanted to use a split mechanical seal instead —because its installation and eventual replacement takes far less time. However, to enhance the operation, a dry seal was needed.

The problem? At the time, no manufacturer was producing a dry-running split seal.

The second obstacle was the length of the shaft. The mixing operation uses a long unsupported shaft, where it is common to experience excessive shaft run-out at the mechanical seal.

We recommended installing a sleeve

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bearing made of DuPont Vespel CR6100 polyimide. The additional sleeve would help the long shaft run true and minimize shaft run-out at the mechanical seal.

The typical clearance for a steady bearing for a shaft of the diameter used for this mixer (3 to 5 inches) is 0.020 in. of total clearance. The Vespel sleeve bearing was machined for a total clearance of 0.007– 0.010 in. The reduction in clearance between the bearing and shaft allowed the Vespel sleeve bearing to act as a primary seal as well as to keep shaft run-out well below maximum acceptable levels.

The reduction in clearance was possible because of the unique coefficient-of-thermal-expansion properties of Vespel. Thermal growth is largely confined to the *z* direction (along the shaft) — growth in the *x* and the *y* directions is extremely small. In addition, the material is chemically inert to TiCl4 and can operate without lubrication because of its very low coefficient of friction.

John Crane dry-running split seal.

Quadna redesigned the mixer stuffing box for a John Crane Type 3740D cartridge split seal using the Vespel sleeve bearing. This represented one of the first John Crane dry-running beta split seal installations.

During final assembly of the bearing and split-seal system, a slight dimensional issue prevented installation of the John Crane seal. Because time was running short, the mixer had to be placed back into service. During subsequent operation the Vespel sleeve bearing alone sealed nearly 100 percent of the vapor and also demonstrated its effectiveness in reducing run-out. So, Quadna and plant officials decided to continue operating the unit without the seal while the minor dimensional issue was addressed. Then, at the first opportunity, we put in the dry-running seal to ensure complete containment of vapor. The split seal took only hours to install during a brief outage (versus the days required for a double seal) and has operated without a hitch.

Several vessels in the plant that were experiencing similar problems now have received John Crane Type 3740D dry-running split seals as well as Dupont Vespel 6100 sleeve bearings for their mixer shafts, resulting in the containment of all TiCl4 vapor.

These enhancements have provided other benefits, too. Significant savings come from eliminating the mineral-oil barrier fluid and specialized seal-support equipment to regulate flow and pressure required by double mechanical seals. In addition, seal replacement in the future will take much less time.

Quadna team members are incorporating all the modifications as standard offerings for new mixers that Timet is purchasing for the plant. Installation of these mixers should be completed by the end of 2011.

Vic Lundberg is a process engineer for Quadna, a DXP company.

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