Significant cost savings in Crude Oil / Multiphase Pump application by using diamond seal face material technology

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Presenter/Author Bios

Nikolaus Necker is a Lead Expert for Engineered Mechanical Seals at EagleBurgmann Germany GmbH & Co. KG. He is responsible for the application engineering in all kind of Oil and Gas services (On- and Offshore) since he started with Burgmann in 1990. He is a member of the MPUR Advisory Board since 2000. Nikolaus Necker has a Masters of Engineering (Mechanical Engineering, 1989) from the Munich University of Applied Sciences and has a Pump Engineer Diploma from the University of Graz (Austria).

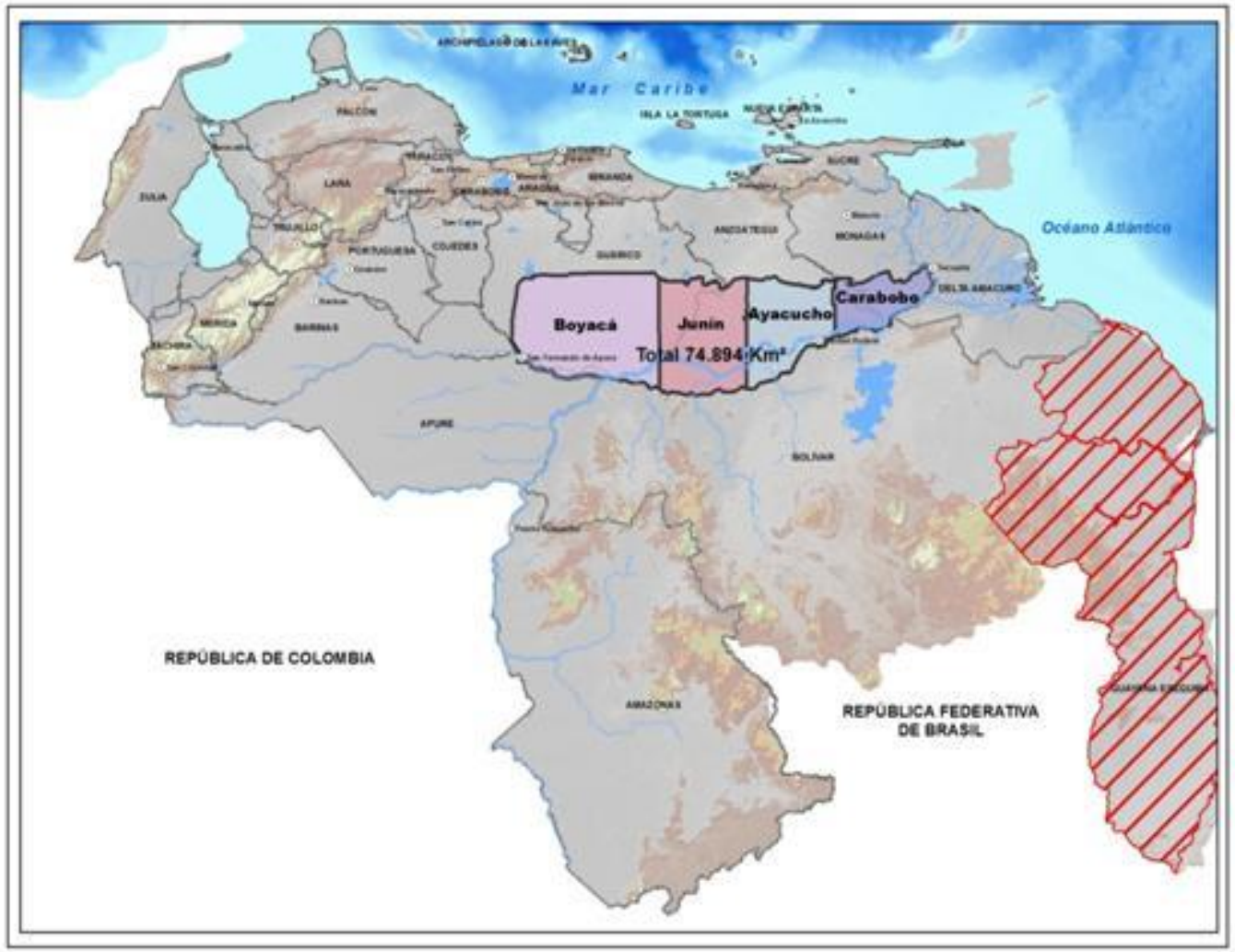
Abstract

In an upstream facility in Venezuela, Single Mechanical Seals in combination with API 682 Piping Plan 32 and 62 have been used in a Multiphase twin-screw pump application successfully over many years. It was clients target to reduce the required flush flow rate by 70% to save costs.

To solve this challenge, an extremely robust slurry mechanical seal design in combination with diamond seal face material technology was installed.

The mechanical seals performed successfully with the significantly reduced flush flow rate, handling solids and gas slugs. Cost savings of appr. 10.000 USD per day, equal to nearly 3.7 million USD per year per pump were realized finally.

The Facts – Heavy crude oil production in Venezuela



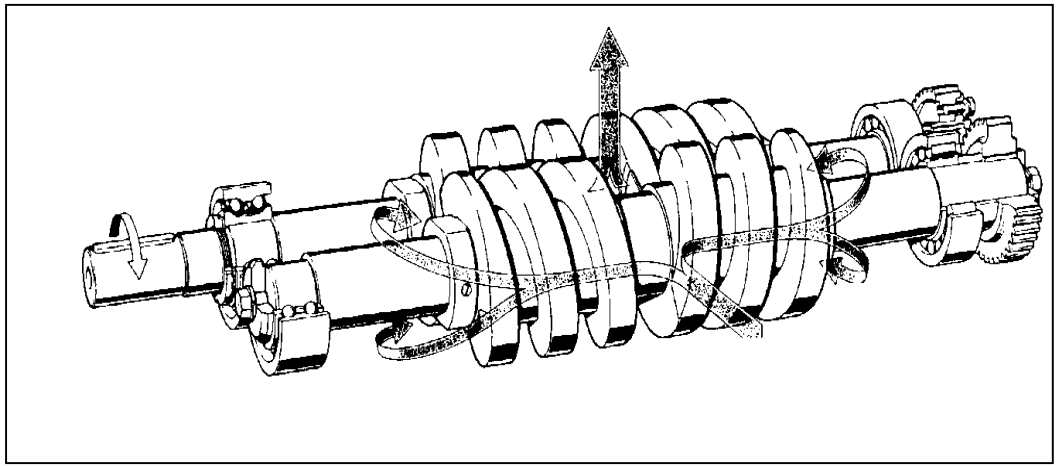
Venezuela PDVSA:

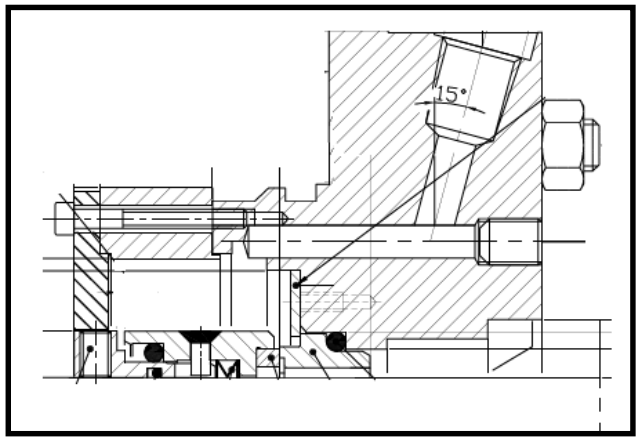
Area: 399 km²
Located: Junin area
API°: 6° to 15°crude oil, water, gas
Production System:
Several Multiphase stations
Productions Pumps:
MPP Twin Screw Pumps
Quantity of Pumps:
22 running at the same time

The Facts – Multiphase Mechanical Seals

Multiphase Applications:

1. Unpredictable composition of the fluid
2. Aggressive media, solids
3. Twin screw pumps (4 seals per pump)
4. Flush/Injection of **diluent or naphtha**



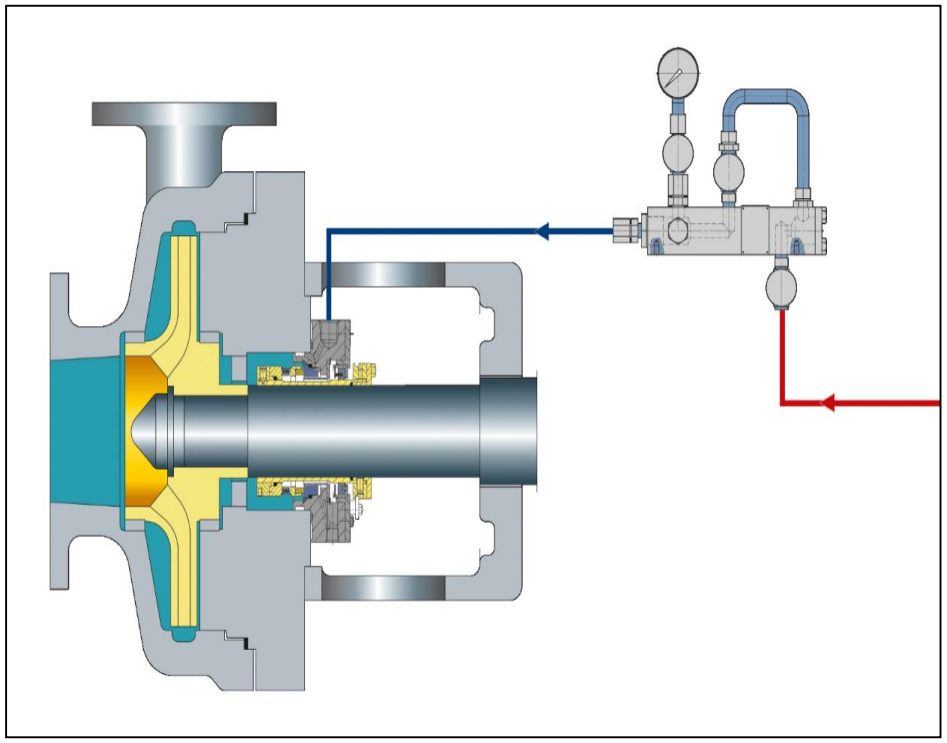


Seal type:	Single - original
Materials:	Q1Q1VMG1
Piping Plan:	32 (Flush) + 62 (Quench)
Speed:	500 - 2000 rpm
Process fluid:	**water, crude oil (EHCO), gas, with sand particles**

The Facts – Flushing System Plan 32

Due to the high viscosity of the Crude Oil EHCO (API 6-8), it was required to dilute it with a much lighter HC, called “Diluent or Naphtha”. The mix reaches API 12-15, which is easier to transport.

The API Piping Plan 32 Flush uses the same “Diluent”. This is extremely necessary for cooling, lubrication and dilution of the EHCO in the mechanical seal cavity. It also keeps away solids and lubricates when the pump handles gas slugs.



Original consumption about
45 l/min of Diluent per pump

In total: 407.55 BD/pump needed

The Facts – Reduction of Flush rates

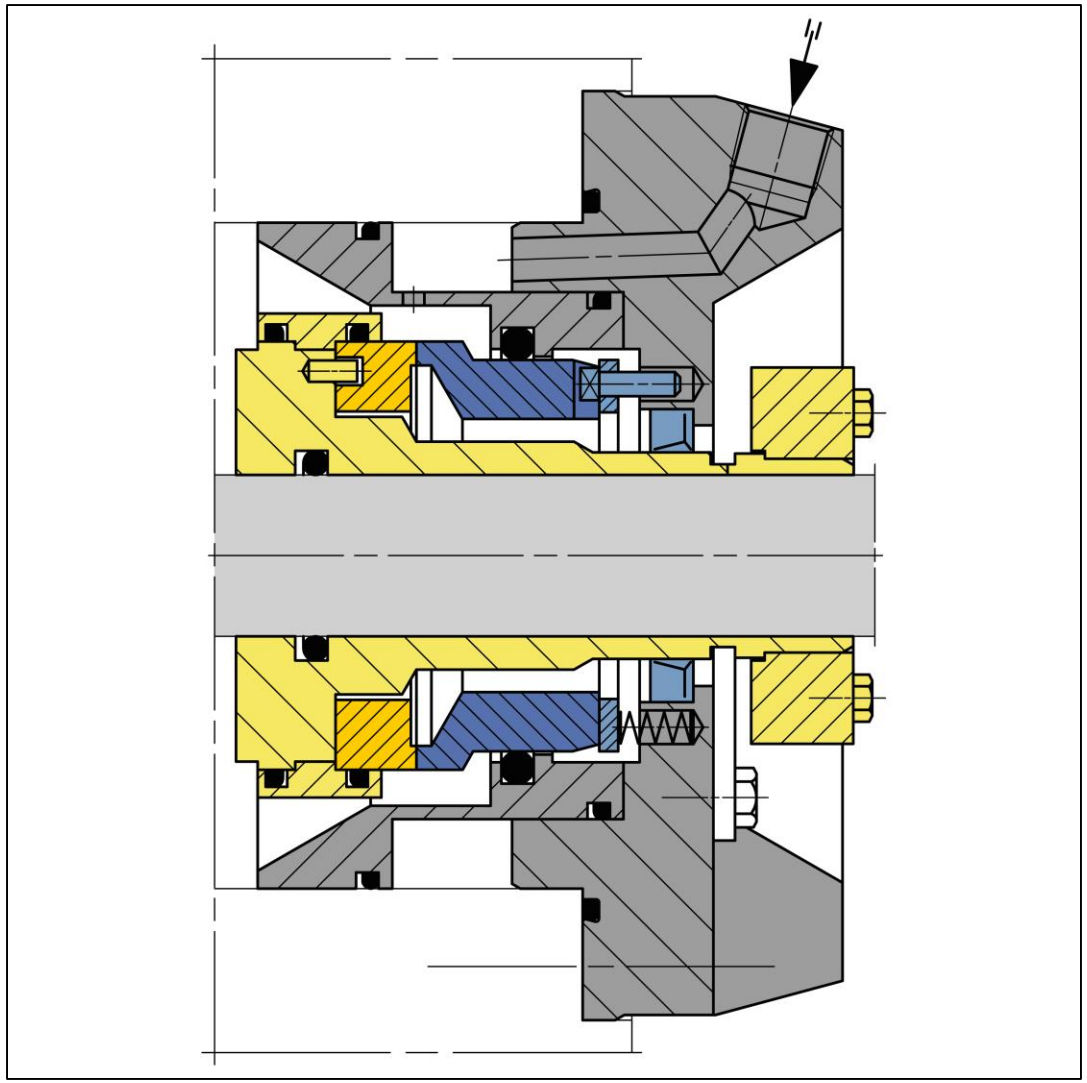
END-USERS TARGET:

The user was looking forward to achieve cost savings, evaluating possibilities to **reduce by 70%** the amount of diluent going through the seals.
The challenge, to handle these demanding conditions:

1. Solid contents about 20 to 25%
2. GVF from 30% to 90%
3. Water-cut up to 30%
4. EHCO poor lubrication properties

New seal configuration, special face materials and R&D work were necessary

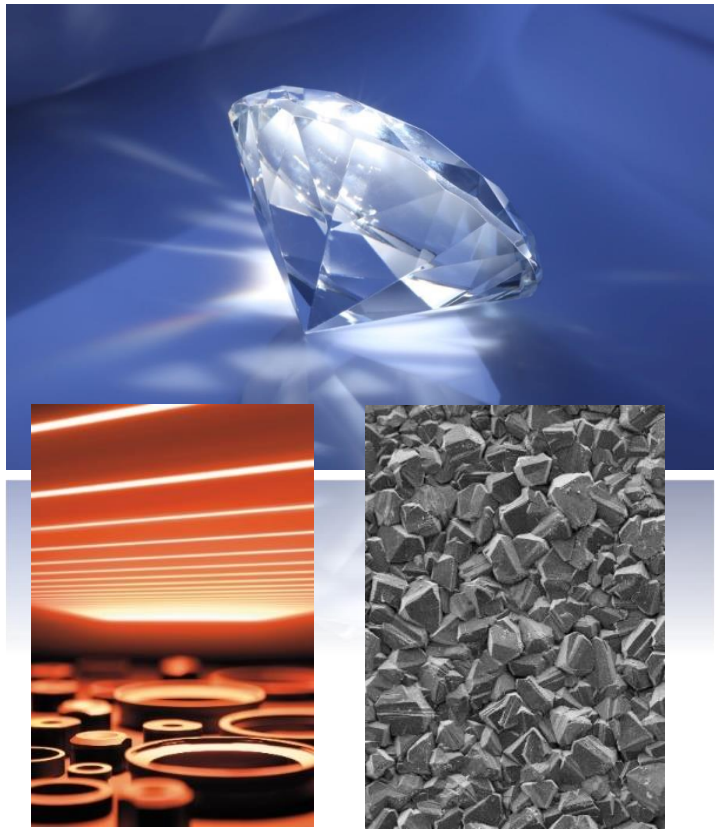
The Solution: New Mechanical Seal Cartridge Design



Single Seal Pusher Type

- Based on Slurry seal design
- Solid seal faces
- Stationary spring unit
- Rotating mating ring
- Big cross-sectional O-rings
- Multipoint Injection
- Hard-hard seal faces, using diamond face material technology

Innovative Material Technology for MS faces

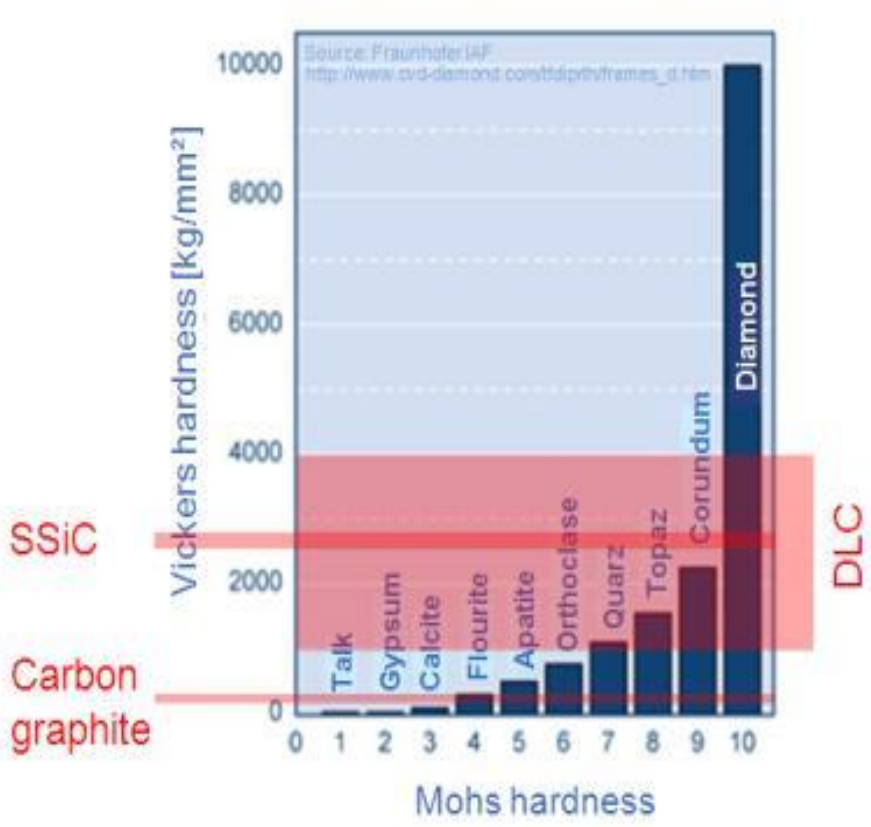


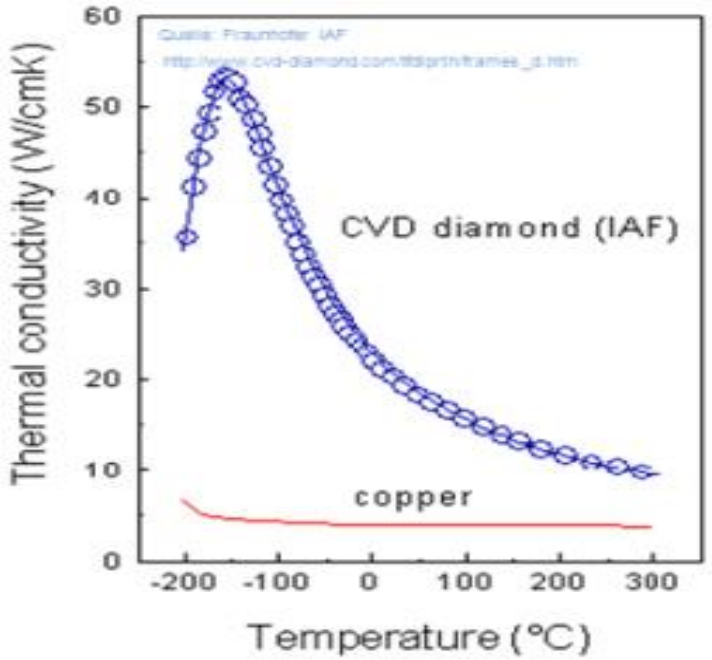
Innovative micro-crystalline diamond seal face material, with all the attributes of natural diamond, which are artificially grown diamond crystals on a silicon carbide seal face surface

Unbeatable advantages

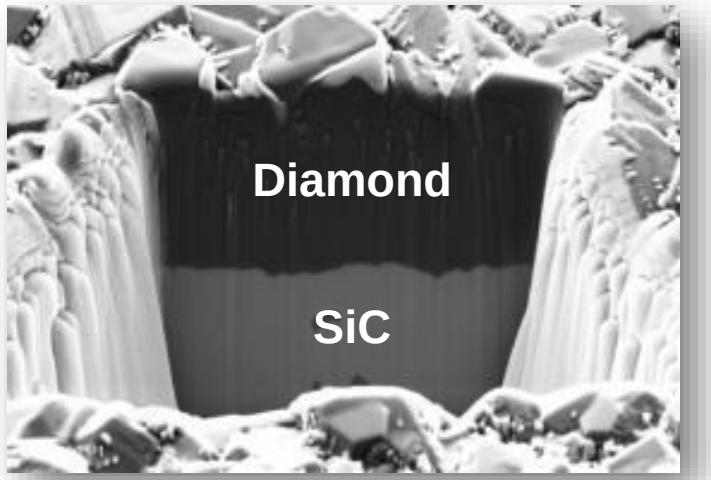
- Extremely hard
- High wear protection
- Maximum robustness
- Excellent heat conductivity
- Minimum friction
- Extended dry running capability
- Significantly extended life-time

Unique properties of this seal face material





Cross section prepared by Focused Ion Beam (FIB) cutting

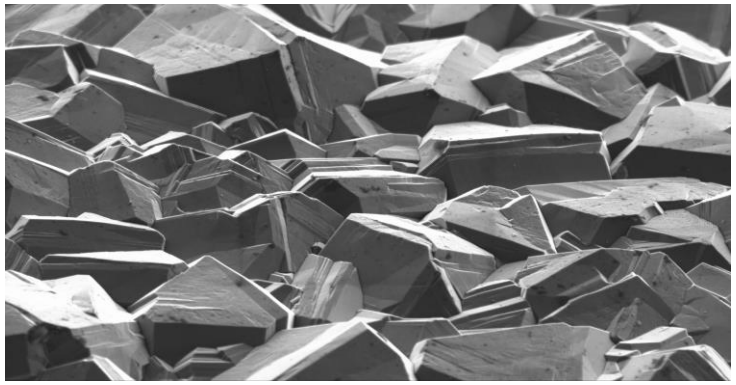


- ✓ Ultimate hardness of diamond / excellent wear resistance
- ✓ Superior thermal conductivity
- ✓ Chemical bonding => Superior diamond film adhesion

Field Test

Operating conditions:

1. Suct. P: 8 barg (121 PSI)
2. Disch. P: 16 barg (240 PSI)
3. Temp: 35 to 40°C (95 to 104°F)
4. Speed: 1.990 rpm
5. New Flush rate: 14 L/min/Pump (saving 70%)
6. Solid Content: 20%-25%



Equipment Details:

1. MPP Twin Screw pump types
2. Single Mechanical Seal
3. First Installation date: 20/11/2014

Field Test Results

Test Highlights:

1. End user switched from regular diluent “Naphtha” to a “Mix of Light Crude Oils” for the EHCO dilution

2. This less quality caused a series of operational problems. 21 had to be shut down mainly because of seals problems

3. Formation of a heavy mix of crude oil stucks around seals, producing obstructions of all the lubricating passes and spaces inside the seals

4. **The only pump that continued to operation was the one using mechanical seals with diamond seal face technology**

Seal stationary section/seat with new face technology after
18 months operation
Seal still in perfect condition

Field Test Results

5. The pump with these seals operated for additional 8 months after the mentioned event. Pump was finally shut-down after 18 months

6. The seals did not show any failure or abnormal leakage

7. A massive accumulation of a “Heavy Crude Oil mixture” was found filling all the spaces inside. The “multipoint injection ring” showed obstruction of the flush, meaning that poor or even no flush was coming to the seals

Seal rotating section/face after 18 months operation (partially cleaned) in perfect condition

Cost Savings Calculation

1) The test ran for 18 months without seal failures
2) The reduction of the diluent was achieved

3) 60% of the diluent will be recovered

4) The use of this technology in one Multiphase Pump saved 3,7 **million USD per year**

Original Flush/Diluent Consumption per Pump	**45 L / minute**

Liters	Minutes	Hours	L / day / Pump
45	60	24	64.800
	40% non-recoverable	**Net Barrel losses/ day**	163
		Total $ / day / Pump	**14.670 $**

1 barrel = 159 L	**159**
1 barrel cost $	**Diluent 90**

Savings / Day / Pump	**10.106 $**
Savings / Year / Pump	**3.688.690 $**

Total $ / day / Pump with diamond seal face Technology	**4.564 $**

Conclusion:

By this field test, it has been proven that significant cost savings can be achieved by using Engineered Mechanical Seals with diamond seal face technology in Extra Heavy Crude Oil, Sand presence, Multiphase applications, due to important reduction of Flush requirements for the seals injected thru the seal support systems API Piping Plan 32

If you have any questions please contact the author
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