

*Duane Daws, rotating equipment supervisor for Countrymark Refinery, Mt. Vernon, Indiana, U.S.A.*

**“I switched to Kaydon Pumping Bushing Oil Seals to protect my catalyst and to reduce scrap oil by 90%”**



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Turning Ideas Into Engineered Solutions

**KAYDON**  
RING & SEAL, INC.



■ Duane Daws, rotating equipment supervisor for Countrymark Refinery, Mt. Vernon, Indiana, U.S.A., inspects the Kaydon pumping bushing oil seal.

# A Reasonable Alternate To Dry Gas Seals

## Kaydon's Pumping Bushing Oil Seals Solve Problems with Hydrogen Compressor

When Are Dry Gas Seals Overkill? Duane Daws suggests, before making an expensive compressor seal conversion from oil to gas, try a simpler solution at a small fraction of the cost.

Duane Daws, the rotating equipment supervisor for Countrymark Refinery, Mt. Vernon, Indiana, saved his company a good deal of expense and downtime by choosing to replace his existing oil seals with Kaydon pumping bushing oil seals.

Countrymark, an American Farm Cooperative, provides diesel fuel in serving the agri-

cultural markets of Indiana, Ohio and Michigan. The application is a model 2B10-8 Dresser Clark C2-1 unit compressor, which is used for hydrogen recycle service at the refinery. Hydrogen gas is compressed in the unit. The compressor has a 4.5 in. (114.3mm) diameter shaft operating at 11,000 RPM (rotational speed) with inlet pressure at 132 psia (9.1 bar) and discharge at 387 psia (26.7 bar).

The compressor was put into service in 1992 and its oil seals were changed 3 times for excessive leakage before Kaydon seals were installed in 1998. Seal oil consumption for

the previous oil seals reached 0.066 gal/min (250 l/min), or about 100 gal. (379L) per 24 hours for the system: 50 gal. (189 L) per day at each seal. This was unacceptable performance. The compressor OEM specifications indicated that acceptable seal oil demand should be no more than 20 gal. (76 L) of oil for the system per day.

Because the frequency of maintenance and level of performance left so much to be desired, Daws began his search for a change in either technology or manufacturer, or both! A dry gas seal system was explored. Daws received

proposals for dry gas seals, but found that this change in technology would have required days of downtime and about \$250,000 for the seals and the support system. He next contacted the compressor manufacturer about improved oil seals. One of the upgrade proposals would have required Countrymark to pay additional service fees for engineering redesign costs and compressor cavity modifications. Installation would have still required extensive downtime because of the cavity alterations. If this had been the only other way to go, it would have been less costly than a switch to dry gas seals, however, Kaydon offered a better solution.

Kaydon Ring & Seal proposed their pumping bushing oil seal design. They offered a competitive price for a seal that was built to the compressor manufacturer's prints and specifications with no additional engineering charges required. No changes were necessary for the ancillary oil seal control system, either. This approach was important to Daws.

"I don't think I remember anyone but Kaydon saying that they were willing to modify their design or dimensions to make it fit our machine. It was always that we'd have to make our machine or case fit their seal. I think that's the most impressive thing—that Kaydon adapted their product in size. Even though the design criteria remained the same, they made changes to accommodate us and lessened our downtime.

"In order to verify the dimensions in the stuffing box, there was a question whether that machine had been modified previously, because this is a very dated machine remanufactured to fit our process applications. As a matter of fact, it was even de-staged. There were two stages taken out of the machine to get it to fit our parameters, as far as ACFM and pressure differential across the machine that we needed for our process. Kaydon allowed some extra material on the axial length and

the O.D. of their cartridge in some areas—it was just a few thousandths—but it enabled us to easily custom fit the seals. So even though it was a ‘standard cartridge,’ they customized it to fit our application. That was impressive, I thought, that they were able to leave them large enough in the right areas. That took some research of the records between Kaydon and the remanufacturing company.”

The pumping bushing design has twice the typical operating clearances of an oil film design, but with much lower leakage. This greater clearance makes the seals less susceptible to compressor shaft movement or surge destroying the seal clearance. This design feature also makes the seals more resistant to failure on re-start.

Duane Daws commented, “Working with hydrogen is a challenge. It is a very light, low mole weight gas. To design a mechanical seal to separate that very light weight gas from the lubricating oil is a challenge. Some of the advantages I see with the Kaydon design is that they use hydrodynamics, rather than just simply close tolerance fits, to cause that separation. They still employ a labyrinth to achieve the pressure drop required, but with that pumping bushing and the way they have that pumping groove designed, it actually builds a dam of oil, in effect, to close up that tolerance.

“The original OEM seal we had in there relied totally on close tolerance fits. With the close tolerance fits, if you get

any rotor movement due to a surge condition, dropping of the rotor at lower speeds, going through critical speeds where you might pick up some harmonics and different vibrations, any of these can cause seal failure. With Kaydon’s design, this is not so critical now, because you’ve got the extra room. The shaft can actually move further without making contact or rubbing the seal area. So the big advantage I can see is that now we can get the lower leak rates due to the hydrodynamics of the seal design, without running those close tolerances.”

Countrymark accepted Kaydon’s proposal in mid-January 1997. The typical time frame for a seal redesign and manufacture is 16 weeks; however, Countrymark needed installation by mid-March—only 10 weeks. This delivery was accomplished and installation took place with minimal down time.

When the seals were uncrated, Daws remarked that the surface quality of the components looked polished and plated. He was also impressed that once the old seal was removed, the Kaydon cartridge design simply fit into place. With the cartridge design, no individual parts needed to be assembled on the shaft or into the seal cavity. The seals performed flawlessly as soon as they were started up. Initial leakage of seal oil to the drainer was 10 gal/d (38 L) per seal, and after several days of run-in, stabilized at 2.5 gal/d (19 L) per seal. This was well within Kaydon’s



■ The pumping groove Daws refers to can be seen here. This design develops hydrodynamic pressure to create the seal, while allowing greater mechanical tolerances that adapt better to surge conditions, harmonics, vibrations and deflections.

expectations, as confirmed by their in-house dynamic testing of the seals. Daws was particularly impressed with the documentation Kaydon provided with their seals, including the shop test data, which showed him exactly what to expect in the way of performance for his seals.

“They put them through a great variety of tests and came

up with a leak rate in gallons per day for a number of parameters. They were tested at a variety of speeds, at varied inlet oil pressures, and at different temperatures. They are actually tested to as close as you can get to our operating conditions, but using nitrogen instead of hydrogen. The report is a fingerprint of the actual seal that I’ve got in the box.”

Duane Daws is confident that his decision led to cost savings for Countrymark. He also reports that working with Kaydon has been a positive experience. Impressed that Kaydon is a full line manufacturer of industrial shaft seals, Daws feels that he can get a



■ This Kaydon dynamic test rig (right) proved the pumping bushing seals, simulating Countrymark’s running conditions for the hydrogen compressor (left). A dynamic test report was provided for each seal.

response that is based on his needs; not a more expensive work-around based on the limitations of the manufacturer. And because Kaydon can repair or retrofit seals by any manufacturer, Duane reports that he feels less inclined to settle for poor performance by unknowns.

Daws concludes, "Contamination of the process is a big concern. This particular unit uses a very expensive platinum-coated catalyst downstream of that compressor, so consequently, if you get any petroleum based oil with any traces of metals, you can poison the catalyst. It's a very expensive thing to destroy your catalyst.

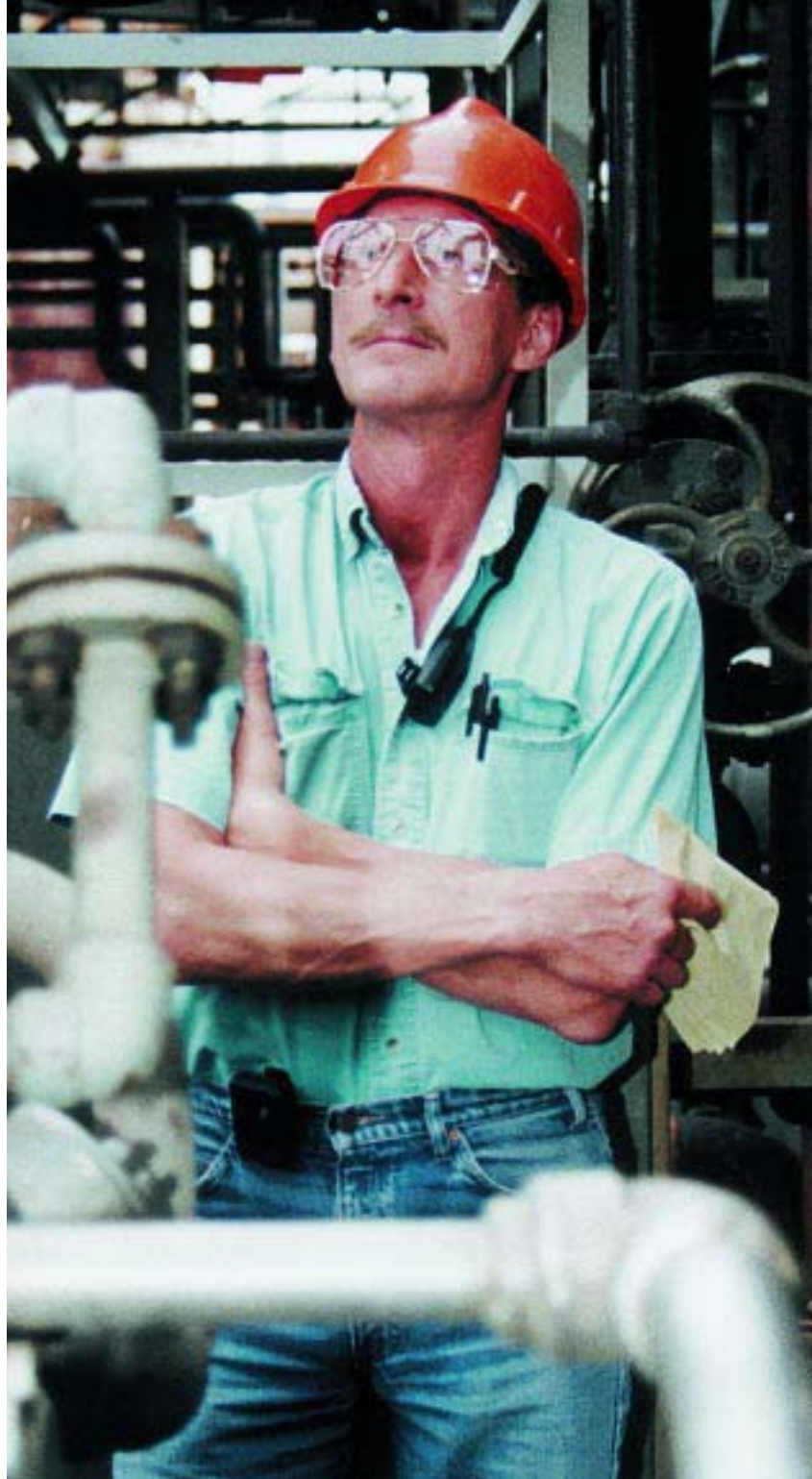
"In the past, we've had some catalyst damage that's cost us a lot of money. When you are looking at the seal

design, you are not only looking at the cost of scrap oil, which at worst case scenario, the leak rate we reached prior to the changeout was somewhere between \$80-90,000 per year just in scrap oil expense. But even more than that, if you look at the possibility of catalyst poisoning—that could be in the millions. And with the original seals, that situation did occur—not necessarily due to seal design, but due to what the seals did with other problems concerning the machine. And there again, one of the advantages we feel we have with the extra clearances of the Kaydon seal—we can have more of the rotor movement and still maintain a safe seal."

## "Here's another thing that impressed me about Kaydon:"

"There was a sense of urgency. We knew we couldn't continue to operate the way we were. And Kaydon took that same sense of urgency and acted in a very quick manner. We got more than just a seal in a box. As you can see, there is a lot of engineering and testing involved, and professionalism.

"When I have a problem with a piece of equipment, it becomes MY problem. It's a personal thing—if you care about the company you work for and you're interested in making that company survive. What I got from Kaydon is that they took our company problem and treated it as a personal problem. They got right on it and helped us come up with a solution."



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