

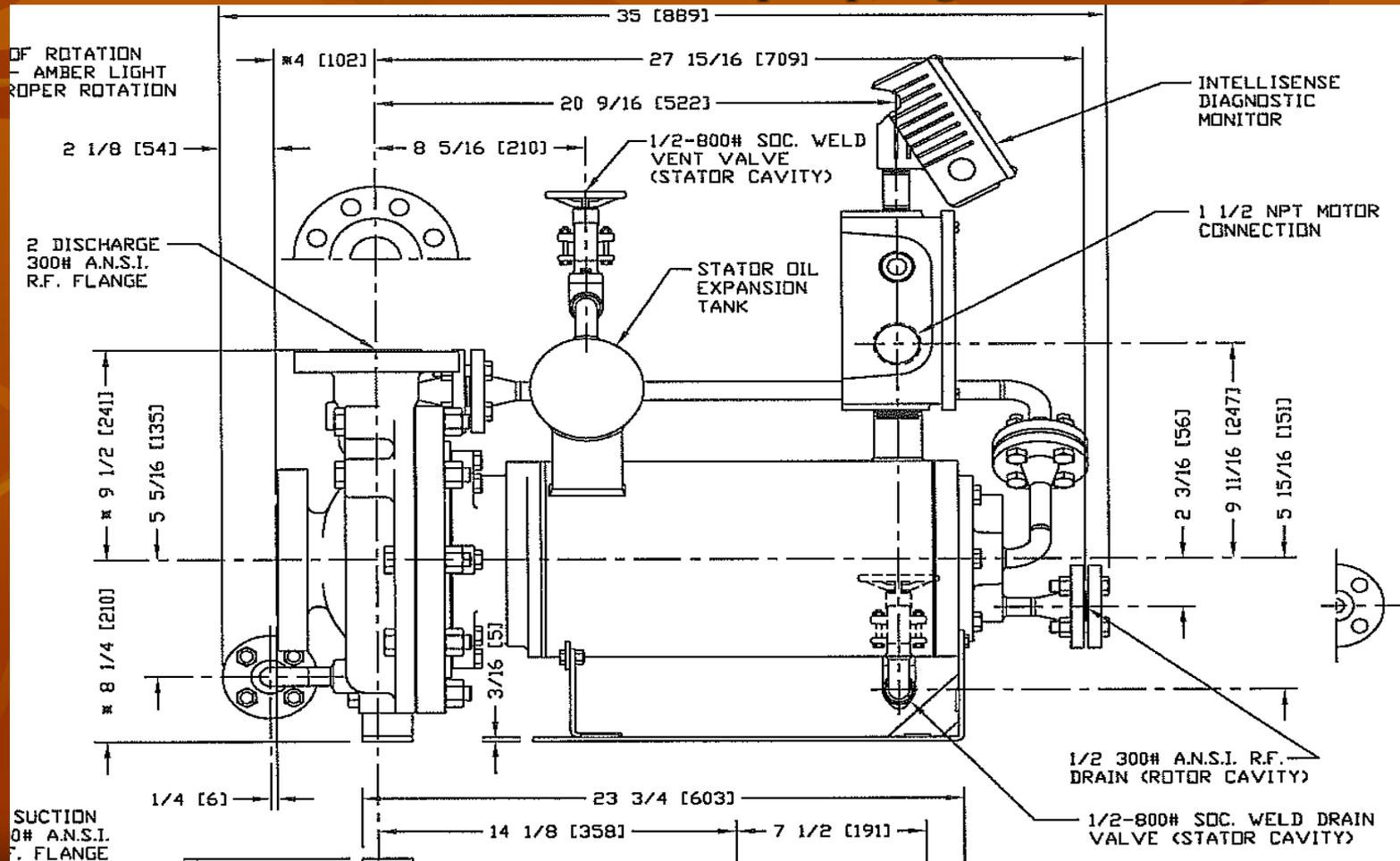
Corrosion and Materials Issues in Converting a Conventional Pump to a Canned Motor Pump.

Experience is what you have just after you
needed it.

By: Ron Carlson



A Gulf Coast Refinery needed to upgrade or replace a pump in its' HF Alkylation unit. Product is Propane with traces of Hydrofluoric (HF) Acid. Traditional sealing design is a double seal using Isobutane as the barrier fluid. As environmental emission limits were lowered, the pump began failing Leak Detection And Repair (LDAR). Evaluation of the options lead to the decision to install a canned motor pump, Figure 1.



OPTIONS CONSIDERED

1: Modify the existing pump to accommodate a triple seal. Advantage is that this is proven technology. Disadvantage is the expense and does not minimize the environmental and safety risk. The expense came from the need to replace the bearing housing and cover plate along with the amount of infrastructure required to support the triple seal.

2: Replace the pump with a canned motor pump. Advantage is dual containment that eliminates leaks (more on this later) which minimizes the safety and environmental exposure. Cost estimate was lower than the triple seal option. This option required a new pump which was about the same cost as modifying the existing pump, but the piping changes were much less expensive. Disadvantage was this was unproven technology in our HF unit, and therefore high risk.

API 685, Annex G calls for material class S-9 for HF service, S-9 in Annex H calls for 316L rotor and stator liners with most of the pump being made of Monel. Industry experience has shown that 316L is acceptable for anhydrous HF Acid. However, Monel is the material of choice for impure HF, so Monel liners were specified, along with all of the other wetted parts. During manufacturing and testing process, we learned that the Copper in Monel prevented the bearing wear indicators from functioning properly. Recalibrating the bearing wear indicators was possible, but calibration had previously been done for Hasteloy C, which is acceptable for HF at the concentrations we run. Therefore, we changed the liners to Hasteloy C while having the rest of the pump manufactured out of Monel. The pump was installed and performed well, figure 2.

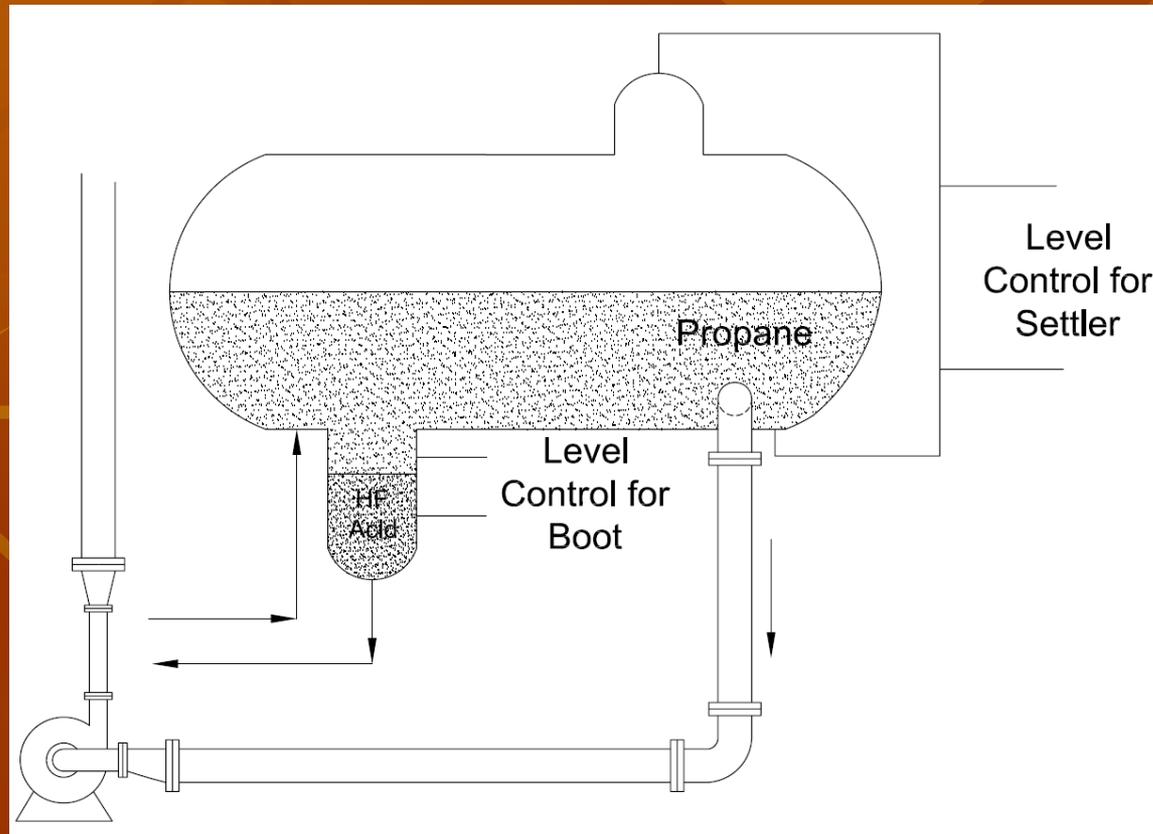


Figure 2

The unit ran well for two weeks. A discoloration was then observed at the weld where the flush line entered the rear bearing housing. A call to the manufacturer resulted in a rapid response of a field service representative, and a lead engineer to assist in the failure analysis and determine a path for corrective action.



We also observed a leak with the o-ring seal of the rear bearing housing.



- The first repair attempt involved grinding out the weld and re-welding the area. NDT (dye penetrant) did not reveal any leak paths. After reassembly, the pump was pneumatic tested to 50 PSIG with no evidence of leakage. Hydro-testing was not performed as we did not have another set of o-ring gaskets for this service.

During the commissioning of the pump, vapor was observed coming from the same weld area as the first leak. A small leak was evident in the weld zone of the flush line to rear bearing housing. We felt that we had a defective casting, so we decided to have a new bearing housing fabricated from a billet to maximize our chance of a successful outcome.

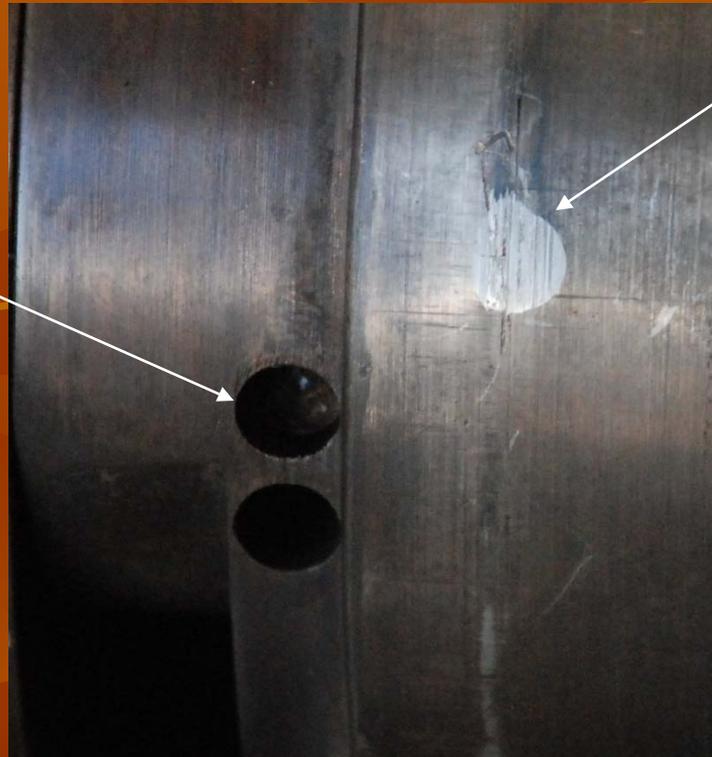
- After the repair, and prior to installation, a successful Helium mass spectrometer leak test was performed on the assembled pump.

Installation went smoothly and start up was non-eventful. Readings were taken by the LDAR technicians daily for four weeks to insure the integrity of the repair. Everyone was finally happy.

Five months of successful operation ended when the motor overload tripped. Disassembly and inspection of the pump did not show any cause for the overload. Inspection and testing of the electrical system revealed no cause for the trip. Again, the pump was reinstalled, commissioned, and operated successfully. Much head scratching ensued. The operators logged the amp readings four times per day for four weeks to determine if we had a slowly developing issue. No change in amp readings was observed.

Five more months of trouble free operation ended when the motor overload tripped, again. Inspection of the electrical system showed no faults. Disassembly of the pump displayed a small pimple on the rotor sleeve which had lightly rubbed the stator liner. Speculation was that, while not correct, this would not cause enough drag (3 HP) to overload the motor.

Holes
drilled for
balancing.



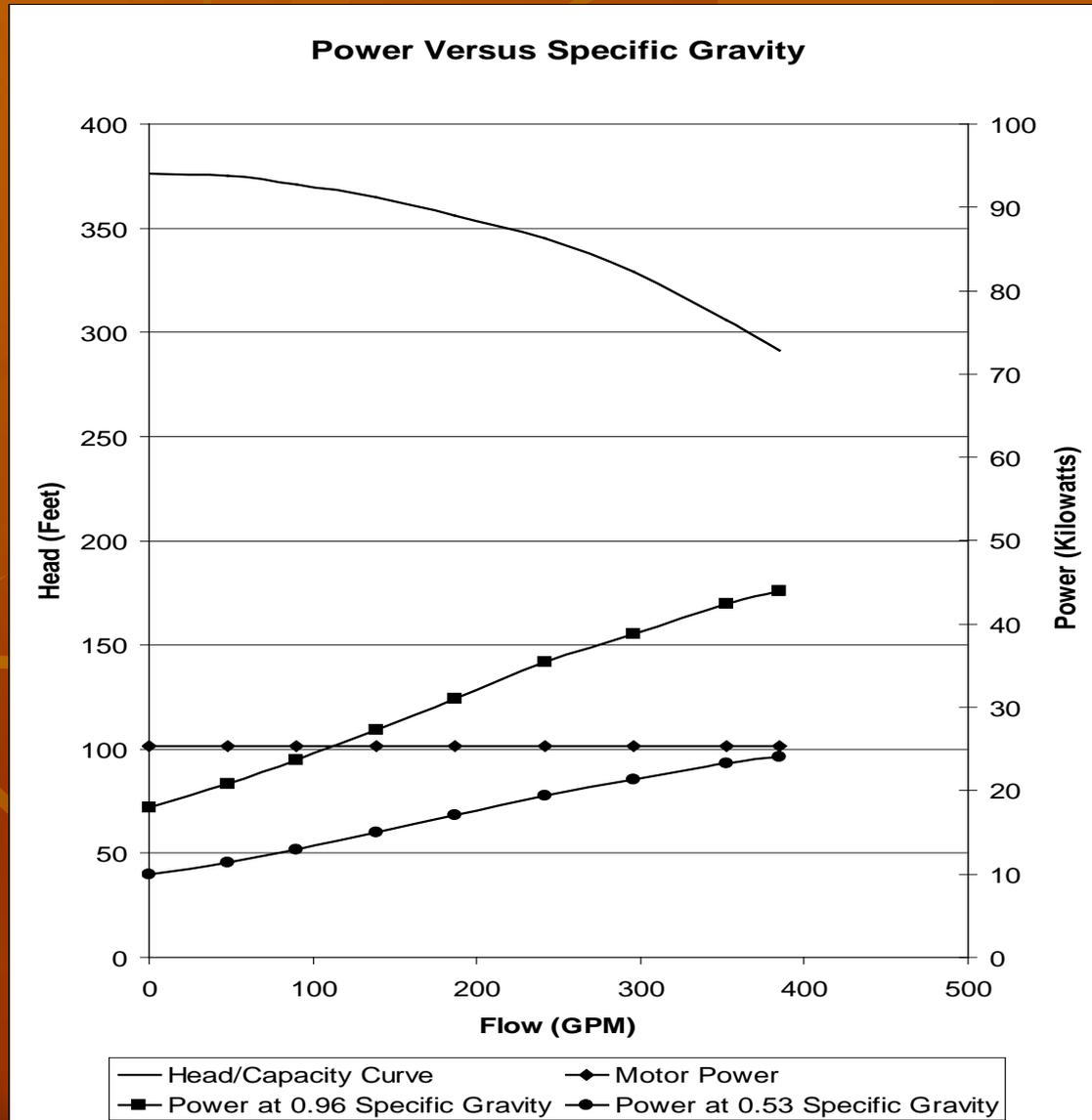
“Pimple”,
0.008” high.
(0.20 mm)

Over this 10 month period, a slight discoloration around a couple of the rear bearing housing bolts had been observed. LDAR and chemical sampling had not detected any sign of a leak, but the discoloration indicated a very small slow leak of the bearing housing o-ring.

While the deformity on the rotor sleeve was repaired, the case sealing areas were modified for spiral wound gaskets to eliminate any future leak issues with the o-rings.

Another failure analysis was conducted with no clear answer to the motor trips being identified. A hypothesis was postulated that the very low velocities in the suction (<1.4 fps) and discharge (<3 fps) piping, as well as the piping arrangement, were causing HF Acid to accumulate until the concentration was high enough to overload the motor, Figure 3. Note: HF relative density is 0.96 and Propane relative density is 0.526. Power curve for HF versus Propane on the next slide.

Pump Curves Including comparison Of C3 and HF Power



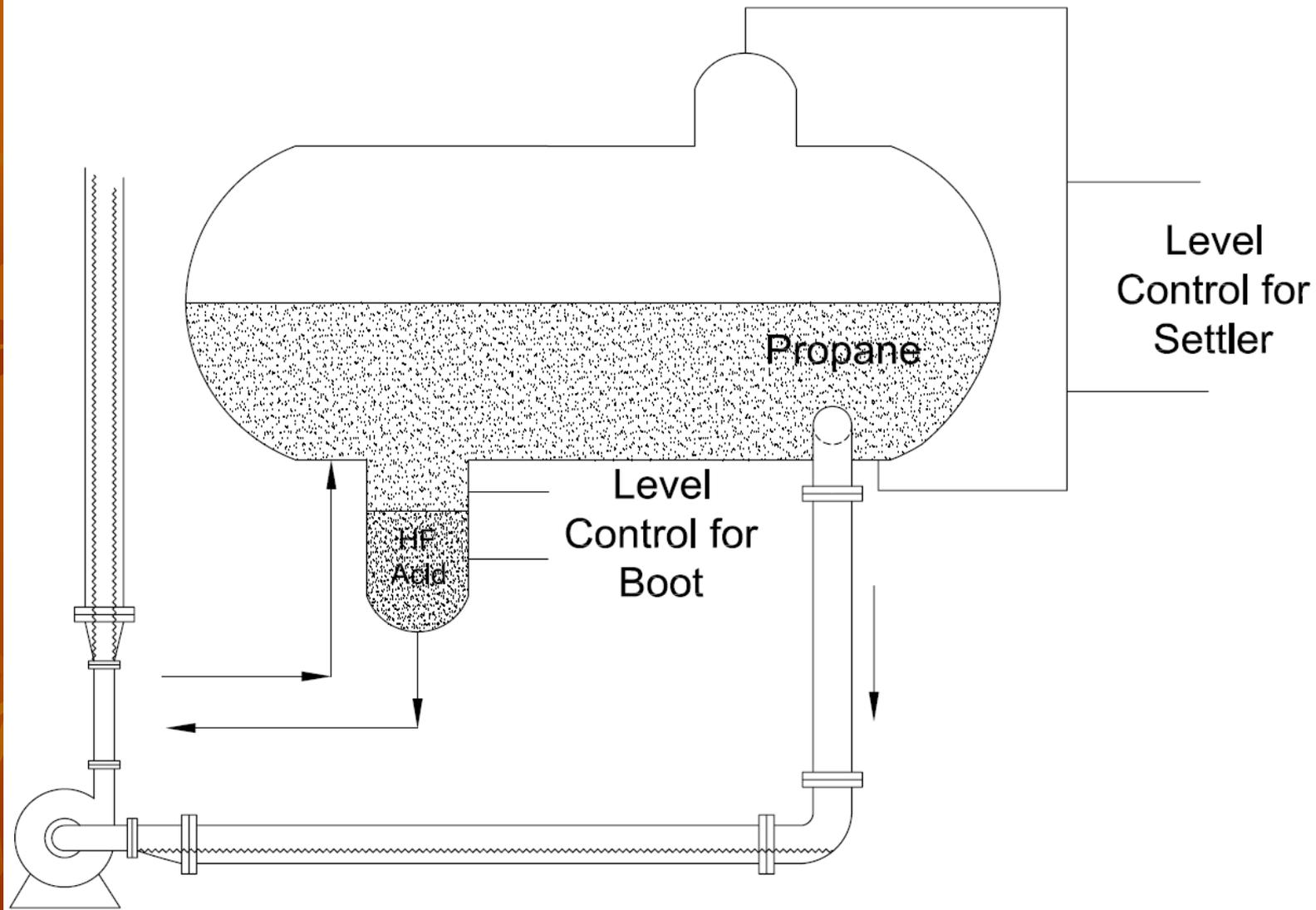


Figure 3

Some of the learning's we took away from this experience:

- 1. Would have liked to install a motor good for HF, water would have been better. The HF Unit has been de-bottle-necked until there is no power available.**
- 2. Traditional construction of pumps in HF service is a carbon steel case with Monel cladding. By asking for a price comparison between a solid Monel case and a carbon steel case with Monel cladding, we learned that solid Monel is less expensive and eliminates the corrosion issues of a cladded case. (Cladding requires a lot of labor) There is a size were the cost of material will overweigh the labor costs, but not in this size pump.**
- 3. We have been successful with o-ring seals on several other canned motor pumps and other applications, but Propane with trace HF is difficult. Future canned motor pumps in the HF unit will be ordered with spiral wound gaskets. There are alternatives, but this is working so we will stick with it.**
- 4. In discussions with some metallurgists, we have discovered that Hasteloy C is chemically compatible with HF in concentrations between 90% and 100%. Discussions with manufacturer's showed that, in their experience with Hasteloy C versus Monel, Hasteloy C, while a more expensive material, is easier to cast and weld and is offered at a lower price due to the lower rejection and rework rate. API 685, Annex H lists material code H2 which calls for all Hasteloy C except the case bolts, but Annex G does not call for material code H2 for any application, yet. For HF>96% Annex G calls for Monel. The next edition of API 685 will add H2 as one of the options in Annex G.**

How is the pump running? Glad you asked. The pump has been online since October, 2008 and is performing flawlessly. Operating procedures have been modified to swap pumps with the spare every two months and to drain the pump and associated piping between the isolation valves. So far, this is working. From a technical curiosity view point, I would like to determine the exact mechanism causing the overloads. This is not going to happen.

Why did the previous pump not have this issue? Easy, it never ran five months at one time. Environmental issues prevented us from ever getting longer than a three month run.

Questions or comments?

The background of the slide features a pattern of stylized, overlapping leaves in various shades of orange, brown, and tan. The leaves are rendered in a flat, graphic style, creating a textured, autumnal effect. The text "Questions or comments?" is positioned at the top center in a bold, white, serif font with a slight drop shadow.