TR-1096

HyPlex Visual Inspection Guide

Introduction

The purpose of this document is to provide a visual guide to the observations that technical service personnel may encounter during the servicing and troubleshooting of the HyPlex pump. The examples provided are the most common types of damage and the most typical observations that these personnel will come across.

Do to the fact that detailed information regarding the failure of Flow International Corporation (FLOW) products may provide information to our competitors that compromises our position in the market, this document shall be considered classified for internal use only.

Plunger damage: contact with dynamic seal carrier

Damage seen on this plunger is typical to that seen on a plunger that has been allowed to run through the failure of a dynamic seal. Often one side will show heavy black marks. Any variation of marking in this area that can not be removed by wiping with a rag requires replacing the plunger or risk an early seal failure after the following maintenance.

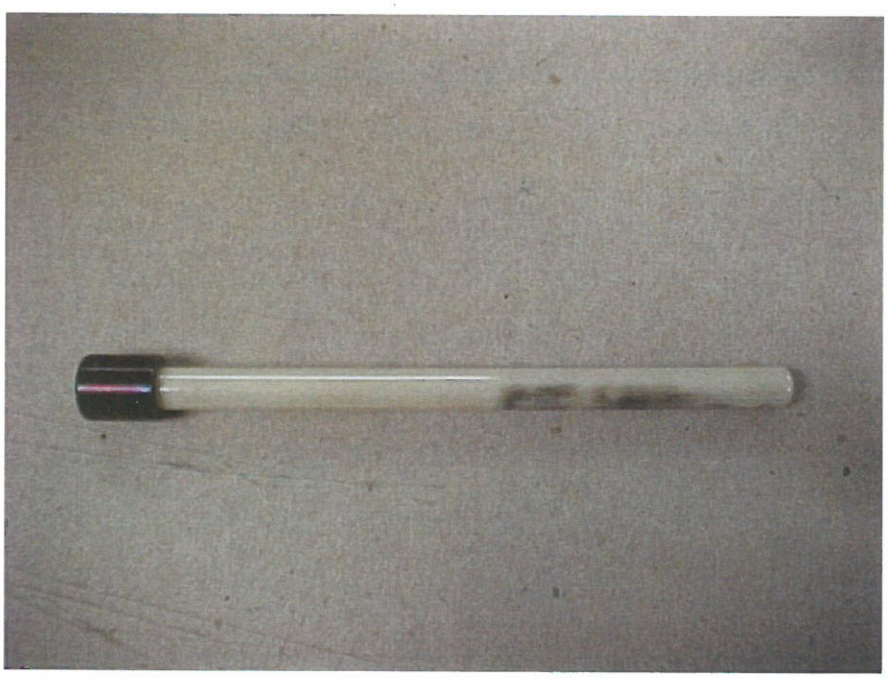

Figure 1

Plunger damage: misalignment

The plunger on the top has seen minor contact with the inlet spring. A close inspection of the inlet spring reveals that the last loop of the spring nearest the poppet is shiny. This will contribute to lower than normal seal life. The cause of this contact is most likely misalignment. The life of the inlet spring is not known to be affected even after contact with the plunger.

The plunger on the bottom has seen sever contact do to misalignment. In this case, the misalignment would be expected to be even more extreme. Plunger replacement is required in both examples shown in the photos below.

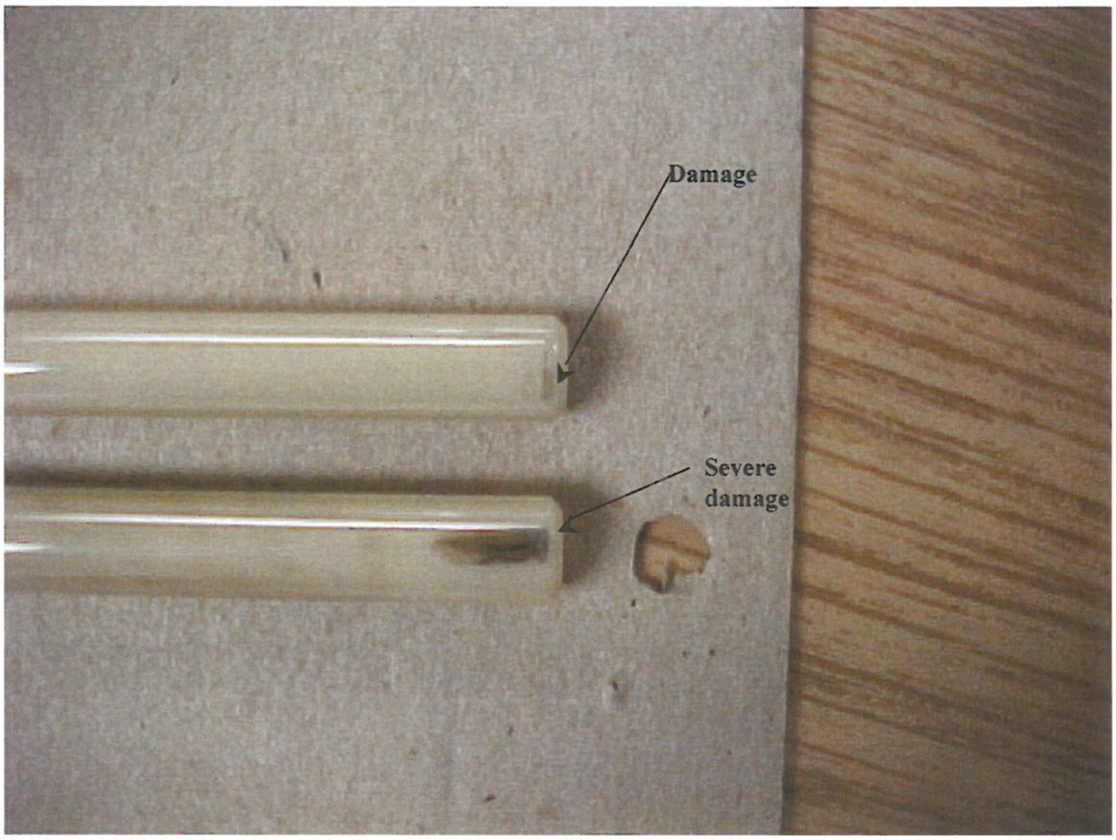

Figure 2

Dynamic seal carrier damage

The dynamic seal carrier is one of the most critical parts in assuring proper pump performance. If the dynamic seal fails, damage often occurs to the carrier. Two types of damage can occur. One type is contact between the plunger and carrier and the other type is erosion caused by dynamic seal leakage. The evidence of plunger contact is noticed easiest by looking at the plunger as was discussed in the previous section. Holding the carrier up to a light source so that the surface can be viewed has also been found to be useful in identifying plunger contact. If plunger contact exists, then the carrier must be replaced. Axial scratches on the inner diameter (shown below) of the carrier are indications of contact with the plunger.

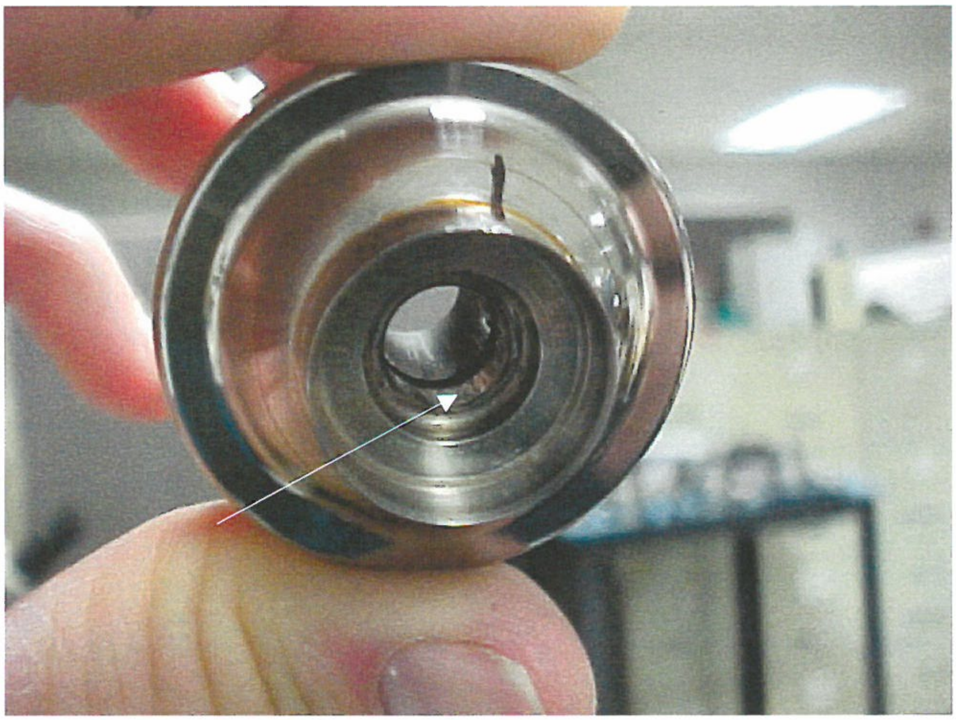

Figure 3

Identifying damage to the edge, shown in the below photo, is critical to ensuring proper performance of the next seal that will be used with this carrier. The most effective means fo detecting this damage is by visually inspecting the carrier with magnification. This is often not available and therefore other methods must be employed to detect minor damage to the edge. One method employed is to mark the entire edge with a marking pen, like the"sharpie" brand. The ink will penetrate into the minor erosion damaged locations. Next, the surface is wiped clean. Only the machined surfaces get wiped clean and the erosion marks are highlighted by the remaining ink. Magnifying the surface enhances this method further. Minor erosion marks, even those barely visible with the naked eye will adversely affect the performance of the seal. If erosion marks are present, then the carrier should be replaced.

Figure 4

Inspecting the carrier to insure loose bearing material does not exist should be conducted. The below photo shows an example of this damage. If a broken piece of bearing becomes dislocated the likely result is a premature dynamic seal failure

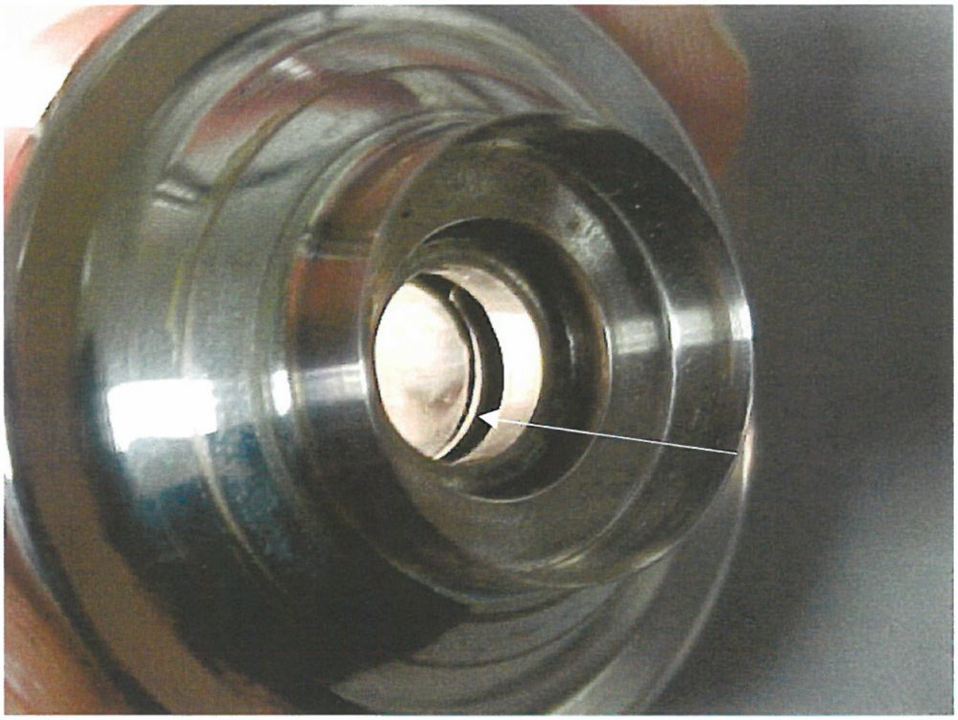

Figure 5

Damage can also be observed on the carrier if the inlet poppet is pinched during assembly. The result of this assembly error can be seen as imprints on the thin lip that extends out from the static sealing face. The photo below shows the four imprints from the filler tube. Often this end is bell-mouthed as well. The carrier can be reused if this damage is noticed, but other items like the filler tube sleeve and the inlet poppet should be inspected.

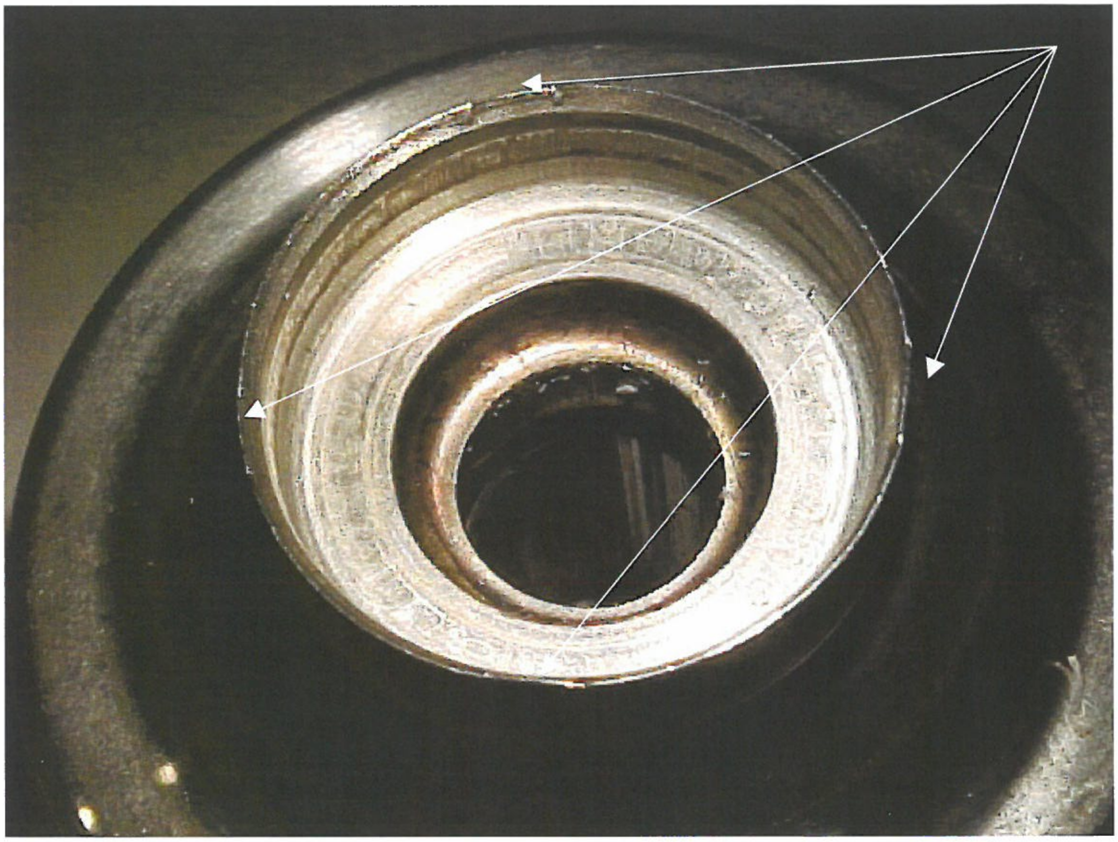

Figure 6

Dynamic seal

The appearance of the dynamics seal is a common point of question when seal life is less than expected. Unfortunately, there are normally not tell tale signs available from looking at the seal itself. The following photos provide some information regarding seal appearance.

Figure 7

The above photo shows a typical seal after some run time. The greatest wear in the seal should be apparent at the (as shown) lower end, inside diameter of this seal. This photo is not detailed enough to illustrate the wear.

Figure 8

Above is another typical view of a used seal. This seal does not show evidence that it was failed since the end, shown here as the top, remains very uniform. The darker material attached to the outside of the seal is a combination seal material and u-cup material. It is typical to see this buildup.

Figure 9

The above seal experienced plunger/carrier contact and damage to the bearing. Numerous observations from the field indicate that dark material on the inside of the seal is common. The current stance of engineering, regarding this observation is the following: Don't replace a seal that has a dark material in its bore just because it is dark. In troubleshooting an early failure of a seal, observing the id color along with other features of the plunger and seal carrier may be useful in determining the mode of failure.

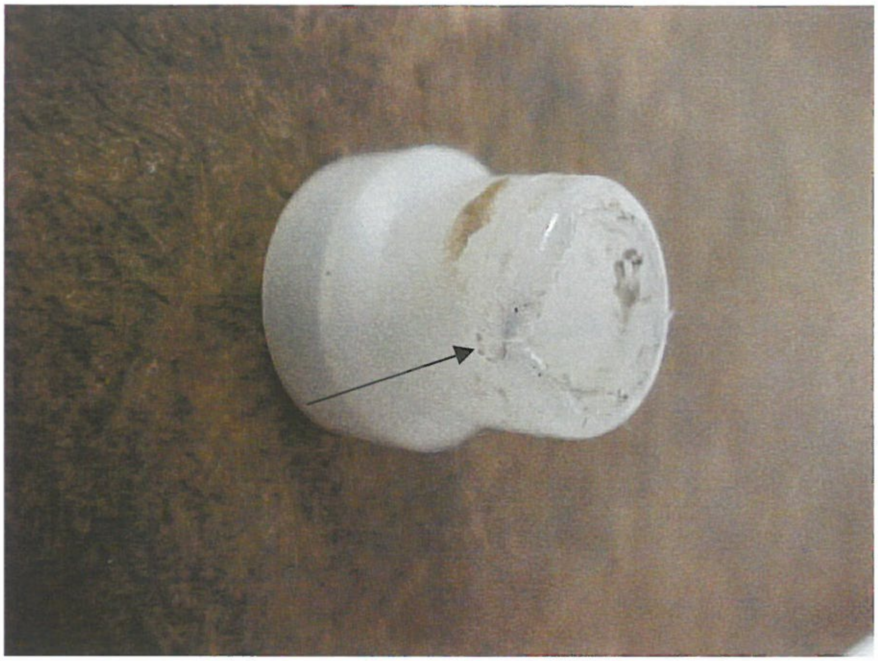

Figure 10

The above seal failed. The feature that best identifies a failed seal is appearance of a region that has lost more material than other locations. This location is commonly called a "mouth"(arrow) or "v-notch". The "mouth" or "v-notch" is the location where leakage occurred.

When a dynamic seal is allowed to run until failure, the u-cup seal is often damaged adjacent to the failure of the dynamic seal. The typical damage to the u-cup is seen below.

Figure 11

High-pressure cylinder damage

The edge that transitions the bore of the cylinder into the sealing face of the cylinder is susceptible to deterioration from fretting. The surface upon which sealing occurs will have a shiny appearance. The condition that causes the failure in this manor is similar to fatigue. The contact stress between the cylinder and the checkvalve body or the dynamic seal carrier changes with every stroke. After many cycles the material will begin to exhibit the appearance that small sections of the material intend to separate from the surface. This is some times referred to as "spalling". If allowed to continue the material loss will be sufficient to render the contact surface useless. Some amount of deterioration is normal through the life of the parts. If damage at the static sealing surface is sufficient to require replacement of the cylinder, checkvalve body or carrier, it is recommended to replace all mating components at that time. This strategy is consistent with the part replacement conducted in the major maintenance kit. It is not usual for this damage to appear early in the life of the component.

The damage shown in the photo below is in the advanced stage but, the sealing surface is still in tact; therefore we would expect this part will seal up if re-installed. All cylinders will eventually become damaged like the one shown below. Replacing them at the first sign of this damage is not recommended because this will result in high operating cost. If it re-seals the cylinder would be considered "good". The likely downside of reinstalling a cylinder with this advanced level of damage is that the debris will cause checkvalve damage. The debris may also travel to the nozzle. Customers using small orifices may experience nozzle plugging or damage under this circumstance. If damage like this is seen on parts with less than 1000hrs then, lower than normal tie rod load (not necessarily torque) may be the cause.

Figure 12

The photo shown below is a typical surface with slight evidence of material deterioration moving into the sealing surface. This part would be reused.

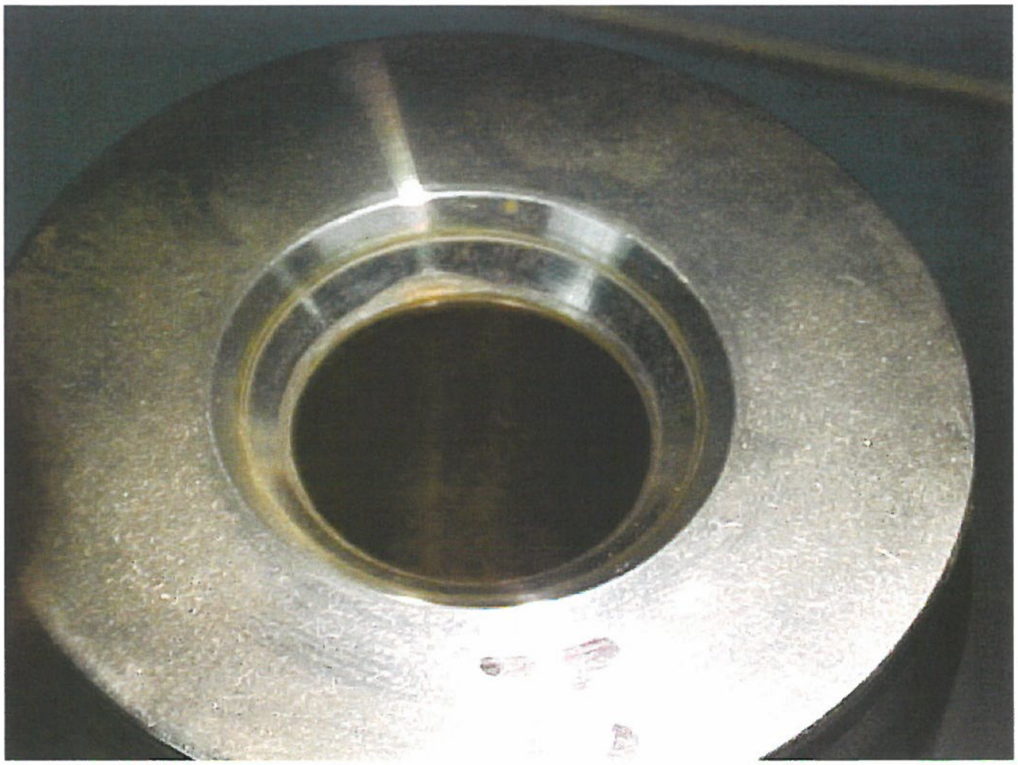

Figure 13

The below photo shows the typical look of the dynamic seal carrier end of the cylinder. We expect that fretting damage can happen here as well as the checkvalve end of the cylinder.

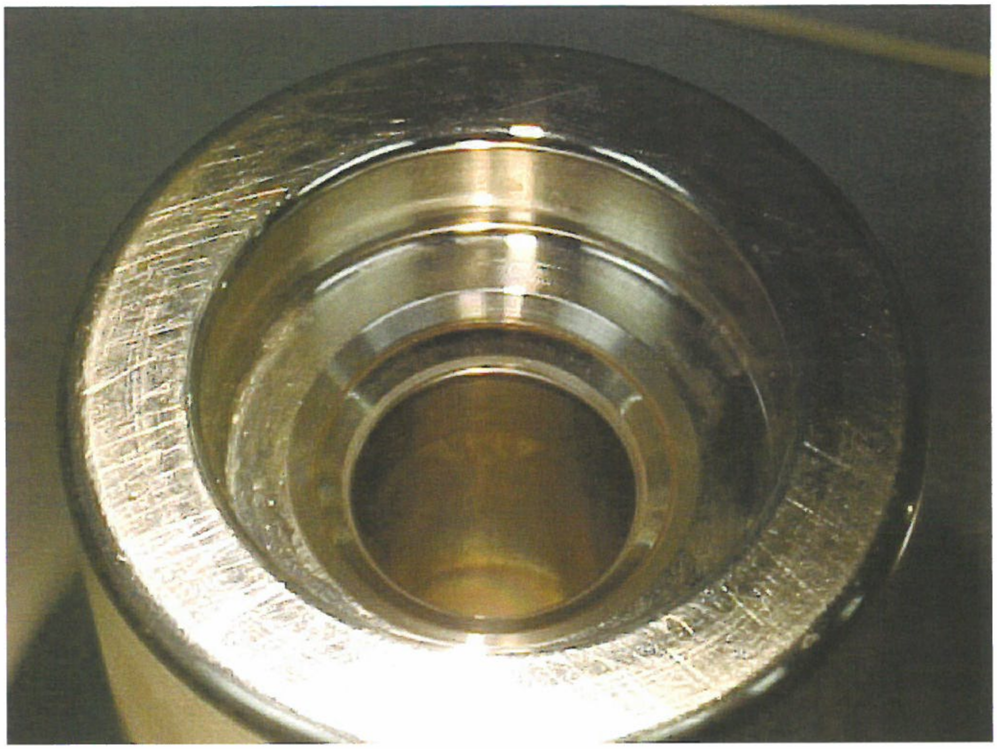

Figure 14

Check valve body damage

Fretting damage can affect the checkvalve body as well. The photo below shows the spall of material lost from what started as fretting damage. This body must be replaced.

Figure 15

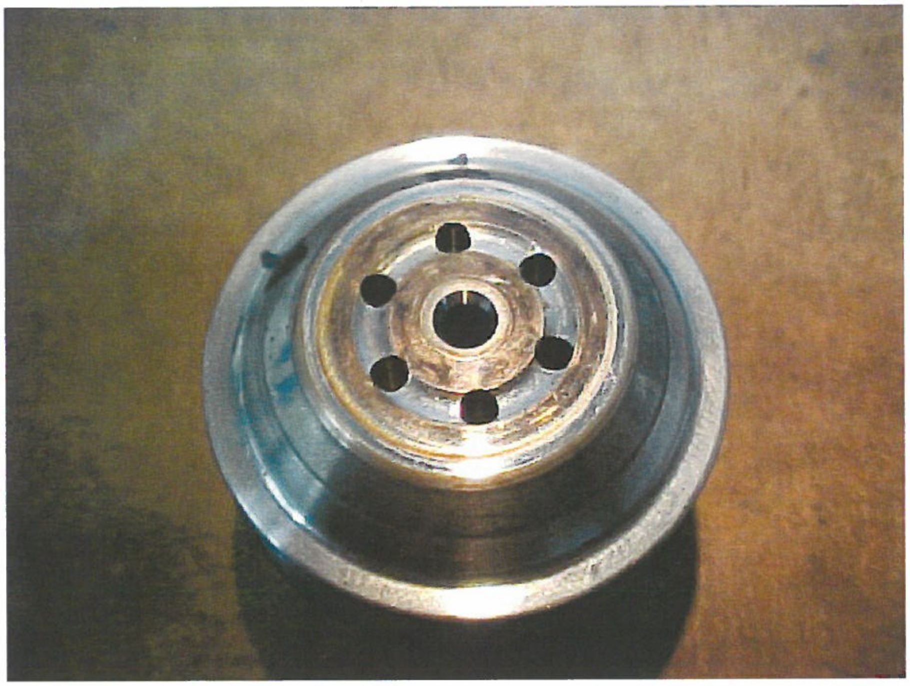

Figure 16

Typical inlet check surface at 500hrs/50hp HyPlex. This face should be lapped as described in the maintenance procedure prior to reuse.

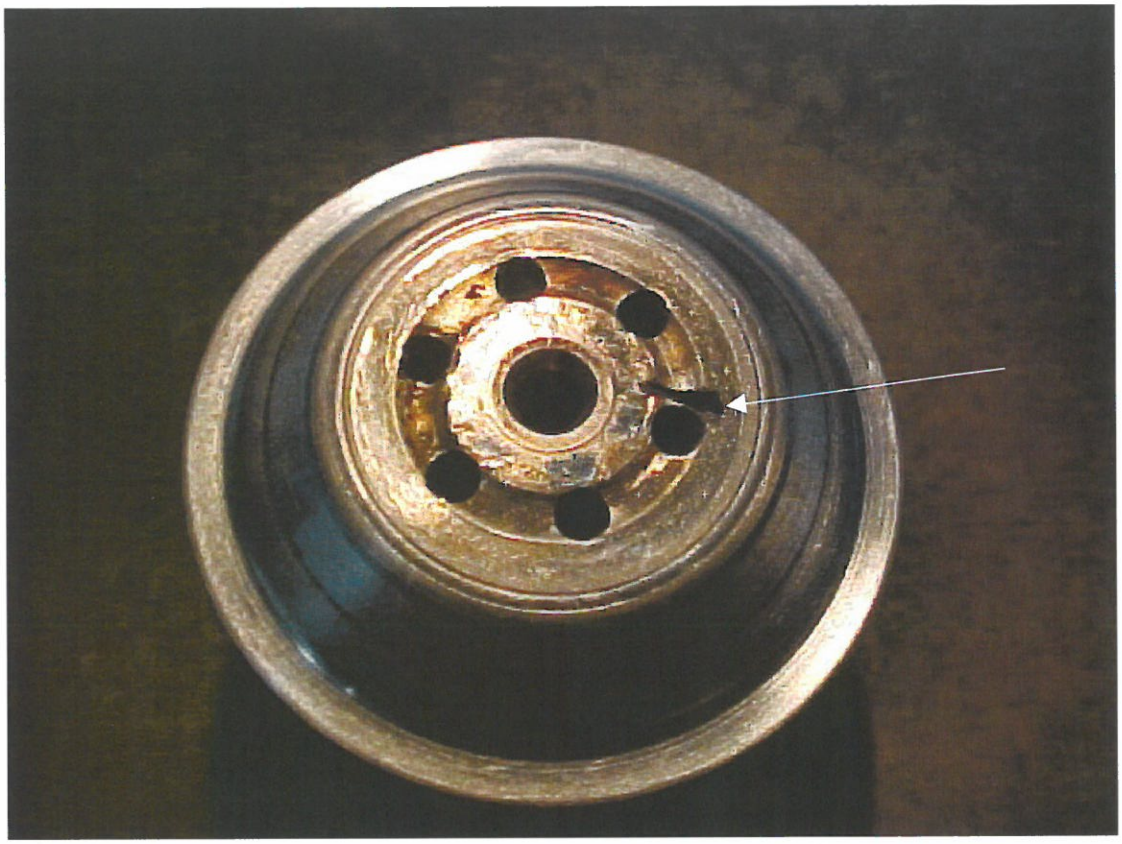

Figure 17

This inlet checkvalve body face surface shows an erosion path. This erosion track is too deep to be lapped out and the body will need to be replaced. Erosion damage like this may have been caused by a piece of debris that became stuck between the inlet poppet and the body face.

Filler tube sleeve damage

The telescoping filler tube sleeve was developed to help insure successful assembly of the high-pressure components. Nonetheless, our experience tells that even with this aid, the parts are sometimes assembled incorrectly. Evidence of misassembly can be seen by looking at the end of the filler tube. A coined imprint can be seen if the filler tube was once assembled where it pinched the inlet poppet. If damage/deformation is severe enough, motion of the poppet may be impaired. In this case it is possible to flip the part end for end and use the undamaged surface nearest the inlet poppet.

Figure 18

The second photo shows the typical look of an undamaged filler tube sleeve. A shiny end surface is typical and is caused by repeated contact between the filler tube and the checkvalve body. This reciprocating contact wears the sleeve and eventually shortens it to where it must be replaced. The sleeve length should be .670 +/- .002.

The sleeve is now part of the minor maintenance kit.

Figure 19

Endcap failure

End caps ideally should not experience the pressure fluctuations great enough to result in fatigue failures. Our experience shows us that reality is not ideal and endcaps fail due to fatigue. Applications with many pump motor on/off cycles are the most likely to see endcap failures. Pressure pulse resonance problems may also be suspected. The endcap failure is identified by this classic characteristic: A crack originating from the endcap outlet hole at the inner diameter of the cap, propagates upward to intersect with the manifold bolt hole. The leakage that results is often mistaken for a failed manifold seal. Inspection of the bottom of the bolt hole will reveal a small crack as shown below.

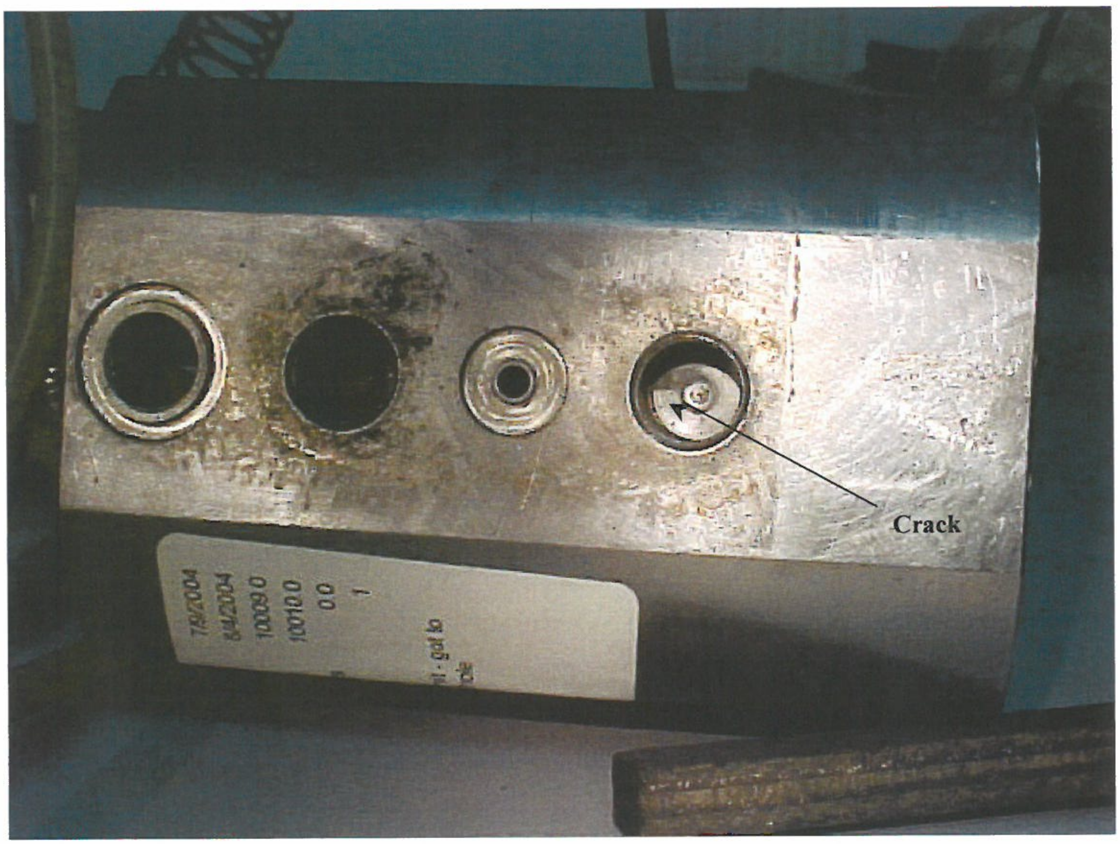

Figure 20

Manifold static seal damage

There are two bronze manifold seals, one at each end of the manifold. When a PCV is used (30 and 50hp units) then, the outlet end has an adapter with a large static seal. The PCV seat on the other end uses a smaller version of this seal. Our experience shows us that the large seal is a bit sensitive to leakage if the torque is not high enough. If a drip is evident at the weep hole, experienced operators will encourage the seal to stop leaking by applying a little more torque to the fitting. If the seal is allowed to leak, the seal (and possibly the manifold) will become eroded and the damage may be enough that the seal will never seal again. Troublesome seals should be inspected for erosion damage. The photo below shows a seal with minor erosion that should be replaced. The adapter, while damaged, does not need to be replaced.

Figure 21