KETO
GLOBAL PUMP SOLUTIONS

GREEN PAPER
KETO EXPELLER DISCUSSION

Table of Contents

Background

Wilfley Pumps developed the first expeller and patented the innovation some 90 years ago (in 1920). Since then the fundamental design has remained the same. When Wilfley's patent expired in 1940 (after the usual 20 years), many pump companies started supplying 'expeller' sealed pumps.

Function

The function of an expeller is to reduce the shaft pressure at the shaft seal area. The following Perspex model from a Wilfley shows their chemical pump expeller seal in action.

Wilfley hydraulic seal in actual operation.

It can be seen that the expeller is creating a 'dry seal' at the shaft location, which is the intent of an expeller working properly.

When the pump is turned off the shaft still needs to be sealed to prevent leakage.

This is usually done via one of the following methods:

1. External water flush using constant flow valve.
2. Grease lubricated packing.
3. Lip seals.
4. Sometimes an inflatable bellows.

In most pumps the expeller vanes are generating enough head to overcome the suction pressure and the pressure created by the impeller. If the suction pressure is increased, there is more load on the expeller, and at a certain suction pressure the expeller will no longer be able to operate with a dry seal putting the load onto the packing or expeller.

Operation in slurry

For decades ALL slurry pump manufacturers have had an expeller seal option. The 'pump out vanes' on the shaft side of slurry pump impellers reduce the seal chamber pressure significantly whilst also reducing the thrust loads on the bearing assembly. These impellers are commonly used on packed gland arrangements.

The pumpout vanes used on slurry pump impellers (shown below) are a bit like using two expellers in series. They dramatically aid the expeller in operation and have a large impact on the effectiveness of creating the dry shaft.

Operating performance

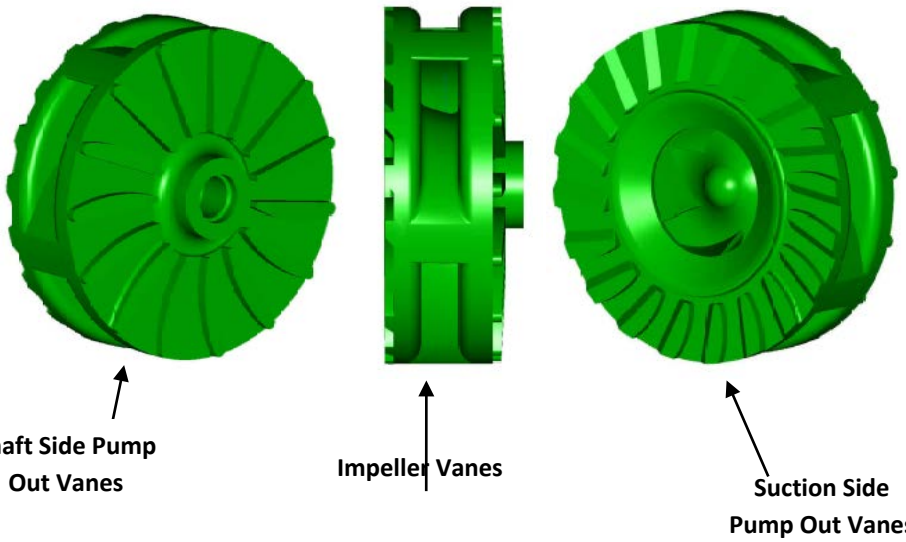
A rule of thumb for slurry pumps is that the expeller absorbs an additional 5% power and are effective with suction pressures to a MAXIMUM of 10% of the discharge pressure. Published pump performance curves do NOT generally show the power consumption with the expeller fitted.

Until very recently the dominant slurry pump competitor standardised on an expeller design that used a 'C' section seal and enabled the use of STANDARD liners which could be used for the packed gland and mechanical seal options.

Expeller sealed pumps are NOT recommended for pumps operating on suction lift as the negative suction pressure can often result in the pump dropping prime due to air being sucked in through the seal chamber.

Impeller pump out vanes

When operating at the pumps best efficiency point, 'Pump Out Vanes' cast into the impeller are designed to produce a higher head than that developed by the impeller vanes. In fact, the expellers often do not do ANY work at all until the Pump Out Vanes are very worn.



High Efficiency impeller designs from slurry pump competitors, and impellers the competitors supply for use with mechanical seals do NOT have pumpout vanes. The result is that the expeller is not assisted by the usual pumpout vanes and thereby expellers can NOT be used with their high efficiency impellers. There is also a higher thrust bearing load.

Removal of the pumpout vanes from the suction side of the impeller, when used with the standard throat bush, also leads to eddies creating severe localised throat bush erosion.

ALL KETO impellers, although a high efficiency design, incorporate 'Pump Out Vanes' on both sides of the impeller. They can be used to save power and increase life in expeller sealed, gland sealed, and mechanically sealed services.

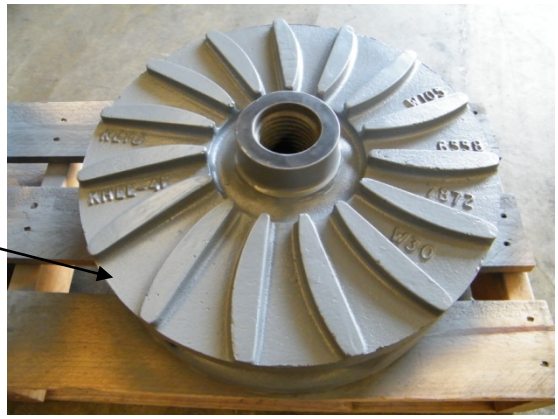
Operation at partial flow

The style of pumpout vane patented by the competitor and used by them until the patent expired was affectionately known as the 'Hockey Stick' style as they were a curved vane in the shape of a hockey stick.

The Hockey Stick pump out vanes were very effective at reducing the pressure at the seal chamber when the pump was near its design point but not effective when the pump was operating at a partial design capacity or on solids that could block the vanes. Accordingly the conventional expeller with the Hockey Stick design vanes was NOT recommended for use for pumps operating at partial flows.

The KETO impellers have very effective and efficient radial design pump out vanes. These are better at generating head at partial flows and taking the load off conventional expellers.

KETO style
'Pump Out'



Pump efficiency and wear

To work most efficiently and with the least wear in a pump, the impeller should be set as close as possible to the throat bush. This reduces the amount of slip that occurs between discharge pressure and suction pressure.

In contrast, for the expeller to work most efficiently, it is set against the frame plate (i.e. in the opposite direction to how the impeller is set). The sacrifice in using expeller sealed pumps is an increase in the power consumed and the wear rate of the impeller and throat bush.

Most sites thereby compromise and set the impeller and expeller at the midway point.

'High Seal™ Expeller*'

Nineteen years ago (1994) the leading competitor designed an expeller with a larger diameter. The larger diameter enabled it to produce a slightly increased centrifugal force thereby a marginally higher head.

The larger diameter expeller was called a High Seal™ expeller and a drawing from the IOM follows.

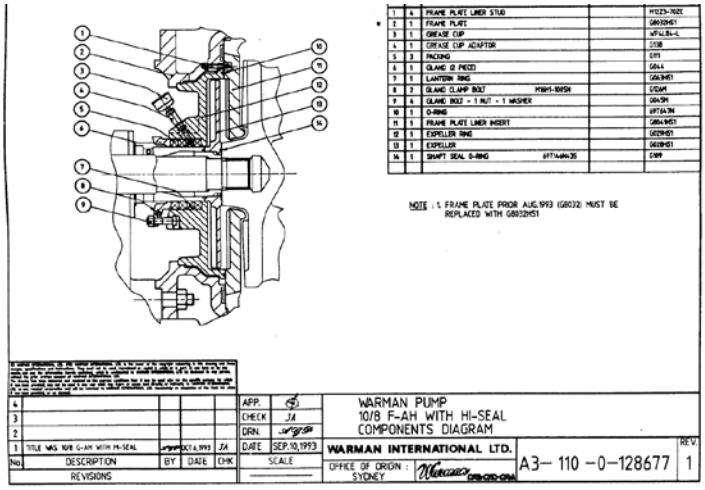


Figure 2 Warman Pump 10/8 F-AH with Hi-Seal Components Diagram

From the published test data at the pumps best efficiency point, when running at a typical 700rpm for an 8/6 in a severe duty, there was about a 6kPa improvement in the maximum allowable suction pressure (66kPa rather than 60kPa). With many applications having an SG of about 1.3, this equates to a suction tank being able to have a maximum tank level of about 5.2m with a conventional style expeller instead of 4.7m. At higher speeds the expeller and impeller create even more head, with even less noticeable difference between the two expeller styles.

Where the difference was noticeable is when the pumps were operating well below the pumps design flow (at about 20% of BEP) where slurry pumps do not usually operate due to increased wear.

The advanced design of the KETO pump out vanes, with their radial rather than curved design, work more efficiently than the old 'Hockey Stick' style of vanes that the 'High Seal ™' expellers were originally designed for, particularly when the pump is running at partial flow. The result is the conventional expeller in the KETO pump will work at higher suction pressures without shaft leakage in much the same way the High Seal™ expeller reduced leakage on pumps with Hockey Stick vane designs operating at partial capacity.

For the competitor to use the High Seal™ expeller, which has the larger diameter, the standard frame plate liner **cannot** be used. Even the studs differ as to fit they have to be a smaller diameter.

Until around 2009, the result was that the liner used in High Seal™ pumps differed to the liner supplied for gland packed and mechanically sealed pumps. The conventional style expeller that had been used for about 40 years was still preferred by most clients as this way the spares remained interchangeable between their expeller sealed pumps, gland packed pumps and mechanically sealed pumps. Most were satisfied with the function of the conventional expeller they had used successfully for many decades.

To rationalise spares, particularly liners, the dominant competitor is now supplying many new pumps with stuffing boxes, mechanical seal chambers and

High Seal™ expellers that all use the same larger diameter sealing area (converted from C section seal to an O ring). For green fields projects, this makes very good sense. For clients with existing site inventory, using the conventional style components, interchangeability with existing site stock is lost which causes problems. The leading competitor will supply the common conventional style on request, but if not specifically requested the 'HS' style swill be supplied thereby sacrificing interchangeability with existing plant.

High Seal™ parts also have a premium price versus the conventional design which has resulted in many clients converting High Seal™ pumps back to the more common liners and seal chambers. KETO have assisted many clients convert their pumps back to the conventional style and welcome enquiries to assist do so.
In every case all parts associated with the High Seal™ design have a part number that incorporates 'HS' into it. For example the High Seal™ expeller has a part number of DAM029HS1 instead of the more commonly found DAM029. A new (currently rare) stuffing box of the new configuration, no longer interchangeable with older plant, is DAM078HS1, instead of the common DAM078.

KETO opinion

KETO have endeavoured to maintain interchangeability with existing plant and equipment.

The modern design philosophy of the KETO engineers has been to reduce power consumption, reduce wear, and rationalise on stocks.

If zero seal leakage is desired and higher suction pressures are needed than expellers provide, our Patented KETO KISS mechanical seal system is highly recommended. Instead of suction pressures up to about 70kPa maximum, our mechanical seal system will allow up to 10 times this pressure (ie 700kPa depending on service).

The KISS Mechanical seals do not absorb more power than gland packed pumps with external flush so our seal offers substantial operating savings compared to expeller sealed pumps. For example, an 8x6 pump at 1300rpm at BEP in a typical slurry duty will absorb in the vicinity of 300kW. The rule of thumb for the expeller this equates to around 15kW and even being conservative and calling this 10kW, with power at $0.15/kWhr the cost to run the expeller in a continuous duty (90% availability) for one year equates to around $7,900!

Modern plants often want to use variable speed drives on the slurry pumps to further reduce operating costs. As the pump speed is reduced, so is the effect of any style of expeller, and the shaft seal starts leaking. Mechanical seals and externally flushed gland packed pumps do not suffer the same fate.

If however clients find an expeller is best suited to their application we are more than happy to offer them.

To rationalise stock holdings, the KETO seal chamber parts ALL interchange with the majority of field installed competitor equipment but NOT the 'High Seal™' components. Upgrading 'High Seal™' units to the KETO designs, by converting them back to the conventional style will save clients a considerable sum during repair of their equipment.

*High Seal™ is a trade mark of Weir Warman Australia. Any use of competitor names, trademarks, model no, item no or part no is for reference purposes only. KETO and are products are not associated with, endorsed by, or sponsored by Weir-Minerals Pty Ltd.