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PLUNGERSEALS

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INTRODUCTION

The dept. of Environmental Engineering, Lund Institute of Technology have carried out laboratory tests on handpumps since 1982. These results and results from other lab. tests and field tests have pointed out the below ground parts of the pump to be the most wear sensitive and most difficult to repair. Because of this the project entered a new phase in cooperation with The World Bank and SIDA. The new project is named "Preparation of quidelines for selection of plunger seals" and consists both of laboratory testing of seals and compilation of results from other test institutes and field tests.

This report is the result of a literature study at IRC, Den Haag, Holland, and discussions with their personal. It was carried out during August 1986.

The objective for making this study is to get a better view on what has been done and what is going on concerning plunger seals.

The discussion was primarily held with Mr Hofkes and valueable help has been contributed from Mr Dietvorst and Ms Westerhof at the IRC library.

Robert Hahn and Henrik Aspegren at the department are indebted for being of great help when writing this report.

REVIEW

Laboratory tests and field tests have been made in various places in the world. Below a list follows on institutions and others who have been working with the subject or where information could be found.

IRC

Receives and collects material from a lot of sources concerning handpumps in general, and publishes it in handbooks and newsletters.

IDRC

Collects and publishes results from tests on PVC-handpumps with plunger rings.

Batelle Memorial Institution.

Involved in the development of the US-AID hand operated pump in the late sixties and early seventies. Made a lot of lab. tests with different materials for both plunger seals and cylinders.

The World Bank/UNDP

Is running the interregional project for Laboratory and Field Testing and Technological Development of Rural Water Supply Handpumps. In this project extensive field tests are carried out in 17 countries, and laboratory tests of handpumps at CATR, England and Lund Institute of Technology. The World Bank is also involved in the development of the Tara and Afridev handpumps.

Georgia Institute of technology

Continued the work after Batelle Memorial Institute with field studies and lab. testing of derivates from the US-AID handpump.

CATR

Created a model and a program for laboratory testing of the whole handpump. They started with the tests in 1979 and have since then tested a great number of handpumps.

Lund Institute of Technology

Lab. testing of the cylinder assembly and development of quidelines for selection of plunger seals.

University of Malaya, Malaysia

Lab. testing of the Waterloo handpump (PVC, shallow well).

The University of Malawi

Field tests and Lab. tests of a shallow well pump without seals or with plunger rings.

Chulalongkorn University, Thailand

Involved in the development of a shallow well PVC-handpump in cooperation with the WHO. The pump is working with leather seals.

Indian Inst. of Technology Science

Under Mr Rama Prasad tests were made to describe the characteristic of the plunger seal. The tests consisted of both laboratory and field tests.

Blair Institute, Zimbabwe

Field test and Lab.tests of a shallow well pump without seals or with plunger rings.

Asian Institute of Technology, Thailand

Lab and field tests on the Waterloo handpump (PVC plunger rings).

India Institute of Public Health

Made a study on shallow well handpumps for the WHO, the tests consisted of laboratory tests.

China

A laboratory have been set up in Brijma and one in Changsha but they have not published any results yet.

Others

Manufacturers of handpumps carry out tests but do not publish the results. Another source is respectively countries' ministeries which make field tests but as the maunfacturers do not publish it for official use.

RESULTS

Factors affecting the duration and performance of plunger seals are basicly the three listed below

1. The plunger seal
2. The cylinder
3. The plunger

THE PLUNGER SEAL

The material in the plunger seal varies from different synthetic materials to leather treated in different ways. Both groups of seals have their advantages and disadvanteges. One big problem when testing leather seals is the variation in quality and size between seals of the same brand. It is therefore not sufficient to make a single laboratory test on a seal, since it does not give a significant result for that specific seal.

The variation in quality most likely depends on:

+ rawmaterial
  - what kind of animal is used.
  - gender of the animal.
  - age of the animal.
  - the animal's environment.
    - altitude
    - climate zone
    - indoor/outdoor living

+ tanning
  - what kind of tanning process is utilized.
    - vegetable (different kinds)
    - chrome
    - vegetable/chrome
  - time duration between slaughter and tanning.

+ impregnation
  - the efficiency of the tanning process.
  - what impregnator is used.

+ manufacturing uniform instruments.
skill of labourers and management.

Two different shapes of the plunger seal can be distinguished namely the cup seal and the lip seal. It is nearly impossible to manufacture a leather seal in the shape of a lip seal. There have been discussions whether it is right to make synthetic seals in the shape of a cup seal.

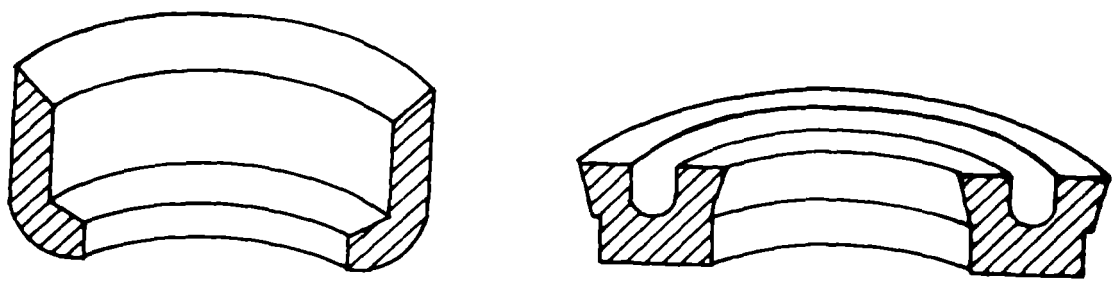

Figure. A) Cup Seal B) Lip Seal

Size

All leathers when under water absorb some of it and expand while synthetic material do not expand at all. The swelling of a leather seal must be controlled since the performance of the pump depends highly on it. If it swells to much then the force needed to get the plunger to its lower position is so high that the plunger stops in the upper position. If the swelling is not enough the efficiency of the pump will be low.

Mr Rama Prasad have made some tests of the swelling with different seals. It shows that the swelling does not stop until after about six days for leather from the best part of the hide. This self adjustment of a seal is an advantage, if the cylinder is not completly circular or shows other irrigularity in its form. The opposite

occurs when seals of synthetic material is used. it has to fit perfectly in the cylinder from the beginning since the expansion is close to zero.

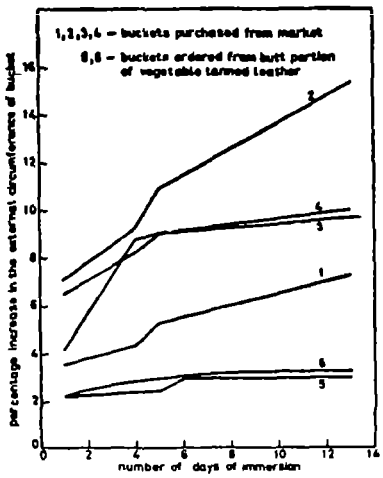

Figure. Water absorption in leatherseals of different quality. (Handpumps:problems and search for remedies, 1979)

Material

Below a list follows of different materials used in seals and where they have been tested.

Leather:

untanned	Indian Institute of Science,
veg. tanned leather	Georgia Institute of Technology,
chrome tanned leather	Batelle Memorial Institute,
veg/chrome tanned leather	LIT, CATR.

Synthetic:

polythene	As above.
neoprene	
natural rubber	
nitrile rubber	
PVC-rings	Asian Institute of Technology.

Of the above mentioned, a good quality leather seal and nitrile rubber show the best testresults.

Quality

The advantage of a synthetic seal is the uniform quality from a specific brand. A lot of improvement can be made when manufacturing leather seals. A good quality leather seal has shown to be as good as the best synthetic material in laboratory tests.

Location

Leather is as stated before an water absorbing material and the cycle wet/dry is weakening the material. Therefore it is not recommended to use leather seals in a shallow well suction pump or in pumps which do not have the seals under water all of the time. In the cases mentioned above it is better to use a synthetic seal.

What effect the pressure has in deep wells on soft material is not clearly stated but the deformation of the seal assumes to give exstensive wear or even a total breakdown, if the seal is to soft and the height is to low the risk that the seal would turn outside in is high.

THE CYLINDER

The smoothness of the cylinder is one of the big secrets to longer seal life. Batelle memorial Institute made a few tests and Georgia Institute of Tech. noticed the phenomen in a field test in Nicaragua/Costa Rica. The results show that Iron and poorly made cylinders have to high roughness and is of no use in a handpump. Extruded brass cylinders and coated cylinders have a very low smoothness. The form of the cylinder is another factor in the choise of seal material. A synthetic seal demands a perfectly circular cylinder while the expanding leather seal does not require this.

CONCLUSIONS

Below is a list what most likely have happened to a seal during a breakdown.

1. A cylinder with to low smoothness or irregular form has been used.
2. The leather seal does not fit in the cylinder. It is either to small or to big, no consideration hase been given to the swelling or seals with various quality have been used.
3. Synthetic seal is used in an oval cylinder or cylinder with irregular shape.
4. Leather seals is used where wet/dry conditions occur for instance in suction pumps.
5. The leather seals is of low standard, rawmaterial, tanning, impregnation is not done professionaly.
6. The material of the seal is to soft that it deforms under the pressure loads.
7. The impacts on the seal have been underestimated.

There are a few things to consider when choosing a plunger seal.

A lot of tests have shown that seals of good quality are performing very well. The things that give the quality of leather is listed on page 6. Even if the leather or synthetic seals are more costly to purchase its a good investment in the long run since the cost of a seal is about 1% of its replacement cost.

The use of a cylinder with a high smoothness rate is also important. Some coatings are not wear resistant and the friction gets higher due to wear.

Measurment have to be made on the fitness of the seal in the cylinder. Notice a week is required for a leather seal to swell.

The use of leather seals in suctionpumps where wet/dry cycles occurs is nothing to recommend.

If the cylinder is oval or has other irregularties it is better to use a leather seal.

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