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PEOPLE AND SYSTEMS FOR WATER, SANITATION AND HEALTH

The afridev handpump – problems and solutions

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THIS PAPER DISCUSSES problems encountered with AFRIDEV handpumps during 6 years of implementing Rural Water Supply and Sanitation (RWSS) programmes in Malawi, including 4 years of detailed monitoring of 375 water points. Suggested solutions for each problem will also be presented.

The programme

The implementation of RWSS in Malawi, with bilateral co-operation between the governments of Malawi and Germany funded through the German Bank for Reconstruction (KfW) commenced in mid-1995 with the Kalembo Groundwater Project. A total of 375 boreholes with AFRIDEV handpumps were installed. The project ended in mid-1998.

The implementing agency for the programme is the Ministry of Water Development who has employed GITEC Consult of Düsseldorf in Germany to design and supervise the projects.

A second project in East Mangochi district has been designed, implementation started in early 1999 and is ongoing.

Monitoring of the Kalembo Groundwater project started in the third quarter of 1997 and is ongoing. Each of the 375 water points is visited quarterly.

The AFRIDEV handpump

Development of the AFRIDEV handpump started in Malawi in the early 1980's with the collaboration of the Malawi Government, UNICEF, UNDP and World Bank. A pump called the Malawi Development Pump (MALDEV) was developed. Research and development was moved to Kenya in 1983 and the pump name was changed to the Africa Development (AFRIDEV) pump after some modifications.

The Swiss Centre for Development Co-operation in Technology and Management (SKAT) issued the first specifications and drawings for the AFRIDEV in 1989. There have been three revisions since then the latest being in 1998. The AFRIDEV is a "Public Domain Pump" and has no copyright or patent, anybody can purchase the specifications from SKAT and manufacture the pump.

The AFRIDEV has been adopted as the standard deep well handpump for Malawi.

Operation and maintenance

The AFRIDEV is a true Village Level Operation and Maintenance (VLOM) pump. All the internal moving components can be withdrawn without the necessity of removing the rising main. Pump Caretakers are trained to remove the internal components and replace fast wearing parts.

At times it is necessary for the rising main to be removed e.g. when the rising main fails; when a pump rod breaks; when the rods are dropped; when the foot valve is jammed in the cylinder; etc. The rising main is made of UPVC with permanently bonded joints using solvent cement. The programme introduced a system of Area Mechanics whereby suitable individuals within the community are identified and trained to withdraw the rising main. This is done with the help of the community who withdraw the rising main in one piece. The necessary repairs are carried out and the cylinder and rising main replaced, again in one piece. There is therefore a capacity within the community to repair the entire pump without recourse to other, often centralised, organisations.

Spare parts supply and distribution

Without a reliable supply and distribution of spare parts there can be no sustainability of the pump and hence the water point.

Malawi is in the process of developing a sustainable supply and delivery of parts. The supply has been the most problematical with the Ministry of Water Development making the procurement utilising funds solicited from donors. A revolving fund was set up which, for a variety of reasons, failed to provide sufficient funds to reorder replacement stocks. General opinion is that the procurement and supply of parts should be privatised and moves towards this end are under way.

A distribution system was put in place through Chipiku, a nation wide chain of wholesalers. The stocks have been supplied by the ministry and are sold on a commission basis.

AFRIDEV problems and solutions

A number of problems were encountered with the pumps during the implementation of the Kalembo Groundwater Project. All of the problems identified can be avoided with careful procurement procedures and close supervision of installation.

The problems identified have been categorised into:

- Design flaws;
- Manufacturing defects; and
- Installation faults.

Suggested solutions for each problem are included.

Afridev problems and solutions

Location	Description	Possible cause	Suggested solution
Foot valve	Initial fitting of foot valve. In some cases the foot valve has hung up (stuck) on the lip at the top of the cylinder. The depth of plunger setting (**Timing**) is then set incorrectly with the plunger operating in the rising main.	The foot valve oscillates in the rising main as it descends and can lodge on top of the brass cylinder. *There is 508mm of brass cylinder liner above the top of the foot valve, the stroke is only 225mm.*	The length of the top rod can be easily calculated (even roughly) to double check the setting depth. (Installation fault.)
Foot valve bobbin	**Displaced bobbins** are being found in the foot valves jamming the valve open.	1) When the foot valve is dropped into the rising main it hits the water fast which, when coupled with possible oscillation, could cause displacement. 2) Dimensional.	Pre-shipment inspection. (Manufacturing defect.)
Cylinder	**Bent.** Cylinders have been found to be bent, oval and undersize.	This occurs during the assembly process especially during the cooling of the assembly after shrink fitting the plastic pipe and brass liner.	Pre-shipment inspection. (Manufacturing defect.)
"U" Seals	**Fast wearing** ***(in some cases within 1 month)*** **& rolling out of location groove.** Many "U" seals have a very short operating life and a number have also been rolling out of their grooves.	1) Material consistency, some very soft ones have been found. 2) Dimensional? 3) Rolling out may be caused during withdrawal against the inside of rising main joints. 4) Siltation.	Pre-shipment inspection. (Manufacturing defect.)
"U" Seals	**Blocking of cylinder.** When "U" seals become dislodged and remain inside the cylinder it is not possible to withdraw the foot valve without withdrawing the whole pump.		
Plunger	**Dimensional.** The groove for the "U" seal is asymmetric and dimensionally incorrect. Could contribute to "U" seal problems.	Incorrect spin welding of the two parts of the plunger.	Pre-shipment inspection. (Manufacturing defect.)
Plunger	**Plunger legs breaking** and blocking the foot valve.	Maybe caused during foot valve installation or when excessive force is applied.	Cut off legs before installation. (Design flaw.)

Afridev problems and solutions

Location	Description	Possible cause	Suggested solution
Rod centralisers	**Bad wear** of rod centralisers often causing heavy friction during operation.	1) Heavy siltation of bore-hole. 2) Coincidence of rod and rising main joints causing the centralisers to wear excessively.	If the first pipe installed above the cylinder is 1.0 metre long then the joints cannot coincide. (Installation fault.)
Rods	**Bent rod joints.** Rod joints misaligned with the axis of the rod causing excessive friction.		Pre-shipment inspection. (Manufacturing defect.)
Rods	Bent rods.	1) During transportation or storage. 2) During installation. 3) During subsequent re-installations.	Careful supervision.
Fulcrum and hanger pins	**Cracks** in the stainless steel sleeves.	Corrosion of inner mild steel pin.	Consider solid stainless steel pins. (Design flaw.)
Rising main	**Straightness** of individual pipes.	Poor transport and storage conditions.	Careful supervision.
Rising main	**Straightness** of rising main column.	Tension is being induced in the rope causing the rising main to bend.	Rope should be slack as shown in the SKAT install-ation manual. (Installation fault.)
Rising main	**Joint alignment.** The socket is not aligned with the axis of the pipe.	Incorrect formation of sock-et.	Improved socket formation at the manufacturers. An extended mandrill should be used to align the socket former with the axis of the pipe. (Manufacturing defect.)
Rising Main	**Joint preparation.** Sharp edges left inside and outside the spigot. Inside causes a problem with the plunger and centralisers, outside hinders jointing.		Both the inside and the outside of the spigot must be bevelled. (Installation fault.)
Rising main	**Jointing** incorrect, not pushed home far enough. *(Must be 115mm.)*	Depth mark not drawn on spigot before jointing, in-sufficient effort to joint correctly.	The marks should be made at the workshop, not in the field. (Installation fault.)
Rising main	**Double sockets** are not long enough (should have the same socket dimensions	Use of short double sockets designed for jointing hori-zontal pipes which are	Double sockets should be parallel and at least 230mm long.

Location	Description	Possible cause	Suggested solution
	as the pipes) and also many are necked (smaller diameter in the middle as the pipe) causing a re-striction to the plunger and centralisers.	readily available.	These need to be made available at spare part outlets.
Operation	**Short pumping strokes** during operation are causing excessive wear throughout the pump.	1) Foot valve not working. 2) Plunger timing wrong. 3) Children operating pump.	1) Remedy technical problems. 2) Educate users.
Solvent Cement.	Not readily available for maintenance purposes.		Packaging quantity should be reduced to enough solvent for a double socket joint i.e. 2 joints, and sold with the double socket.

Conclusions:

Pre-shipment inspection:

All consignments of pumps and/or spare parts must be inspected in the country of manufacture before shipment and payment. Control of pump imports must be put in place, maybe by stipulating that all pumps installed must have an inspection certificate.

Design flaws:

SKAT have been notified of the problems encountered and some modifications have been offered as alternatives in Revision 3 of the Specification.

Installation faults:

All pump installers should receive approved training and be certified. Only certified pump installers should be allowed to install pumps.

"U" Seals:

The "U" seal seems to present a disproportionate number of problems during the operation and maintenance of the pump. It is not just that it wears out but it also causes other more serious problems often requiring the withdrawal of the rising main.

The locating groove in the plunger body is formed at the joint of the two components of the plunger body during spin welding, which is often out of tolerance. This, coupled with the widely varying quality of the material, often causes it to roll out of it's location causing a blockage in the cylinder.

It has also been observed that silt settles out of the water column overnight filling the inside of the seal and when full, overflows inwards into the groove, thus pushing the seal out causing it to wear irregularly.

After discussion with SKAT and other users the programme has now specified the use of a brass plunger with a more substantial cup seal as used in the India Mark III.

Fulcrum and hanger Pins:

Both the fulcrum and hanger pins are of similar design with a 2mm thick stainless steel sleeve glued onto a mild still pin using epoxy resin. Both these parts operate within a very humid atmosphere and moisture penetrates along capillaries in the resin attacking the mild steel pin. The resultant corrosion causes the sleeve to split which in turn destroys the bush bearings.

The programme has specified that both pins should be manufactured from solid stainless steel.

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Table 1. Spare Part consumption for 375 AFRIDEV handpumps from October 1997 to March 2001.

Bush bearings	48
"U" Seals	186
"O" Rings	42
Bobbins	36
Rod Centralisers	40
Rising Mains	21
Cones	1
Covers	0
Cylinders	1
Plungers	9
Foot valves	3
Pump Rods	25
Fulcrum Pins	12
Hanger Pins	6
Rod Hangers	0
Handles	1
Pump Heads	1