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AFFORDABLE WATER SUPPLY AND SANITATION – Discussion paper

Water pumping technologies – NERD experience

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DEVELOPMENT OF SUITABLE pumping devices to meet the growing demand for water pumping has been a great challenge for those involved in research and development work in that discipline. The variables governing the successful operation of a water pump are numerous and they become particularly difficult to control in the third world developing countries.

Suitability of a pumping device depend on many factors. Availability of primary energy sources which could provide drive power for pumps stands atop of them. In fact many of the conventional pumping stands atop of them. In fact many of the conventional pumping systems which require some form of commercial energy for its operation are unsuitable for places where there is inadequate supply of commercial energies - for example non availability of grid power, unaffordability of fuel oils due to poor economic standing of consumers, etc.

Other factors such as acceptability, maintainability, durability, affordability, etc. come next. The degree of their influence on performance and sustainability of the system can vary depending on the circumstances - culture, beliefs, education, adaptability, skills, etc. The problem become further complicated when trying to popularise non-conventional technologies in rural areas due to socioeconomic and political issues due to comparatively lower educational standard and skill levels of consumers in these areas. Introduction of any new pumping device (pumps other than those operated on conventional energies) even with VLOM (Village Level Operation and Maintenance) features can have resistance from prospective consumers mainly due to the unfamiliarity with the new system and perceived socioeconomic differences.

The situation is most demanding and forceful enough to draw the attention of the researcher to concentrate more on appropriate technologies when developing new pumping systems. National Engineering and Research and Development Centre realizing the need for different but effective pumping systems undertook some pioneering research work in developing and testing a number of non-conventional pumping devices. Some of them are based on novel concepts and others tried to improve on existing systems. The key factors taken into consideration when developing these new systems are use of non-conventional energy sources, flexibility of the system, minimum maintenance, affordability and use of local raw materials. This paper discusses some of the work undertaken by the NERD Centre in developing two types of non-conventional pumping systems, their popularization problems and other related issues.

New concepts and development of pumping devices

The NERD Centre has undertaken extensive research in the development of following non conventional pumping devices and obtained some encouraging and useful results. The most significant feature of these pumping systems is that they rely on non-conventional energy sources for their operation.

Pneumatically operated water pump

Figure 1 shows a schematic view of this pump. It operates on a new concept based on buoyancy effect to activates the pump. Compressed air provides energy for pumping. The device is automatic and intermittent in operation. Methods are available to minimize the non-pumping time, in which case pumping can be almost continuous.

Main features and advantages of the pump

- Compressed air supplies the motive power required to operate the pump. Not dependent on conventional energies.
- It is a positive displacement pump.
- Greater flexibility in the installation of pump. For example, unlike in the conventional pumps where the pump and the prime mover (electric motor or engine) are in one unit or are installed very close to each other, in this pump the compressed air generator can be installed away from the pump. This flexibility gives a lot of advantages when selecting locations for installing pumps in remote areas and when security could be a problem.
- Source of compressed air supply is immaterial - It could be either electrically driven, windmill driven, hand operated or any other.
- Since the pump works automatically it starts operating when ever the compressed air is available and stops when compressed air is cut off. When the pump is driven by a wind mill air compressor (NERD has developed this) it takes advantage of this feature, because of the windmill operation may not be regular.
- The pump can be easily fabricated out of locally available raw materials.
- The pump is submerged below the water surface, therefore, it has no suction head.

Figure 1. Compressed air pump

Figure 2. Pneumatic pump discharge data

Operation of the pump

When the pump (Figure 1) is lowered into water, water enters the cylinder through the bottom foot valve. Due to the weight of water in the cylinder, the cylinder moves down along the two guides. Since the valve operating mechanism is attached to the cylinder (and some parts to the guides) this movement activates the value and connect up the air supply to the pump cylinder. The compressed air then pushes out the water in the cylinder through the discharge valve. When water in the cylinder is emptied the buoyancy force acting on the cylinder pushes it up making the air valve to operate again - this time it connects the cylinder (now filled with compressed air) to atmosphere allowing compressed air in the cylinder to release and at the same time cutting off the compressed air supply to the cylinder. This action allows the cylinder to fill again with water. The operation of the pump starts again and continues in a cyclic manner. The weight connected to the guides keep the pump stable in water.

Popularization efforts

Extensive field testing carried out in the operation of the pump indicated very promising results. However, major economical and political forces tended to paralyze the popularization efforts undertaken even with the State patronage.

In 1989, for example, NERD Centre undertook a major water pumping project at Mahakanadarawa, about 150 km North of Colombo, in Anuradhapura district. The objective was to provide water for Chena cultivation for farmers in this village. Total of eleven wind mills and pneumatically operated pumping units were installed to supply nearly 20 acres of Chena land. Water has to be lifted up from open wells to a height of 4 meters (from ground level to water level in the well). The Ministry of Energy to water level in the well). The Ministry of Energy Conservation through its Energy Conservation Fund arranged all funding and the North-Central Provincial Council, under whose purview the administration of the district comes, coordinated the implementation of the project. Initially all parties agreed to install compressed air pumps together with matching windmills to supply compressed air. So NERD Centre started the project with confidence, backed by the State guarantee, and worked hard to see that the project was completed successfully. Half way into the project, however, things began turning against the very objective of the project only to satisfy short term benefits of individuals. To our dismay the Provincial Council had arranged to distribute Kerosene Powered portable pumping sets to all those farmers who were earmarked for windmill driven compressed air pumps. This made people to lose interest on the new pumping device even before its installation could be completed, because kerosene pumps are more flexible in usage and gave other personal advantages to the users. For example, people can hire out the Kerosene pump to outsiders and generate additional income even at the expense of their own use. Inspite of all these demotivational events that took place during erection of wind mills and pumps the NERD Centre managed to complete the installation and commissioning in just three and a half months. Thereafter, the system continued to operate for over one year without much problems and NERD Centre carried out whatever the routine maintenance work required during the period. In fact the project became popular among some farmers mainly due to the greatly reduced operating cost - free energy. Problems cropped up, however, as to the continued maintenance of the system after NERD Centre withdrew from the project. Initially it was agreed to hand over the project to a Pradeshiys Saba which came under the North Central Provincial council. But, training of personnel to man the project (just two craftsmen to attend to routine maintenance and other occasional repairs and adjustments work) as proposed by NERD Centre did not materialise due to various reasons which were beyond NERD's control. Issues such as funding for training, payments for work attended to, etc. did not never receive concerted effort from the parties benefited by the project.

Performance

Since the pump is of positive displacement type the discharge characteristics are more or less linear and are determined by the pressure and the volume of compressed air supply. Delivery head is proportional to the air pressure and the flow to the volume of air. Figure 2 shows pump discharge when connected up to a windmill air compressor at NERD's test site.

Barrel pump - rotating coil pump

Figure 3 shows a schematic view of the barrel pump. It is a classic example of the use of non-conventional energy for pumping water to moderate heights. It utilizes the energy of a flowing stream and no regulation is normally required. It can be easily fabricated from locally available raw materials and no special skills are required.

Main features and advantages of the pump

- No external energy is required. The pump extracts energy from the flowing stream in which the pump is half immersed. Hence, the device is very useful in areas where conventional energies are in short supply or hard to get at. Sustainability is reinforced due to this.
- The pump is of very simple design and construction, and since it operates by itself when lowered into a flowing stream no operators or training of personnel are required to operate the pump, a very positive point for sustainability of the system.

Figure 3. Barrel pump

Construction

A flexible hose of predetermined diameter is wound around a water tight barrel, the diameter and length of which must be able to exert sufficient up trust on the pump so that the barrel would float half immersed when lowered into a flowing stream. One end of the hose is open and will come in contact with water intermittently when rotating. The other end is taken out along the axis of rotation of the barrel and through a rotating joint and serves as the delivery. A number of vanes made of sheet metal are fixed to the barrel radially, in which case the axis of rotation will be perpendicular to the direction of flow of the stream. It is also possible to have the axis of rotation in the direction of flow in which case the vanes would be of propeller type fixed at one end.

Operation

Lower the assembled pump into a flowing stream - there should be sufficient depth of water to enable the pump to float freely - and tie it to the two banks with ropes or other convenient arrangement to prevent the pump from drifting down stream. If the pump is released now, it will start rotating due to the flow and water will be pumped out through the delivery line. Stream velocity of 2 to 3 ft / sec would be sufficient to operate the pump and the discharge would vary according to the size of the hose, rotational speed of drum, size of hose and the delivery head.

Test results

Table 1 gives the results of a test carried out with this pump. Details of the pump are as follows.

Hose diameter	=	2.25"
Number of coils around drum	=	12,
Drum diameter	=	25"
Number of water inlets	=	1.

Conclusion

The two pumps described above are ideally suited to conditions prevailing in many developing countries. They will also make a significant contribution to conservation of energy without creating any environmental problems.

Table 1: Rotating coil pump

Barrel speed rpm	*Delivery head - ft*	*Flow rate - gpm*
6	8	160
7	8	180
8	8	240
7	6	148
8	6	216
10	6	270
12	6	294