

The NDUME turbo-pump — a user experience

by T.B. Muckle

New methods of pumping for different circumstances are being invented all the time. Here's one that works with a low head of water and at reduced stream flows.

THE NDUME turbo-pump is an axial-flow turbine which is directly coupled to an opposed-piston pump. The penstock or intake is made from 200-litre oil drums welded to form a tube, to which the turbine is bolted at the outlet end (Figure 1).

Axial-flow turbines operate at low heads of water compared to other types of turbine. In this particular case a head of about 1.5m is sufficient, while the pump output will depend on the flow available. Sites with such low heads occur naturally in many areas, but even if they have to be created, the cost is usually less than that for cross flow or Pelton wheel turbines, which are generally found only in hilly or mountainous areas.

Piston pumps will operate at variable speeds, thus the turbo pump will continue to function, although at a reduced rate, as the stream flow diminishes, even to the point where centrifugal pumps would cease.

Axial flow turbo-pumps are particularly useful in small rivers and streams and can be used for domestic and livestock purposes as well as micro-irrigation. The output of the unit being described is used for the following purposes:

Domestic: 15 people
Livestock: 20 cattle, 60 sheep or goats
Irrigation: 4ha forage/fruit/vegetables

The NDUME turbo-pump has been developed using the company's resources only, and to date about 300 have been sold.

Operation

The rotor drives the pistons via a variable-throw crank, and the water is alternately inducted and expelled from the cylinders through valves operated by pressure differential (Figure 2). The variable stroke of the pistons allows them to be set for optimum performance, taking into account the flow through the machine and the total head

being pumped. It also permits operation during periods of diminished flows, when the water is most needed.

Performance

This will depend on the flow through the turbine and the total head being pumped. Piston pumps are capable of generating high heads: 200m has been measured but heads of up to 100m are more commonly employed.

The installation being described has the following characteristics:

Head over turbine: 1.3m
Total head pumped: 45.0m
Length of pipeline: 1.7km
Optimum speed of rotation: 15-180rev/min

Approx output:

Maximum stroke: 4000l/h
Median stroke: 3000l/h
Minimum stroke: 2000l/h

As a result of seven years' experience the median setting has been found to be the most appropriate, as the maximum stroke can only be used at the height of the rains, when water is seldom needed! The minimum stroke is used when the flow diminishes and the speed falls to about 100 rev/min. Below this speed the water does not flow cleanly through the blades and tends to back up on itself.

Maintenance

The turbo-pump is more complex than other turbine/centrifugal pump combinations, and this is compounded because the bearing is under water during operation. The bearing lubrication, and the protection of it from the effects of water, are accomplished by having the crankshaft bearings closed from the exterior by oil seals fitted in the reverse of the conventional sense. Grease is the lubricating medium, and it can be applied while the machine is in operation. The big-end bearing is a sealed unit and is greased from time to time, while the little-end is a hard plastic material which is water-lubricated. Regular lubrication is essential for good bearing life, and the example being discussed is using a set of crankshaft bearings fitted in 1987 and showing little sign of wear.

The machine is normally closed down during the height of the rains, a total of about 50 days per year, when



Figure 1. The turbine outlet, with the pipe built from oil drums.

the water is not needed. This tends to reduce the piston-washer wear.

A daily visit is essential to clear debris from the intake, and this is combined with greasing to ensure maximum component life.

Repair

The bearings, seals, and piston washers are standard motor vehicle/windpump components, and as such are generally available where service facilities for these exist. Two sizes only of nuts are used, thus simplifying repair which is carried out using normal fitting practice. The unit can simply be removed from its oil drums and carried to the river bank for a major repair, while minor jobs can be carried out in-situ.

Typical component life is:

Piston washers: 9-12 months

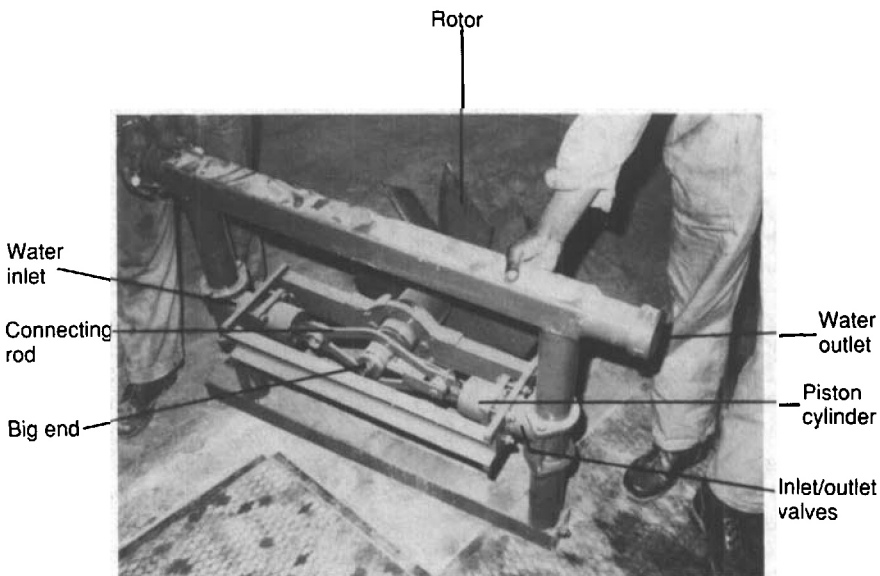
Big end bearing: 12-18 months

Crankshaft bearings: 2-4 years

Piston cylinder: 4 years

Capital cost

The unit costs about US\$1300 ex-factory, to which must be added the costs of any structures to control and divert the water. These can vary greatly, from temporary, replaceable structures to permanent and more expensive measures. In the case under discussion temporary structures were abandoned after one year because of leakage in the weir during periods of



The main components of a NDUME turbo-pump.

minimum flow. A permanent weir was subsequently built, which solved the problem (Figure 3).

Operating cost

The operating cost will depend to a considerable extent on the level of suspended matter in the water, which wears the pistons and washers, together with the regularity of lubrication, which controls bearing life. During the seven-year life of this unit, the average annual cost of grease and spare parts

has been US\$71, but this is decreasing as a result of component modification and operating experience.

If a diesel-driven pump were to be used to raise the same amount of water, it is estimated that some four litres of diesel fuel would be consumed per day during each of 300 days per year. At a local cost of US\$0.30/litre this would give an annual cost of US\$360. To this should be added the cost of spares and repairs at, say, 50 per cent of the fuel cost, thus giving a total annual cost of about US\$540. Other factors, such as the availability of spare parts and fuel and their transport, have not been considered.

The seven years on-going experience of the NDUME turbo-pump has shown its feasibility in raising water using low heads. The operating cost is less than any other simple system. Compared with a diesel engine pump, the fuel cost saved in the first three years of operation was equal to the cost of the machine. ●

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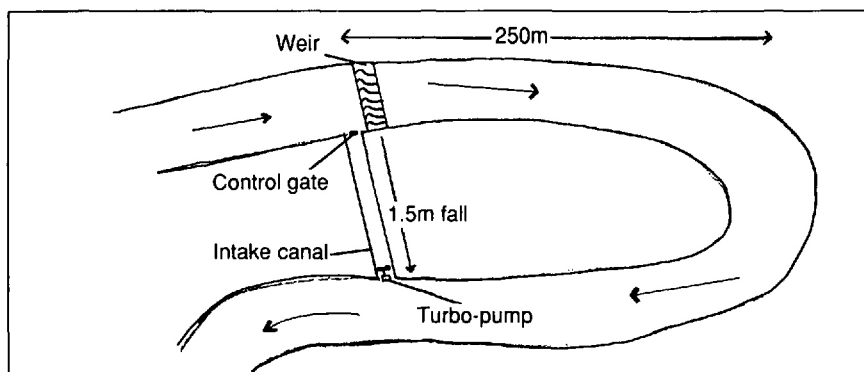


Figure 3: A permanent weir was built to control and divert the water.

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