PERFORMANCE OPTIMISATION OF MANUAL SUCTION WATER PUMPS

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ABSTRACT

Proper use of water entails efficient methods of water lifting for domestic and irrigation use. Irrigation in most parts of Africa depends mostly on manual lifting methods and conventional motorised pumps, which are expensive. Apart from the high operating cost of motorised water pumps, the cost of spare parts and availability makes them unreliable to most farmers in Africa. Similarly the size of land to be irrigated, which is mostly small, makes investment on motorised water pumps expensive and therefore uneconomical. On the other hand the per capita income of most peasant farmers are very low, the return on investment is quite low and therefore the ability to invest on the farms is quite low. The farmer in Africa needs an efficient low cost water pumping technology that guarantees low cost of investment and hence low risk.

Tests were performed for different suction valve diameters and cylinder diameters for total pumping heads of 4m, 6m, 8m, 9m, 11m and 14m with alternate suction and pressure heads of 2m, 4m and 7m with a fixed suction pipe internal diameter of 29mm. The pump cylinder diameters used in the tests are 35mm; 46mm and 54mm with suction valves diameters of 10mm, 15mm, 20mm, 25mm, 30mm and 35mm.The data collected were the time taken and the number of strokes to fill a 20 litre container for the test configurations.

It was found that there was no definite relation between the cylinder size and the suction valve flow diameter. The best performance suction valve flow diameters were 30mm and 35mm which are closer to the suction pipe diameter, with ratio of the suction valve flow area to the suction pipe flow area of between 0.8-1.56 i.e. closer to unity (1.0). This shows that the best performance suction valve flow diameter should be slightly above the suction pipe flow diameter taken, as 35mm and this will take care of the frictional loses and effectiveness of suction valve opening. It can be taken on the higher side of the ratio given as 1.56 of the suction pipe flow area.

Using the 1.56 as the best ratio the following formula was derived and can be used to determine the suction valve flow diameter for different sizes of the suction pipes used:

$$d_{sv} = D_{sp}\sqrt{1.56}$$

Where d_{sv} is the suction valve flow diameter and D_{sp} is the suction pipe diameter.

The hand operated reciprocating suction pump performance characteristic curve deviates considerably from the motorized reciprocating pump performance curve. It is seen that as the total pumping head increases the performance characteristic curve shifts to the left at the total pumping head of 6m for pump cylinder diameter of 35mm and at 8m for pump cylinder diameters of 46mm and 54mm, while it is approximately vertical at total pumping heads above and below this point. The pump performance characteristic curves show transition point from low total pumping heads to

high total pumping heads with two approximately vertical lines and a slanting transition line.

It is recommended that research should also be done using leg muscles operation with big cylinders and short pumping strokes to determine if similar trends can be seen. Similarly the suction pipe can also be varied to find out its relation with the suction valve flow diameters.

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