EXPERIMENTAL INVESTIGATION ON VERTICAL PUMP FOR AGRICULTURE

M.Ravichandra[1] Dr.K.Nagaraju[2] P.Nagaraju[3]

(Author[1], Assistant Professor, Dept of Mechanical Engineering, SREC, Nandyal-518501, India.)
(Author[2], Assistant Professor, Dept of Mechanical Engineering, MRCET, Hyderabad, India.)
(Author[3], Assistant Professor, Dept of Mechanical Engineering, SREC, Nandyal-518501, India.)

ABSTRACT

The recent issues in developed countries were found to be deficient in Water supplies, especially farmers were found to be difficult to supply necessity nutrients. For water Pumping we need high amount current it effect more on economy and insufficient current supply effect more on cultivation of major crops like paddy and usually driven by an AC induction motor. Main aim to fabricate this vertical pump is a chance to overcome such problems in agriculture sector, where the less amount of power is required. The Working principle is same as may also pump from an open body of water such as a river, reservoir, or pump intake structure, rather than from a bored well. In addition to that it also be mounted on top of a tank in an industrial plants to provide fire water and also mounted inside a barrel, so that the suction source may be higher or lower than atmospheric pressure.

I.INTRODUCTION

In this chapter we have had a fair idea on several important aspects of pumps, such as, parts of a pump, principles of working, salient aspects of design and operation-these items are considered a desirable knowledge for a civil engineer. In this unit we go into a few special suspects of vertical turbine pump which can also be considered to belonging to the class of rot dynamic pumps. A vane diffuser pump, built earlier, was called a turbine pump owing to its similarity in appearance to a turbine. The earliest known application of turbine pumps was in lifting water from small-diameter wells for purposes of imagination and water supply. With increase in the requirement head, and with the limitation concerning small impeller diameters, multi voltage arrangement was developed with each impeller discharging into a fixed vane diffuser (or bowl) which is coaxial with the drive shaft. Because the first use of vertical turbine pumps was almost exclusively for deep wells the name of deep-well turbine pump still holds. There are, however, mixed flow and propeller-type pumps being used for non-deep well use, such as, pumping large quantity of water through smaller heads as in the case of from one canal to another. Deep well turbine and submersible pumps are basically diffuser-type vertical centrifugal pumps; they are specially designed in order to pump water from tube wells. These pumps are provided with a bowl, in place of a volute, to affect the conversion of velocity head to pressure head--the bowl assembly houses an impeller and guide vanes, and is almost always located beneath the water surface that exists below the ground level. Therefore, these pumps are best suited to situations where seasonal fluctuations in water level (in the well) are encountered. Also, as mentioned these are adapted to high lifts, and possess high efficiencies. However, these pumps involve higher initial costs, and are more difficult to install and get repaired, as compared to volute pumps.

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps are operated by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water –cooling and fuel injection, in the energy industry

For pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical industry. Double/multi-stage pump – When a casing contains two or more revolving impellers, chemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and prosthesis. Single stage pump – When a casing contains only one revolving impeller, it is called a single stage pump. it is called double or multi-stage pump.

1.1 Types of pumps:

Mechanical pumps may be submerged in the fluid they are pumping or be placed external to the fluid. Pumps can be classified by their method of displacement into positive displacement pumps, impulse pumps, velocity pumps, gravity pumps, steam pumps and valve less. There are two basic types of pumps: positive displacement and centrifugal. Although axial-flow pumps are frequently classified as a separate type, they have essentially the same operating principles as centrifugal pumps.

The pumps are usually driven by an AC electric induction motor or by a diesel engine through a right angle drive. The pump end consists of at least one rotating impeller that is attached to a shaft and directs the well water into a diffuser casing called a bowl.The pump controller is used to drive the pump electric motor via converting the input DC power from the PV arrays to the required AC power, voltages and currents suitable for the pump operation. Deep well turbine and submersible pumps are basically diffuser-type vertical centrifugal pumps; they are specially designed in order to pump water from tube wells.Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers.

II. LITERATURE SURVEY

In 1931, when Thoma and Kittredge (1931) were trying to evaluate the complete characteristics of pumps, they accidentally found that 14 pumps could be operated very efficiently in the turbine mode. The turbine mode operation became an important research question for many manufacturers as pumps were prone to abnormal operating conditions. Later in 1941, Knapp (1941) published the complete pump characteristics for a few pump designs based on experimental investigations. In the 1950s and 1960s, the concept of pumped storage power plants, in the range of 50 to 100 MW, was evolved mainly in developed countries to manage the peak power requirements. In later years, chemical industries became another area for the application of PATs for energy recovery. Even in water supply networks identical applications of this technology were found. This background gave some momentum to a rich phase of research and then onwards, standard manufactured pumps were studied in turbine mode. In later years, many more techniques were developed by many researchers (Rawal and Kshirsagar, 2007). The technology for the use of PAT for electrical power generation was not available earlier. However, advances in electrical machinery control technologies which allow the driving regulation with variable velocity, rotation sense and torque have created the possibility of the utilization of pumps working in inverse mode for power generation (Fernandez et al., 2004). Agostenelli and Shafer (2013) tested many pumps in turbine mode over the years and concluded that when a pump operates in a turbine mode, its mechanical operation is smooth and quiet; its peak efficiency is same as in pump mode; head and flow at the best efficiency point (BEP) are higher than that in pump mode and the power output is higher than that the pump input power at its best efficiency. Various pumps which can be used as turbines for the power range of 1 kW to 1 MW are (Chapallaz et al., 1992). It can be seen that multi stage radial flow pumps are suitable for high head and low discharge sites; whereas, axial flow pumps are appropriate in low head and high discharge range. Similar chart was also presented by Orchard and Kilos (2009) (range: 5 to 750 kW).

III.IDENTIFICATION OF THE PROBLEM & SOLVING PROCEDURE

Main aim for fabrication of this smart pump is now a days in agriculture sector farmers face so many problems .In those main problem is water related problems .For water Pumping we need high amount current it effect more on farmers economy and insufficient current supply effect more on cultivation of major crops like paddy. Due to less amount of water supply so many crop fields are turned in to wasted lands.

To overcome of the water problems where the less amount of power is available areas we fabricate this type of smart pump. By using smart pump we reduce the power consumption and increase the water discharge in less amount of time. By using this pump we can easily pump the water from ponds, rivers and side canals also. It will help the farmers for easily maintaining of crop in fields.

IV CONSTRUCTION

A vertical turbine pump (which can be either water or oil-lubricated) may have impeller that either enclosed on semi-open. Basically the important elements of the pump are the main pump element, discharge column, and discharge head, bowl assembly, etc.

4.1. Bowl assembly:

Pump Bowl Assembly The bowl assembly is the heart of the vertical turbine pump. The impeller and diffuser type casing are designed to deliver the head and capacity that your system requires in the most efficient way possible. The fact that the vertical turbine pump can be multi-staged allows maximum flexibility both in the initial pump selection and in the event that future system modifications require a change in the pump rating. A variety of material options allows the selection of a pump best suited for even the most severe services. The many bowl assembly options available ensure that the vertical turbine pump satisfies the users' needs for safe, efficient, reliable and maintenance-free operation.

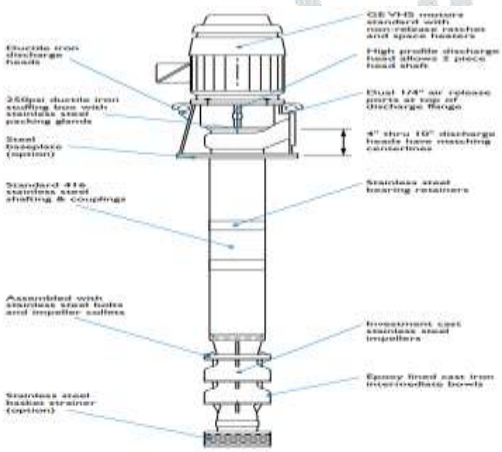

Fig:4.0 Construction of vertical pump

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Standard Design Features :

Suction Bell - Allows smooth entry of liquid into first stage impeller eye, minimizes foundation opening.

Suction Bell Bearing - Provided for shaft stability.

Sand Collar - Prevents solids from entering suction bearing.

Impeller - Semi-open or enclosed for appropriate service.

Pump Shaft - Heavy duty 416SS standard, other alloys available for strength and corrosion resistance.

Flanged Bowls - Registered fits ensure positive alignment, ease of maintenance.

Diffuser Bowl - Available in variety of cast materials.

Sleeve Type Bearing - Provided at each stage to assure stable operation.

Keyed Impellers - Standard for API applications, 18" and larger sizes; furnished on all pumps for temperatures above 180° F (82° C) and on cryogenic services. Regardless of size, keyed impellers provide ease of maintenance and positive locking under fluctuating load and temperature conditions.

4.2 Three common bowl assembly pump models, one:

The three different pump models in the vertical turbine line have one thing in common –the hydraulic design of the pump bowl assembly. Using state-of the art techniques in turbine line covers a wide range of hydraulic conditions to meet virtually every pumping service in the industry with optimum efficiency.

Gould's flexibility of design allows the use of a wide range of materials and design features to meet the custom requirements of the user. No matter what the requirements, Gould's can design and manufacture the pump to best satisfy them, specifically and thoroughly.

This bulletin is designed to assist the user in selecting the best pump for the conditions required; however, any questions will be answered promptly by calling the Gould's sales office or representative in your area.

4.3. Discharge head:

Head is the one term that most scares people when talking about how pumps work. After all when you talk about pumps you should be talking about pressure, everyone knows what pressure is. You put a pressure gauge on the outlet of a pump and you read the amount of pressure. The discharge head functions to change the direction of flow from vertical to horizontal and to couple the pump to the system piping in addition to supporting and aligning the driver. Discharge head accommodates all types of driver configurations. Optional sub-base can be supplied. Gould's offers three basic types for maximum flexibility.

4.4 Types of discharge heads:

4.4.1 VIT discharge head:

Suitable for all service conditions such as high or low temperature or corrosive services. Various materials are available. Segmented elbow available for efficiency improvement. Access ports for easy access to seals and couplings. Base flange can be machined to match ANSI tank flange To direct flow from column pipe to discharge pipe located above or below ground level with single floor or two-floor arrangement as per requirement.

Fig: 4.4.1 VIT discharge head

4.5 COLUMN:

Flanged column construction provides positive shaft and bearing alignment, and also eases of assembly and disassembly. Bearings are spaced to provide vibration-free operation below the shaft first critical speed in order to insure long bearing and shaft wear. The lines haft is supported within the column by use of bearing retainers within the column assembly. These retainers are usually integrally fabricated for all diameters.

4.6 SUB BASE OR BARREL FLANGE GROUTING:

1. Inspect foundation for dust, dirt, oil, chips, water, etc. and remove any contaminants. Do not use oil-based cleaners as grout will not bond to it. Refer to grout manufacturer's instructions.

2. Build dam around foundation. Thoroughly wet foundation.

. 3. Pour grout between Sub Base or Barrel Flange and concrete foundation, up to level of dam. Remove air bubbles from grout as it is poured by paddling, using a vibrator, or pumping the grout into place. Non-shrink grout is recommended. Allow grout to set at least 48 hours.

Fig: 4.6.1 VIT discharge head Blades

Fig: 4.6.2 Horizontal Pump

V. WORKING PRINCIPLE

Smart pump mainly contains shaft which is connected to the motor (0.25hp) at the upper end. The lower end of shaft contains blades which are arranged in the angle around the shaft for pumping of water to higher levels. The entire shaft is covered by long column which is also for direction of water throughout the shaft. Just below the motor discharge tube is connected for water output.

The pumps are usually driven by an AC electric induction motor or by a diesel engine through a right angle drive. The pump end consists of at least one rotating impeller that is attached to a shaft and directs the well water into a diffuser casing called a bowl. Multi-stage configurations use multiple impellers on the same shaft to create higher pressure that would be needed for deeper wells or higher required pressure (head) at ground level.

Vertical turbine pumps work when water enters the pump at the bottom through a bell-shaped part called the suction bell. From there it moves into the first stage impeller, which raises the water’s velocity. The water then enters the diffuser bowl immediately above the impeller, where this high velocity energy is converted into high pressure. The bowl also directs the fluid into the next impeller located immediately above the bowl, and this process continues through all of the stages of the pump.

Fig 5.0 Smart pump

❖ **Schematic diagram of the vertical pump:**

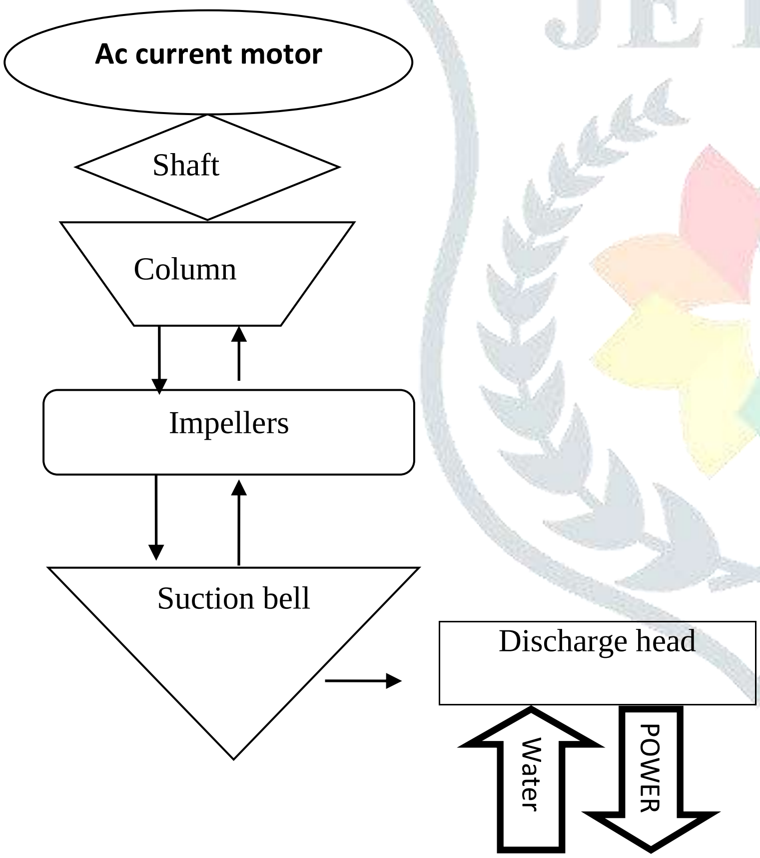

Fig 5.1 Schematic diagram of vertical pump

After the water leaves the last diffuser bowl, it passes through a long vertical column pipe as it rises up the well bore toward the surface. The spinning shaft inside this column is supported at three- or five-foot intervals with sleeve bushings that are mounted inside the column and lubricated by the water moving past them. At the surface is the pump discharge head, which allows the flow to change direction, toward the discharge pipe. A vertical high thrust A.C. motor is mounted above the discharge head. They are primarily used wherever a submersible pump is not possible, because the flow is above the range of turbines, or because the owner prefers a conventional motor mounted at the top of the pump.

They are commonly used in wells that are bored to provide agricultural or turf irrigation, or to provide water supply for municipalities that rely on ground water rather than surface water. They are also used to provide plant make-up water and fire water for industrial plants. Vertical turbine pumps may also pump from an open body of water such as a river, reservoir, or pump intake structure, rather than from a bored well. The pump in this configuration may be used as a booster pump for boosting municipal water supply, or in an industrial application where the

They are very versatile, with flows ranging from around 50gpm to 30,000gpm and higher. The pump is also very versatile as to the amount of head generated, as the pump can be built with one stage or many. These advantages make it one of the most common types of centrifugal pumps, and it's used in many commercial, industrial, municipal, and agricultural applications.

5.1 Suction bell:

Fig 5.0 suction bell

When motor get started, the connected shaft get in to rotation motion due to this impellers start sucking action. At that time water first enter in to the suction bell. It is act as a filter for smart pump. The small holes are at the bottom of the suction bell it allow the water into the pump, during the suction action. This suction bell completely cover by water during pump working the only it gives its working action satisfy.

5.2 Impeller with bowl:

After the completion of filter action of suction bell, water enters into the bowl which is containing impellers. These impellers are connected to the shaft. The overall sucking action is based on these impellers. The blade angle of impellers play a key role in the sucking action, rpm of impellers are control by the motor.

Fig 5.2.0 Impellers

Bowl assembly contains two impellers for effective velocity of water flow to the heights. In our project we kept only the impellers for the small work applications, in heavy work applications we include stages for huge velocity of water for increases the amount of head.

5.3 Supporting column:

Supporting column is located at the upper side of the bowl assembly. Water from the bowl assembly enter into the supporting column, it provide path for the water flow along the head. It is also act as supporter for shaft, for friction less rotation through providing bearings around the shaft in the column. Flanged column construction provides positive shaft and bearing alignment, and also eases of assembly and disassembly. Bearings are spaced to provide vibration-free operation below the shaft first critical speed in order to insure long bearing and shaft wear. The lines haft is supported within the column by use of bearing retainers within the column assembly. These retainers are usually integrally fabricated for all diameters.

Fig 5.3.0 Supporting column

5.4Shaft and Motor:

Motor which is located at the top of the equipment, the overall control of the shaft rotation is maintained by motor. It rotates the shaft if we give power supply to the motor. The shaft which is connected to the motor, Shaft contains impellers to the other end. The action of the shaft is rotating the impellers for suction action.

Fig: 5.4.0 shaft

5.5 Discharging head:

Discharging head is just below the motor and top of the supporting column, the main purpose of the discharge head is outcome of water flow. The discharge head functions to change the direction of flow from vertical to horizontal and to couple the pump to the system piping in addition to supporting and aligning the driver. Discharge head accommodates all types of driver configurations. Optional sub-base discharged pump can be supplied. Gould's offers three basic types for maximum flexibility.

Where changes in pumping heads are anticipated because of plant expansion, changes in a process, or transfer of the pump to a different service, it is relatively easy and inexpensive to add or remove stages from a vertical turbine type pump in order to meet the new conditions. Many users recognize the limitation of the horizontal type of pump in this respect and partially compensate for this shortcoming by specifying on new equipment that full diameter and minimum diameter impellers are not acceptable. It should be recognized that this practice can sometimes mean that the manufacturer, to avoid using a full diameter impeller, is forced to select a pump larger than necessary to meet the initial conditions and in some cases less efficient pump.

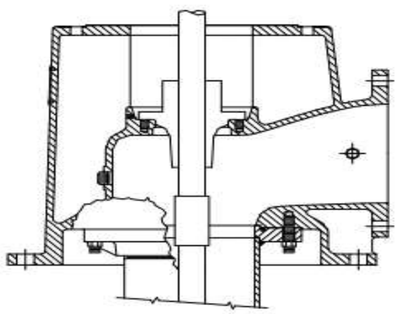

Fig 5.5.0 Discharge head

You put a pressure gauge on the outlet of a pump and you read the amount of pressure. The discharge head functions to change the direction of flow from vertical to horizontal and to couple the pump to the system piping in addition to supporting and aligning the driver. Discharge head accommodates all types of driver configurations.

Fig 5.5.1 working of vertical pump

VI.RESULTS

We are analyze the various characteristics of the vertical pumping system and we have to tabulate the analyze data in the following tabulation. From the analyzed data's we are solve the model calculations theoretically. We have using the general formulae's for calculation of the analyzed data's. The following tabulation and the model calculations are made theoretically. The analysis is made by means of prototype model.

6.1 FOR HORIZONTAL PUMP:

Measuring tank capacity =100 liters

Discharge Q =capacity/time =100/3

=33.33 L/min

= 2 m3/min

Area $A = \pi r^2$ (m^2)

Where Radius r =9 cm

Area A =0.006358 m^2

Velocity = Q/A

V =2/0.006358

=314.564 m/min

Output power = (ṗ × g× H×Q)/1000 (hp)

Where,

Density ṗ=1000 kg/m^3

Gravitation due to force g=9.81m/s^2

Head H =90 cm

Discharge Q =2 m^3/min

Output power = (1000 × 9.81 ×2)/100

=0.004905 KW

Input power = 2 HP

(1 HP=0.745 KW)

Efficiency = Output power / Input power ×100

Efficiency = (0.004905 / 2×0.745) ×100

ɳ = 45 %

6.2 FOR VERTICAL PUMP:

Water Horsepower = GPM x 8.33Head/33,000

= GPM x Head/ 3,960

Whp = 8.8047×8.33×33.33/33,00

Whp=0.00666755 KW Bowl BHP = 33.33 × 8.8074 × 1/ (3960×0.7)

Bowl BHP = 0.1057 KW

Input Horsepower = Total BHP / Motor Eff.

Input horse power = 0.1057 /0.8

Ihp=0.01322 kw

Field efficiency = Water Horsepower/Total BHP

η =0.00666755 / 0.01322

η = 50.4%

S.NO	TYPE OF PUMP	HORIZONTAL PUMP	VERTICAL PUMP
1	Dimensions	Pipe dia-9 cm Head-90 cm	Pipe dia-9 cm Head-100 cm
2	Input power	2 hp	0.25 hp
3	Time taken	1.5 min	2.8 min
4	Output power (hp)	0.73	0.0066675
5	η	41%	50.4%

Table 6.1 comparison of vertical and horizontal pump

VII CONCLUSION

By the experimental study of our project, we conclude the vertical pump can reduces the farmers effectives regarding the water pumping to the crop fields. By using of this type of pumps in fields we can manage the farmer economy also. Space savings – a vertical pump uses 75% less floor space than a horizontal pump with electric motor drive. Non-overloading at flow rates to the right of the best efficiency point (bep) - in many cases drives with small horsepower can be used. It reduces the power consumption when compared to other normal pumps. . Driver is up off the floor, therefore there is less danger of damage due to flooding. May be installed in wells, which eliminates the need for a surface reservoir or tank. This also eliminates the need for an additional well supply pump. Entirely self-aligning between the driver and pump. Cannot get out of alignment due to rabbet fit between pump and driver. Available sizes serve a wide range of capacity and pressure requirements. Can vary the number of stages and the size of bowl assembly and impeller trim for maximum system flexibility. Finally we conclude that this type of pumps are used widely in agriculture sector we reduces the power consumption and also it is financially helpful to the farmers.

7.1 FUTURE SCOPE:

The future work will be the vertical agriculture pumps can run with the aid of solar power by means of using solar panel and battery system. By using the solar power the electricity expenses will be reduced and the system can work at the time of electrical source is not available.

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