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Research Paper

D.C. Submersible Motor With Experimental Results For Remote Area

Engineering

KEYWORDS : SUBERMISIBLE MOTOR, PMBLDC MOTOR, V-notch, Electromagnetic Flow meter, RPM COIL

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ABSTRACT

This paper deals with a method of design of d.c. submersible motor. According to design prototype model is made and it is tested in laboratory, then experimental results are show.

In India, there are many villages where lots of underground water resources available even though they face water crises problems because of non availability of conventional a.c. power. There are also some villages where continuous power not available all the time. For these villages we can run D.C. submersible motor using solar energy with batteries back up (12 v).

Unfortunately not in Gujarat but also in India, there is no specific research and development work done in D.C. submersible motor. At present time, Permanent spilt capacitor run motor (Single Phase) is required electrical power for irrigation and drinking water purpose but no other means by which underground water at depth can be tapped.

I Introduction

A. General :-

Submersible pumps having motors running in the water permit an operating speed of 1500 0r 3000 r.p.m up to duties of about 3MW and have a lower first cost.

B. OBJECTIVE:-

The non conventional energy source like Solar energy easily converted into D.C. supply.

With help of D.C. submersible motor we can solve the irrigation and drinking water problems, where lot's of water resource available but no availability of electrical power.

C. DEFINITION:-

The S.M. also known as underwater motor or tube-motor for short, when water is the surrounding medium is used as a – drive for pumps (-submersible motor pump) installed in boreholes, wells, tanks and open waters.

The S.M.is preferably installed vertically in such a way that both pump and motor are completely flooded.

D. History of S.M. :-(water supply duties)

The FIRST application of submersible pumps in the ***late 1930's*** was to replace the shaft driven borehole pumps using the same pump type of bowl casing restricted diameter design driven by electric motor at two pole speed which was two or three times the speed of original borehole pump, thus saving costs.

In the mid of 20th century, Mr. F. Wood, the chief Engineer of leading UK water authority showed that submersible pumps were more economical than shaft driven pumps on wells deeper than 25 m (82 ft) and that maintenance costs favoured the submersible set.

II EXPERIMENTAL RESULTS

A. Main Parts :-

1. STATOR:-

A double layer winding (lap wdg with diamond coils) located in 20 stator (armature) slots. The conductors diameter da = 0.5 mm have been used.Here we use of ***semi-enclosed slots*** which ***results*** in low tooth pulsation loss & a much quieter operation as compared with open slots.

2. ROTOR:-

We observe ***four piece of Alnico*** (Magnet material). Generally Alnico have blackish colour. Each piece height, width and length is 6.04mm, 52.57 mm & 38.65 mm respectively. **The outer side of rotor** is made of ***stainless steel*** **(SS 410).**

3. ENCLOSURE:-

The enclosure is also made of ***stainless steel*** **(SS 410).**

4. Impeller:-

Here we made D.C. submersible pump of single stage. As no. of impeller increase, the head of submersible pump increase, but at the same time ηpump decrease because of friction loss. The impeller is purely mechanical part which have poor efficiency.

B. Experimental equipment :-

1. V-Notch:-

As name suggest, there is one V-shape gate. The water flow comes out from this gate measure by scale. The scale is calibrated in mm. From this reading we can measure LPM (litre per minute) by following equation,

$$\text{Flow in LPM} = \frac{(V - \text{Notch in mm})^{2.43}}{343.33}$$

With help of this pressure transmitter, we can measure head in m on control panel. There are pressure sensors which sense the pressure i.e. head.

2. Electromagnetic Flow meter:-

It is also measure LPM. So it is use as back up reading of V-notch.

The electromagnetic flowmeter is ***ideally suited*** for measuring the flow rate of fluids in installations where the other common methods of measurement are unsatisfactory. ***The principle feature*** is that it does not present any obstruction to the flow of liquid.

The operation of this type of flowmeter is based on **"Faraday's law of electromagnetic induction".** The law states that the relative motion of a medium flowing at right angles to a pair of

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electrodes and a magnetic field, will develop an induced e.m.f across the electrodes.

$e = B.\ d.\ \upsilon. \times 10^{-8}\ \upsilon$

where e is the induced e.m.f., B is the flux density in teals, d is the distance between the electrodes in meters, υ is the mean velocity of the fluid expressed in meters / sec, and υ is the applied excitation voltage to the coils.

The ***main advantage*** of the device is that its construction is simple and rugged with no moving parts, and hence head loss is low. It has a range of 10:1, with ***good accuracy and reliability***.

3. RPM-Coil:-
With help of RPM-coil, we can measure speed of submersible pump directly on control panel.

4. Voltage Regulated Power Supply:-
Regulated power supplies are basically highly regulated dc voltage required for energising transducers, operational amplifiers, and other electrical systems.

Variable supplies required to be varied from zero to a certain maximum voltage. This configuration is not easily realised with single unregulated supplies and needs additional auxiliary supplies for operation.

5. Control Penal:-
All parameters are shown on control panel.

C. Testing of D.C. Submersible Pump:-
1. Objectives:-
To observe the performance of D.C. Submersible pump

Plot the following graphs

Discharge v/s Head

Discharge v/s Current

Discharge v/s Efficiency

Fine maximum head & LPM of D.C. submersible pump

2. Connection:-
In submersible testing and calibration laboratory there is one under ground water storage tank. The D.C. submersible pump can be fitted to 4" capacity pipe in this under ground water storage tank. So Z value is constant for all the readings. Here Z is distance from water level to pressure transmitter. The pipe leads water to water discharge tank on ground level through valve, pressure sensors and electromagnetic flowmeter. The water discharge tank have only one V-shape gate. The water comes from this gate is measure by V-Notch in LPM. Here electromagnetic flowmeter use as a back-up LPM readings.

3. Line diagram :-

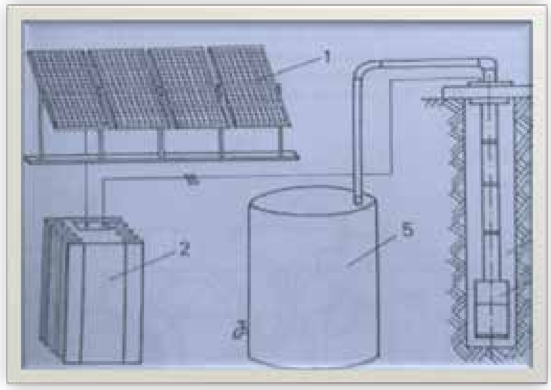


Figure 1: Water pumping system for a remote population center:

Solar panels, 2 – inverter, 3 - submersible PM brushless motor-pump unit, 4 – well, 5 – water storage tank.

4. Precautions :-
Check polarity before starting D.C. submersible pump.

Check voltage magnitude.

Don't run D.C. submersible pump in dry condition.

5. Procedure :-
Check voltage magnitude & water level in water storage tank. Then switch **"ON"** D.C. submersible pump.

The valve fully open to close in such a way we get minimum five readings. i.e., For first reading the valve is fully open & for last reading the valve is fully close.

Here we use voltage regulator as a D.C. source. (0-30 V D.C., 0-30 A D.C.)

Here we measure head by pressure transmitter & LPM by V-Notch and electromagnetic flowmeter both. The electromagnetic flowmeter readings use as a back-up.

We measure speed by RPM-Coil and time by stop-watch.

Switch **"OFF"** the supply.

Draw all graphs.

6. Observation Table:- 1

Sr. No.	Z (m)	Head H (m)	V-Notch (mm)	LPM	D.C. Volt	D.C. Current (Amp)	Speed (RPM)
1	1.06	1.1	40.36	27.95	12	4.8	2860
2	1.06	1.3	37.93	23.89	12	4.3	2864
3	1.06	1.5	34.52	18.92	12	4.1	2872

4	1.06	1.7	28.68	11.99	12	3.9	2881
5	1.06	2.05	0.00	0.00	12	3.75	2900

7. Observation Table:- 2

Head (m)	Time (min.)	D.C. Volt.	D.C. Current (Amp)	Liter	Speed (RPM)
0.12	1.03	12	4.8	50	2875

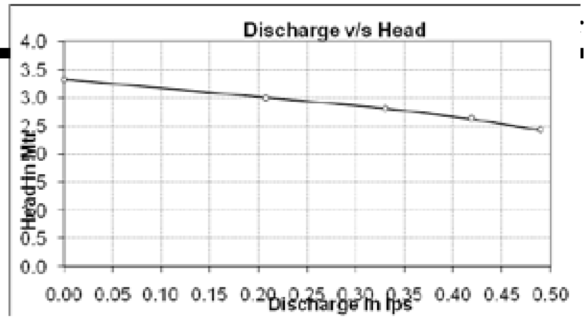
8. Computation Table:-

Sr. No	*LPM* = $\frac{(V-Notch)^{2.48}}{343.33}$	Total Head Ht=Z+H (m)	Discharge Qc (LPS)
1	28.00	2.16	0.49
2	24.00	2.36	0.42
3	19.00	2.56	0.33
4	12.00	2.76	0.21
5	0.00	3.11	0.00
Sr. No	*Pump o/p (kw)* = $\frac{Qc \times Ht}{102}$	*I/p Power (kw)* = $\frac{V \times I}{1000}$	η*overall* = $\frac{o/p}{i/p}$ *%*
1	0.012	0.0470	24.78
2	0.011	0.0419	25.73
3	0.009	0.0397	23.03
4	0.006	0.0374	16.40
5	0.000	0.0352	0.00

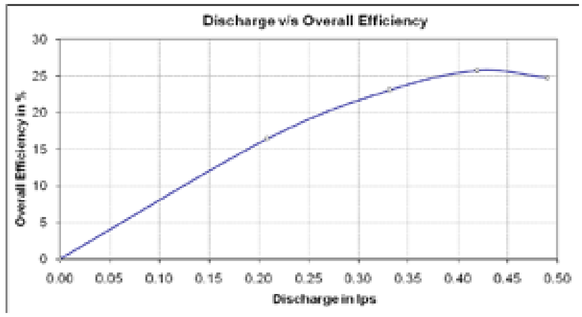
ηoverall = ηmotor × ηpump

D. Graph:-

1. Discharge v/s Head :-



2. Discharge v/s Efficiency:-



III CONCLUSIONS

From this experiment, it observe that PMBLDC Motor has ***high efficiency and high power densit***y as compare to induction motor because no losses in rotor side.

According to graph as Q is increasing, H is always decreasing and vice a versa.

D.C Submersible pump has ***more reliable, low maintenance and high efficiency*** as compare to a.c. submersible pump.

D.C. Submersible pump (45w, 12v, 4.8 A) :-

Max. Head = 3.11, Max. LPM = 28.00

50 liter water in 1.03 min. i.e. We get 50 liter drinking water in just 1.03 min. which is sufficient for one family per day.

Below 1-10 kw range, the PM motor has better **efficiency, torque per ampere, and effective power factor.**

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