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ADVANCED AUTOMATED SLURRY DISTRIBUTION UNIT FOR AGRICULTURAL APPLICATIONS

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Abstract - *Flow distribution and its flow rate of conventional model for slurry distribution are experimentally investigated which consist of a centrifugal pump (generally running at 1750rpm or 3500rpm) along with two tabs and sitting arrangement. The model has been altered (no sitting arrangement) and the new model consist of solenoid valves which works on the electromagnetic principle. Tests were conducted on the model with slurry as working fluid (75% water and 25% cow-dung). Centrifugal pump is replaced by an eccentric rotor vane pump (generally running at 100rpm to 300rpm). The discharge obtained at 100rpm is 23.33lpm whereas at 300rpm it is 70lpm. Based on experimental results, the proceeding work has been proposed.*

***Key Words*: Slurry[1], Discharge[2], Solenoid valve[3], Slurry Pump[4]**

1. INTRODUCTION

In India about 73% of population is directly or indirectly depends upon the farming. Hence it is said that India is an agriculture based country. But till now, our farmers are doing farming in same traditional ways. They are doing seed sowing, fertilizers and pesticides spraying, slurry spreading, cultivating by conventional methods. There is need of development in this sector and most commonly in slurry distribution technique, because it requires more efforts and time to spread slurry by traditional way. Most of Asian nations are at developing stage and they are facing the problem of high population and as compared to that agricultural productivity is much lower as compared to developed nations. India is one of the nations who are facing the same problem. This is caused due to low level farms, insufficient power availability to farms and poor level of farm mechanization.

In order to meet the requirement of food of growing population and rapid industrialization, there is a need of the modernization of agriculture sector. On many farms production suffers because, delay in sowing, improper distribution suffers because delay in sowing, improper distribution of pesticides and fertilizers, harvesting. Mechanization solves all the problems which are responsible for low production. It conserves the input and precision in work and gets better and equal distribution. It reduces quantity needed for better response, prevent the losses and wastage of input applied. It gets high productivity so that cost of production will be reduced.

Now a day's farmer's use following methods for irrigation, they add manure and water in the big tank this mixture is then poured in the tanker and it has two taps at the rear end. The two people sit behind the tanker on suitable arrangement and supply the mixture coming from tap to plants with the help of mug. But there needs to be some advancement in this technology. So after some research, we discovered that rotary pump can be used which sucks semi-liquid material into the tanker which will not only save time but also saves labour work. Also we can use taps which can automatically operate and also we can set how much quantity of colloidal mixture need to be supplied with help of timer.

2. LITERATURE REVIEW

Yousef Faraja, Mi Wanga, Jiabin Jiaa[1] proposed a new indirect method for on-line recognition of the active horizontal slurry flow regime using statistical signal analysis of measurements obtained with a high performance Electrical Resistance Tomography system (ERT).

Sandeep Kumar, Lal Chand Malav, Mahesh Kumar Malav and Shakeel A Khan[2] applied the digested biogas slurry (DBGS) in the field for long term basis which helps in reducing fertilizer demand and provide an eco-friendly way of maintaining productivity and soil health.

Lavinia Warnars[3] Bioslurry can be used to fertilise crops directly or added to composting of other organic materials. Bioslurry is an already-digested source of animal waste and if urine (animal and/or human) is added, more nitrogen is added to the bioslurry which can speed up the compost-making process. The effects of bio slurry application are comparable to the effects of the application of chemical

fertilisers. As such, bio slurry can be a serious alternative to chemical fertilisers.

Lal Chand Malav, Shakeel Ahmad Khan* and Navindu Gupta[4] conducted field trial in 2013-2014 indicating that 50% BGS along with 50% chemical fertilizer gave 20% more yield in terms of cob as well as biomass. Combination of BGS and N fertilizer increase protein and total sugar content of the baby corn cob up to almost 100% and 41% respectively over control.

D. Ryan[5] proposed a tanker that consists of a closed tank with running gear fitted for road and field conditions. A TF spreader is fitted at the back. The slurry is handled by a fixed displacement pump which fills the tank or empties it through the spreader. The pump must be protected from obstacles so an intake filter or chopper filter should be included.

J. Devarenjan, G. M. Joselin Herbert, D. Amutha[6] in their research paper stated about the utilization of bioslurry as a fertilizer. They also stated that the conventional sources of energy are getting depleted day by day. The only option is the renewable source such as biogas. Disposal of large amount of bio gas slurry (BGS) produced is a major concern. Recycling of organic waste such as cattle dung, vegetable waste, food waste by the process of anaerobic digestion in the biogas plant (BGP) will be a great potential than producing any other fossil fuels. Hence, utilization of bio slurry as a fertilizer is an effective way. It increases the productivity of the soil. It is cheap and easily available fertilizer for the small-scale farmers who could not afford in buying synthetic fertilizers. Bio slurry is nowadays being used as an effective source of fertilizer.

T. Burris-Mog, M. Burns, A. Chavez, J. Schillig[7] stated about the nature of permanent magnet solenoid coil. A feasibility study has been performed on an adjustable- field permanent magnet (PM) solenoid concept in an effort to reduce the dependence that linear induction accelerators have on large direct current power supplies and associated cooling systems.

F. Fornarelli, A. Lippolis, P. Oresta, A. Posa[8] proposed about the pressure compensated vane pump, mobile machines, robots and other applications. In the present paper a vane pump will be theoretically analyzed using the software AMESim and/or MATLAB/Simulink, in order to estimate the friction forces and volumetric efficiency loss without hardworking experimental tests.

Debjyoti Sengupta[9] mentioned the details of the design of the experimental apparatus used and its working as well as the experimental data recorded during the experiment to provide an experimental proof of the fact that the Third Law of Motion is disobeyed by all non-contact/conservative forces.

Jian Chu, Yan Feng[10] introduced the automatic control process of solenoid valve production line with PLC control and touch screen user interface. The production line can produce four types of solenoid valves. There are numerous steps in the production process to ensure the quality of the products, e.g. image error detection and Helium leak detection. The system control structure, hardware components, software design, as well as the process of automatic control are articulated in this article. The production line runs with consistent stability, the man-machine interface is user friendly, and all the processes have a high level of automation.

Md Modassar Akhtar, Santosh Kumar Tripathy, Ekula Prasant Kumar, Suryakanta Biswal, Sourabh Kumar, Himanshu Shekhar Dash[11] stated that, a solenoid is a type of electromagnet when the purpose is to generate a controlled magnetic field. If the purpose of the solenoid is instead to impede changes in the electric current, a solenoid can be more specifically classified as an inductor rather than an electromagnet. In engineering, the term may also refer to a variety of transducer devices that convert energy into linear motion. The term is also often used to refer to a solenoid valve, which is an integrated device containing an electromechanical solenoid which actuates either a pneumatic or hydraulic valve, or a solenoid switch, which is a specific type of relay that internally uses an electromechanical solenoid to operate an electrical switch; for example, an automobile starter solenoid, or a linear solenoid, which is an electromechanical solenoid.

Philippe Passeraub[12] stated that, An Inductive proximity sensor are widely used for the contactless measurement of object or target displacement and position in numerous technical products and systems. They are found in various application domains such as transportation, robots, assembly lines, telecommunication or security. The inductive sensing principle is known for its robustness, high precision and low sensitivity to environmental conditions as well as to extreme working conditions like cryogenic temperatures.
Sagar Yadav, Narayanankutty K.A.[13] proposed that, an industrial timer requirement is multifaceted. On-delay, off-delay, cyclic or sequential timing requirements, with usual time range varying from seconds to days, depending on the process. Custom build timers cannot provide all of these requirements simultaneously and hence an advanced timer rectifying this shortcoming has been designed and fabricated in this work. This timer is based on the real time clock chip used in mother boards. Our design can be programmed for a specific time requirement and can later be put to work in standalone mode. A demonstration board is fabricated and tested.

Shobha S, S. Ramachandran[14] stated that, Ladder logic programs paradigm the electrical circuit diagrams used for wiring control systems in the industry. The basic element of a ladder diagram is a "Contact". A contact has only two

states: open or closed. An open contact holds the current flow whereas a closed contact permits current to flow through it to the next element. Programmable Controller substitutes relays, timers and counters using Ladder diagram programming.

Chetan P. Chaudhari, Bhushan B. Thakare, Saurabh R. Patil, Shrikant U. Gunjal [15] studied and proposed that, A bearing is a machine element which supports another moving machine element (known as journal). It permits a relative motion between the contact surfaces of the members, while carrying the load. A little consideration will show that due to the relative motion between the contact surfaces, a certain amount of power is wasted in overcoming frictional resistance and if the rubbing surfaces are in direct contact, there will be rapid wear. In order to reduce frictional resistance and wear and in some cases to carry away the heat generated, a layer of fluid (known as lubricant) may be provided.

Hobart S.White[16] investigated that, materials that may be suitable for usc as oil-free bearings in aircraft clocks and similar instruments between -550 and +700 C, to replace lubricated jewels that do not give satisfactory operation at subzero temperatures because of congealing of the oil. Another advantage of an oil-free instrument is the freedom from cleaning and oiling periodically during shelf storage.
Timur Choban Khidir[17] proposed that, a bush pin type flange coupling is used to connect of shafts which having a small parallel misalignment, angular misalignment or axial misalignment. This is a modification of the protected type flange coupling which has pins (covered by rubber or leather bushes) and it works with coupling bolts. Generally, it is used to assemble electric motors and machines.

3. EXPERIMENTAL SETUP

3.1 Block Diagram

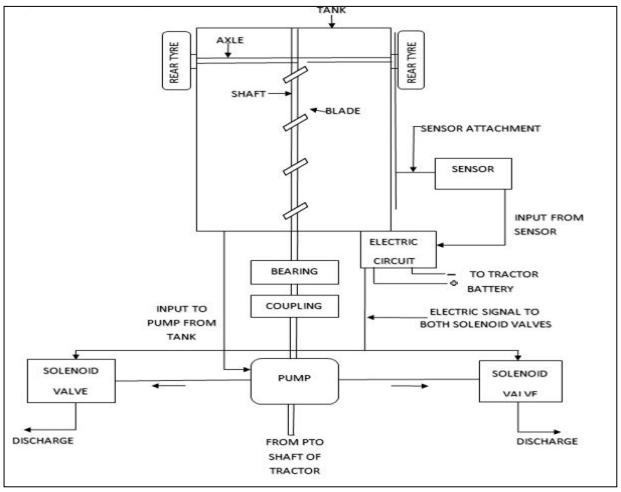

Fig -1: Block diagram of Slurry Unit

3.2 Construction

The details of the experimental set up are shown in the figure. The set up consists of tank in which there is shaft with blades over it which helps to stir the slurry and water. The shaft inside the tank is connected to the pump through bearing and coupling. The pump has one input and three outputs, one input is from tank to the pump, two outputs are given to both of the solenoid valves as shown in figure and the third output is given to the tank so as to avoid overflow of slurry. A provision is made to the side of tank so that the sensor arrangement can be given. An electric circuit is provided which is connected to the tractor's batter

3.3 Working

Initially the cow dung and water are added in the tank. As the tractor gets start the PTO shaft starts rotating and the pump as well as the shaft inside the tank also rotates simultaneously, as the shaft rotates it stirs cow dung and water and gets mixed properly to form slurry. As the pump rotates suction is created which sucks the slurry from the tank and it supplies the slurry to both of the solenoid valves with increased pressure also the excess amount of slurry coming out of pump is again poured to the tank so as to avoid the overflow. A proximity sensor is connected to the tank so as to sense the long and short trees or plants. As the trees or plants are sensed, the signal is given to the electric circuit which is connected to the battery of tractor. The electric circuit is connected to the solenoid valves. A solenoid valve is an electromechanically operated valve. This valve involves a current carrying coil, poppet connected with plunger, half spherical vessel, inlet and outlet ports etc. the inlet is connected to the pump by using hose and outlet is at bottom connected to outlet pipe which distribute slurry to various plants. As the current is owing through the coil it gets energies and create magnetic field, due to which plunger inside the bush located at middle portion of coil get lifted up and poppet connected to plunger also get lifted up and slurry from outlet port get discharge.

3.4 Components of the unit

Table -1: Components of the unit

10	Pipe	Polyvinyl chloride (PVC)
11	Tyre	Rubber
12	Axle	Stainless steel
13	Glan rope	Ceramic
14	Universal joint	Stainless steel

Sr. No.	Components	Materials
1	Tank	Plastic
2	Chassis	Mild steel
3	Shafting	Mild steel
4	Mud pump	Mild steel
5	Electronic circuit	Copper wire solenoid with timer
6	Glan housing	Mild steel
7	Nuts and bolts	Stainless steel
8	Hooper	Aluminum
9	Bearing (Deep groove ball bearing)	High carbon chromium bearing steel

4. DETAILS OF COMPONENTS

4.1 Chassis

A vehicle without a body/component is called as chassis. It is the backbone of slurry unit, on which the total load of the slurry unit is applied. The other components of slurry unit are mounted on chassis. It is the main mounting for all the components so it is called as carrying unit, the main function of chassis is to carry load and support load.

Dimensions of chassis: Length = 1320 mm, Height = 630 mm, Width = 875 mm

Material selected for the chassis is MILD STEEL.

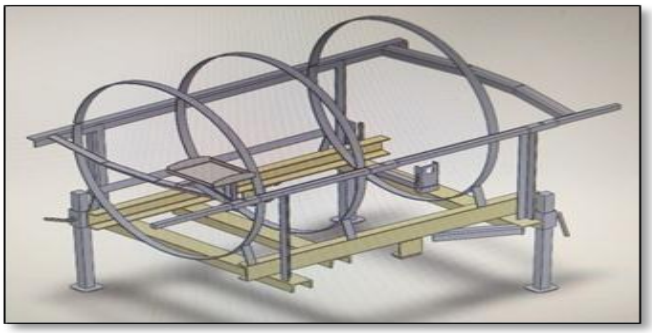

Fig -2: Chassis

4.2 Slurry Pump

A rotary vane pump is a positive-displacement pump that consists of vanes mounted to a rotor that rotates inside a cavity. In some cases, these vanes can have variable length and/or be tensioned to maintain contact with the walls as the pump rotates. An eccentric rotary-vane pump. Note that modern pumps have an area contact between rotor and stator (and not a line contact).

Pump Delivers 84 lpm at 300 rpm and 23.33 lpm at 100 rpm
Materials selection: Material for pump housing, rotor, pump covering plates = Cast iron

Material used for manufacturing of blades of pump = brass
Material used for spring = Stainless steel.

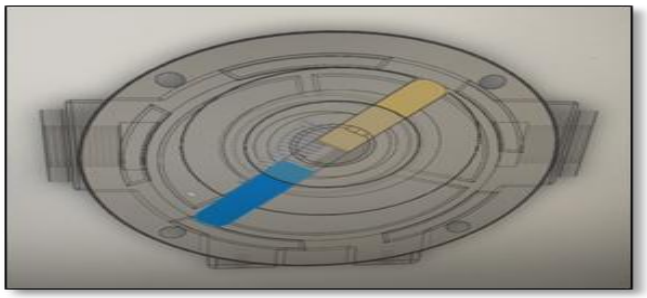

Fig -3: Slurry pump

4.3 Solenoid Valve

A solenoid valve is an electromechanically operated valve. Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid and the type and characteristics of fluid they control. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut , release, and dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

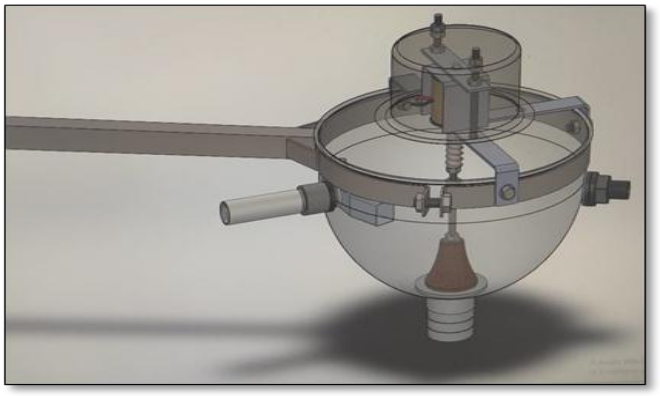

Fig -4: Solenoid valve

Mechanism
This valve involves a current carrying coil, poppet connected with plunger, half spherical vessel, inlet and outlet ports etc. the inlet is connected to the pump by using hose and outlet is at bottom connected to outlet pipe which distribute slurry to various plants. As the current is owing through the coil it gets energies and create magnetic field, due to which plunger

inside the bush located at middle portion of coil get lifted up and poppet connected to plunger also get lifted up and slurry from outlet port get discharges.
Specifications of Valve:
Lifting capacity of valve = 200 gm
Lifting height in valve = 25 mm
Solenoid coil contains = 400 turns
Wire diameter = 1 mm
Power supply = DC power supply (12 Volt)
Material Selection:
Material used for valve housing (hopper) = Aluminum
Solenoid coil is made up of = Copper
Discharge port is made up of = Wooden

4.4 Tank

A water tank is a container for storing water. Water tanks are used to provide storage of water for use in many applications. Water tank parameters include the general design of the tank, and choice of construction materials, linings. Various materials are used for making a water tank: plastics (polyethylene, polypropylene), fiberglass, concrete, stone, steel (welded or bolted, carbon, or stainless).
Material Selection: Polyethylene is a type of plastic which is generally used for manufacturing of tanks.

Fig -5: Tank

4.5 Tyre and Axle

An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In our case axle is fixed to vehicle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. Sometimes, especially on bicycles, the latter type axle is referred to as a spindle. Axles are an integral component of most practical wheeled vehicles.

Fig -6: Tyre

5. COMPARISON

The comparison between conventional model automated model is shown below.

Conventional model	Automated model
Two labourers are required for slurry distribution. Hence labourer cost is involved.	No need of labourers. Hence no labourer cost.
Slurry needs to be distributed according to the convenience of the labourer.	Due to electronic valve, there is ease of slurry distribution according to the driver's convenience.
Slurry is poured randomly.	Slurry is poured in recquired quantity.
Pump used runs at higher speed	Pump can be operated at low speeds.
Mixing of cowdung and water is done outside the tank in a pit.	Mixing of cowdung and water is done in the tank itself.

Table -2: Comparison table

6. RESULT AND ANALYSIS

I. Pump

Pump Discharge
Pump Delivers 70 lpm at 300 rpm 23.33 lpm at 100 rpm
300 rpm = 14 ltr in 10 sec
= 14*6
= 84 lpm
= 0.0014 m3/sec.

II. Tyre capacity

Weight of acting on the axle = Weight of tank with slurry + Weight of chassis
= 622 + 108
= 730Kg
Total weight on the tyre = 730 + 33
= 763Kg
Weight on individual tyre is = 763/2
= 381.5 kg
Standard capacity of tyre is 615 kg

So, Tyre is safe against load acting on it.

III. Capacity of axle

Total load acting on the axle = Load due to tank + Load due to chassis

= 622 + 108

= 730 Kg

Specified capacity of axle by manufacturing company is 2000Kg

So, Axle is safe against load acting on it.

7. CHARTS

7.1 Pump RPM Vs Pump Discharge

The graph of Discharge vs Pump speed is plot for slurry distribution unit.Values of pump(rpm) are plotted on the abscissa and discharge on ordinate. As the pump speed increases,discharge also increases.As the Pump speed α Discharge.Pump speed is measured in rpm(revolutions per minute) and Discharge is measured in LPM(litres per minute).It is observed that for 100 rpm,pump dicharges about 23.3 lpm of slurry and it increases as the speed increases.

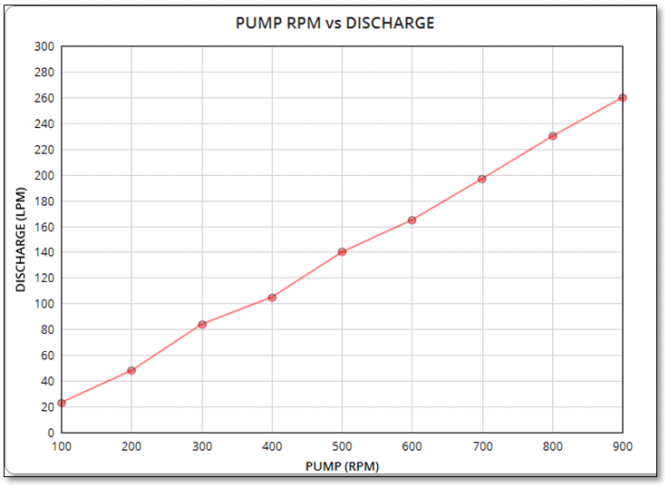

Chart -1: Pump RPM Vs Pump Discharge

7.2 Pump Discharge Vs Time

A graph of Discharge vs Time is plot for slurry distribution unit.Values of Time are plotted on the abscissa and Discharge on ordinate. As the Time increases,discharge also increases. As the Time α Discharge.Time is measured in minutes (min) and Discharge is measured in LPM(litres per minute). It is observed that for 1 minute,pump dicharges about 83 lpm of slurry and it increases as the time increases.

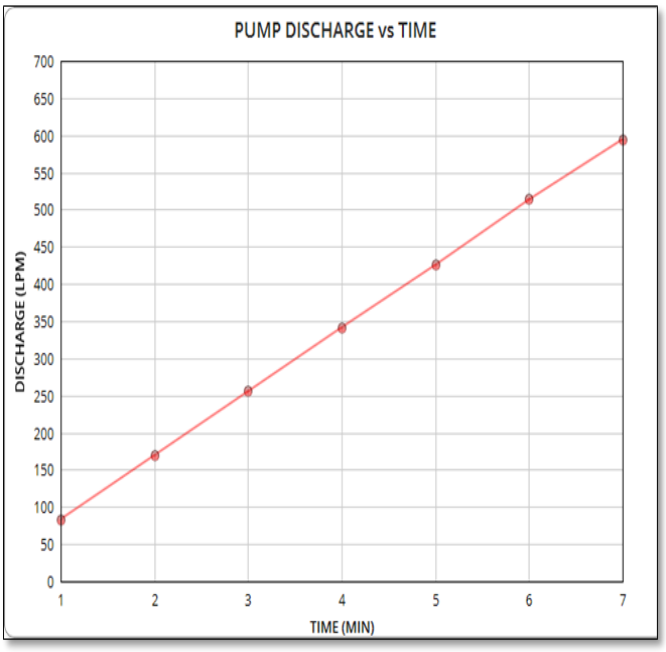

Chart -2: Pump Discharge Vs Time

7.3 Valve Lift Vs Quantity Discharge

A graph of Quantity Discharge vs Valve Lift is plot for slurry distribution unit.Values of valve lift are plotted on on the abscissa and quantity discharge on ordinate. As the valve lift increases, quantity of discharge also increases.As Valve Lift α Quantiti Discharge.Valve Lift is measured in mm(mili metres) and Quality Discharge is measured in ml(mili litres).It is observed that for each solenoid valve for the valve lift of 2mm slurry discharged is about 20ml and it increases as the valve lift increases.

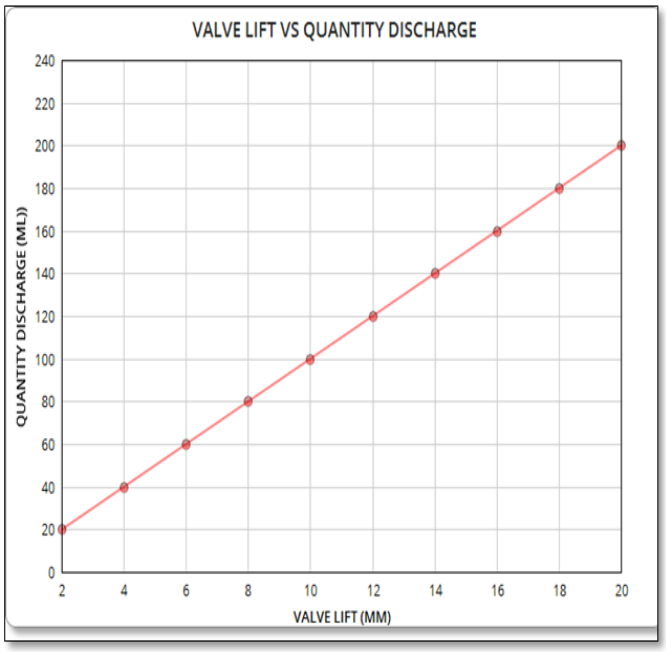

Chart -3: Valve Lift Vs Quantity Discharge

8. CONCLUSION

As the pump creates vacuum between 100 rpm to 300 rpm, the extra arrangement of gear drives which was needed for centrifugal pump has been withdrawn. The use of timer and sensor-controlled solenoid valve, took over the need of labourers which resulted in the decrement of overall expenses. The involvement of rotary vane pump, sensor, and solenoid valves has increased the efficiency of the system. The arrangement of sensor is made such that it can even sense bushes. As the overall cost is less, this system is affordable to middle class farmers too. Thus, this system is more efficient in the farms having large area. Hence this system can be used where there is scarcity of labourers or the cost of labourers is too high. This can help the farmers to pour the slurry to the crops/plants by themselves.

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