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Development of Semi-Automated Barrel Pump

Santosh S. Kumar[1], Prabal G. Meshram[2], Shubham R. Sahare[3], Rajaram B. Janagam[4]
Kartik V. Gandhare[5]

[1] *Asst. Professor, Department Of Mechanical Engineering,*
J D College of Engineering and Management, Kalmeshwar Road, Nagpur – 441501, Maharashtra.

[2, 3, 4,5] *UG Scholar, Department Of Mechanical Engineering,*
J D College of Engineering and Management, Kalmeshwar Road, Nagpur – 441501, Maharashtra.

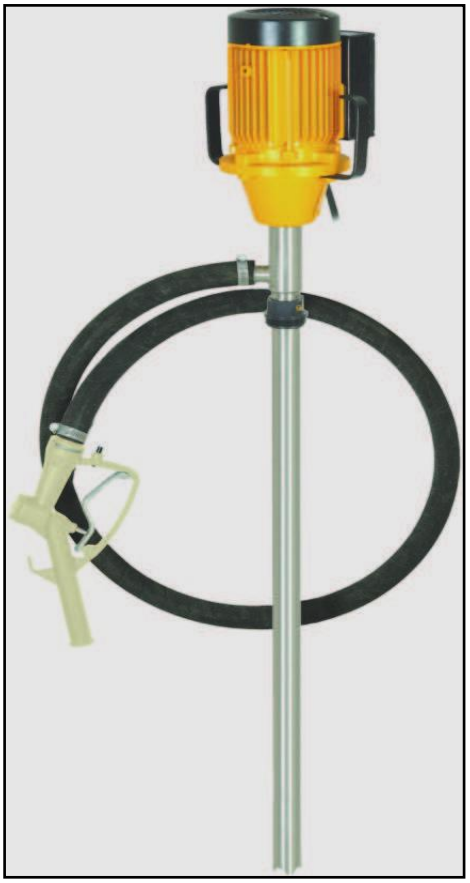
Abstract- *The main objective of the present paper is to design a barrel pump which can extract/suck the oil from barrel which works on the principle of centrifugal force. Centrifugal pump used an impeller and casing to create a discharge pressure and partial vacuum pressure needs to draw oil from the casing. In this we uses a semi closed impeller and volute casing receives the oil to pumped and pressure to it by getting power from a prime mover.*

Here we use a 12V DC Servo motor which gives a kinetic energy to centrifugal pump for extract oil, this servo motor is connected with "Circuito De Control" which is an servo motor controller it is connected with potentiometer or flow sensor for making a closed loop and to get a continuous position feedback from system, if there is a some short of error then it can solve it or stop the system unless and until the problem cannot solved. This system gets a power from 12V DC Battery to run the pump.

Keywords- *Barrel Pump, Centrifugal Pump, Semi-Closed Impeller, Volute Casing, 12V DC Servo Motor, Circuito De Control, Controller, Potentiometer, Flow Sensor, 12V DC Battery*

1. INTRODUCTION

Barrel pumps are used for extract or suck the oil from barrel, The major objective of this study is to design a semi-automated barrel pump, which can reduce the human effort and to make an intelligent system in modern world in which user can easily operate this barrel pump without any fatigue in anywhere like in house hold applications or in industrial applications it can be used in any places, where there is a need of pumping oil. There are various types of barrel pumps which are used in house hold application and in industrial application for filling the container, which are easily available in market (i.e.)



1.1. PNEUMATIC AND ELECTRIC DRUM PUMPS

These pneumatic and electric drum pumps are centrifugal and self-priming type of pumps, which gives accurate and safe way to transfer the fluid from drums. There is a vertical suction and horizontally discharge takes place. These pumps are light in weighted and suitable for flowing non-flammable, non-explosive, low viscous and aggressive types of fluids.

1.2. vACUUM PUMPS

These types of pumps are compressed air operating type of pumps which are used for cleaning purpose in soft floor, waste oil, paint sludge, cutting fluid, contaminated liquids etc. It has an aluminium coated rust-corrosion proof body, this are available with proper air connection kit and suction hose pipe for proper installation.

1.3. HAND OPERATED DRUM PUMPS

These types of hand operated drum pumps are of eccentric or co-eccentric in nature of vane type or some time double acting piston type which sucks or delivers the fluid in both forward and reverse direction, these types of pumps are operate in dry or wet condition without fail and used in chemical companies where temperature goes up to 55°c. These pumps are available in two materials polypropylene and nylon.

1.4. GALLON PUMPS

These pumps are manual hand operating type of made up of thermoplastic material and self-priming in nature and consist of a piston reciprocating type of mechanism in which fluid will deliver in forward stroke. This type of pump is used for pumping clean, less viscous fluid, non-explosive and non-flammable in nature.

2. CONSTRUCTION

Semi-automated barrel pump is simple in construction and in its construction there are number of components are used for achieving required power output through which suction head can de achieve and we extract the oil from barrel for which it is to be design, the following components are:-

2.1. PUMP

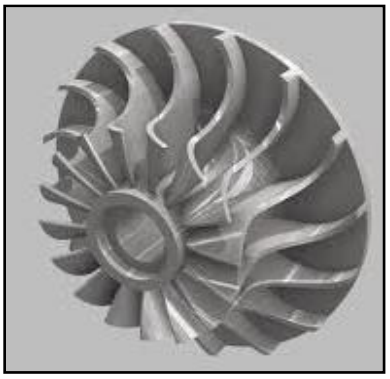
We are using a centrifugal type of pump for making a semi-automated barrel pump, it is a rotodynamic type of kinetic pump which can sucks the liquid from sump by creating a negative vacuum pressure and generated suction head which can sucks the liquid at required limit which we want to achieve, it is using a impeller to increase the flow rate and pressure of the liquid. This types of pumps are usually use for smaller heads and large discharge. It consists of number of multiple parts which are given as below:-

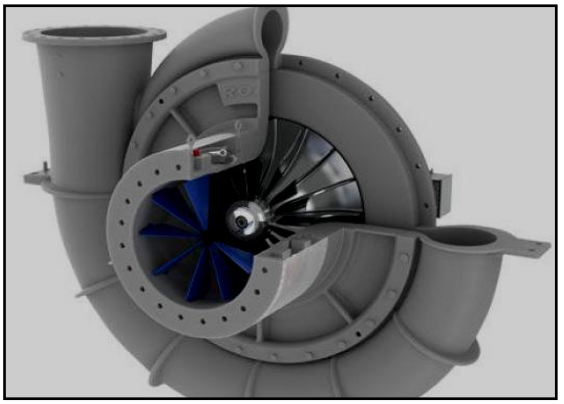
2.1.1. IMPELLER

We are using a semi-closed type of impeller the main purpose of impeller is to increase the flow rate and pressure of the liquid and we are using this pump for pumping an oil. The diameter and the speed of impeller is determines the pressure or head which pump can be produce. In this we are using forward swept blade type of impeller which receives a liquid at inner diameter of impeller by blade design and centrifugal force.

2.1.2. CASING

We are using a spiral or volute type of casing in our pump, its cross sectional area is increasing from tongue to delivery pipe, due to continuous increase in area its velocity is decreases and pressure is continuously increases which we want, most of the pumps which are single in stage it uses volute casing and it also protect to impeller and enclosed in it and protect from outer environment.





2.1.3. SUCTION AND DELIVERY PIPE

Suction and delivery pips are used for carrying a fluid from one place to another place, we are using plastic material for design this pipes which can decrease its weight and it is non-corrosive is nature. For proper working and to provide a satisfactory strength we are manufactured this pipe from taflon material and in suction side strainer is attached with pipe and nozzle is attached delivery side.

2.2. SERVO MOTOR

We are using DC type of servo motor in our project because it gives a maximum power output at higher speed and we are designing a portable barrel pump and can be used in any places so that we can use dc type of servo motor in it. It has also some more functionality through which it can make system smart and automatic due to presence of closed loop feedback system for which there is a sensor is attach with motor.

Table 1. Specification of servo motor

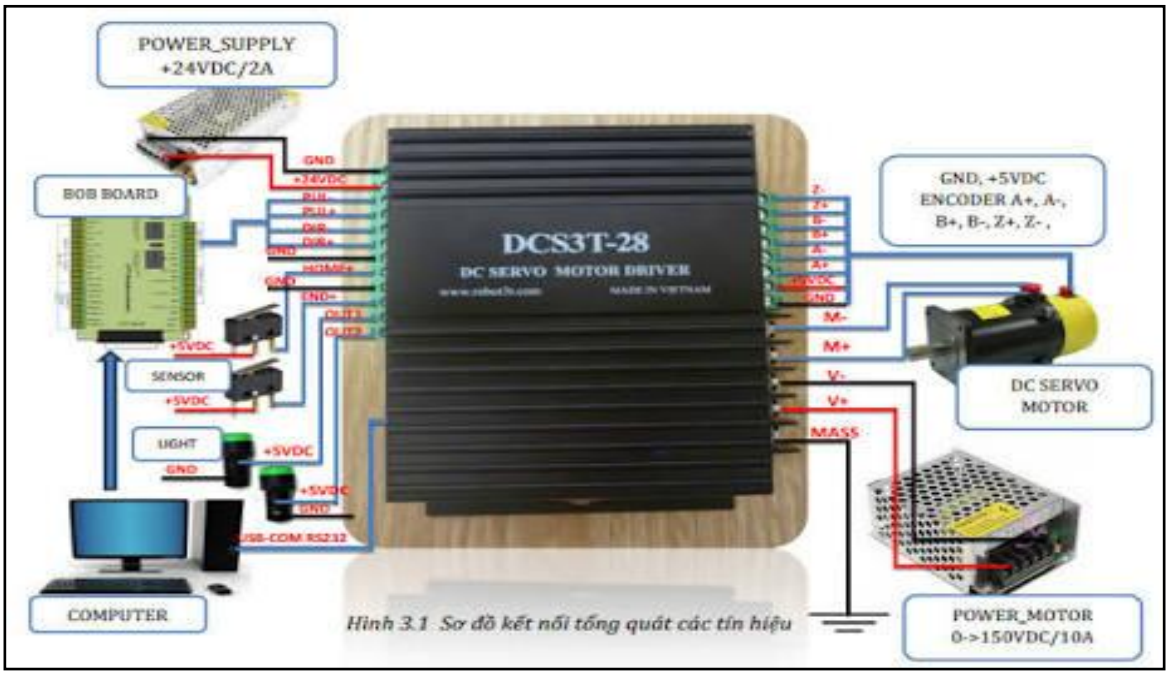
S.NO.	PARAMETERS	RATINGS
1.	Shaft Speed	3180 – 4700 rpm
2.	Continuous Torque	1.70 – 5 Nm
3.	Terminal Voltage	12 V DC

4.	Continuous Output Power	1 – 2 HP
5.	Continuous Current	4 – 8 Amps

2.3. CONTROLLER

A controller is a chip or circuit which can control the system in which it is connected, it gives the specific amout of current to a motor for which controller is attached, we are using Dc servo motor controller to run the servo motor and performing all the operation for which it is to be design it consist of a number of components and its intelligent system through which it is perform all this functionality.

The components are crystal oscillator, reset switch, power connectors, DC socket, voltage regulator IC (7805), microcontroller IC (PIC16F628A), amplifier, LEDs, capacitor, diode, resistance etc. In control system there are encoder/ feedback device, controller algorithm and programming which are used for program the controller circuit.



2.3.1. MICRO CONTROLLER IC

we are using PIC16F628A of microcontroller IC for designing a controller it has a tremendous amount of data memory and 128 bytes of Electrically Erasable Programmable Read only Memory (EEPROM). It executes the instruction in 200 nanoseconds; it is easy to programmable in 35 words of single instruction. It has an 18 pin package and flash based 8- bit CMOS microchips microcontroller pack. It has a multiple features 4MHZ internal oscillator, low clock speed mode, low programming voltage.

Table 2. Description of pin during programing

PIN NAME	DURING PROGRAMMING		
	PIN TYPE	**FUNCTION**	**PIN DESCRIPTION**
RB6	Input	CLOCK	Clock Input
RB7	Input	DATA	Data Input/output
RB4	Input/output	PGM	Low- Voltage Input Programming
VSS	P	VSS	Ground
VDD	P	VDD	Power Supply
MCLR/VPP	P(1)	Programming Mode	Program Mode Select

2.3.2. CRYSTAL OSCILLATOR

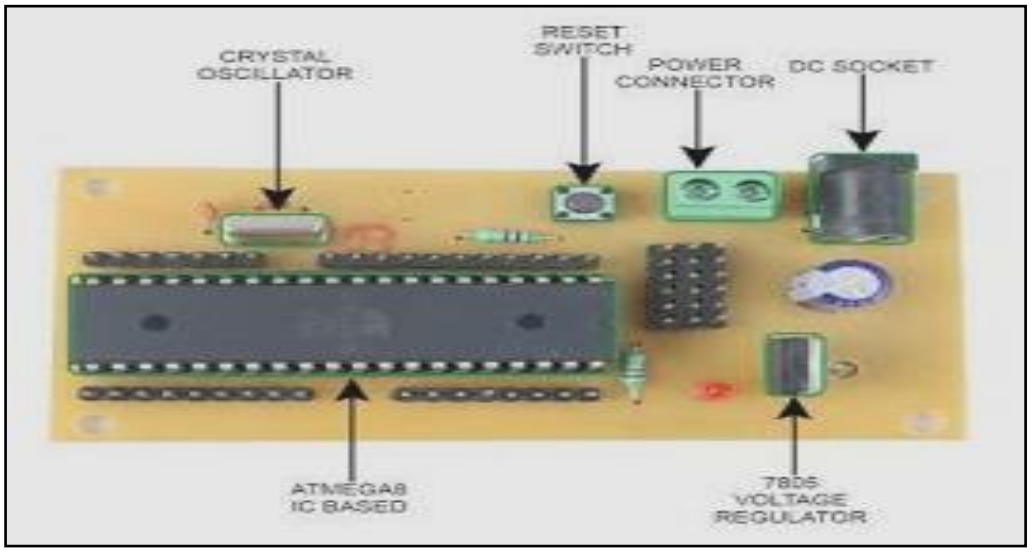
It is an electronic device which uses crystal of piezoelectric material to generate a signal electrically by using vibrating crystal mechanical resonance is to be generated which is made up of piezoelectric material; usually quartz crystal is used in oscillator, it has a frequency of higher stability. Another name of crystal oscillator is also known as piezoelectric resonator; it is oscillating naturally at its own frequency with higher amplitude.

2.3.3. RESET SWITCH

A reset switch or reset button is using for reset a system or devices in which it is to be connected, sometime if the system or program is hanged or not properly works so in this type of situations we need to restart the system by clicking that button, it can cut the power supply through battery to the system it is connected at the staring of the circuit due to which it can perform reset operation.

2.3.4. POWER CONNECTORS

Power connectors are usually used for connection of power in our circuit or device in which it is connected it has a three terminals tip, sleeve and insertion detection. Power connector act as a vital role between power source and the device in which it is connected which required external power or supply for working the system.



2.3.5. VOLTAGE REGULATOR IC (7805)

Voltage regulator IC (7805) is a three pin IC which converts the 12V DC supply into 5V DC supply, it control and maintain the output voltage at constant value. It is a member of fixed 78xx series of voltage regulator in fixed manner. It is used in circuits because there are lot off components in circuit which cannot substation that much of higher voltage if directly 12V is supply to circuit then the ICs, capacitor or diode can damage and circuit fails to working.

2.3.6. POWER DEVICES

Power devices or semiconductor devices are used as a rectifier or switches in power electronics. It is basically not used in linear operation this are the voltage regulator as widespread, radio frequency amplifier etc. In this diode, capacitor, resistor are also include this all are the semiconductor devices which are used for performing little operations. Diode is used for conducting a current in one direction which has a unidirectional flow and high resistance path. Capacitor is used as a power saver which stores the potential energy in field.

2.3.7. ENCODER / FEEDBACK DEVICE

An encoder or feedback device is a circuit program or algorithm that converts and encodes the data or information in one form of data to another form. There are various types of software for encoding. Audio encoder converts analog audio signals into digital audio signals. It gives the continuous feedback to the system it the system will not properly work it gives the negative feedback signal and alert indication is given to operator.

2.3.8. SERVO MOTOR AMPLIFIER

Servo motor amplifier or servo drive is a special type of electronic amplifier, the main function of the servo drive is to receive command signal which is come from control system. Servo motor amplifier is worked on the electric power servo mechanism, it monitor and observe the feedback system which is dome from the servomechanism side and from expected behaviour it continuously adjust the deviation which are occur inside the system.

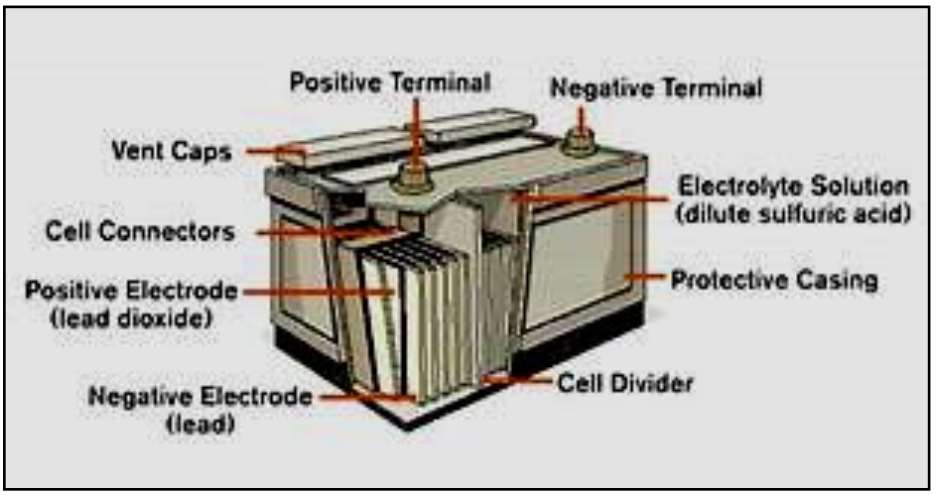
2.4. FLOW SENSOR

Flow sensor is a sensor which sense the how much amount of fluid can flow from suction line and gives the closed loop feedback system to the controller, if the fluid is not flowing properly through the channels or not attaining a required range then in case the controller control the flow of fluid and vary voltage due to which its flow rate is changes and it can attain required output.

2.5. BATTERY

We are using 12V lithium ion battery in our project which gives a power to our system through which our system can be run and pump extract the liquid from sump and sends it to delivery. Battery is a device which stores electrical energy and

supplies this energy when require to perform the required mechanical work. It has a two terminals positive and negative which are connected with the DC servo motor controller which controls or run the motor which rotates a barrel pump.



3. WORKING

To develop a semi-automated barrel pump we are using 12V DC Servo Motor, Servo Motor Controller, Lithium Ion 12V Battery, Flow Sensors and calculated design of pump and its accessories.

Initially the power or electrical charges are pass from battery which is stored in battery, then this supply is send to servomotor controller, it controls the complete system and operates all the functionality it controls the rotating speed of motor due to which achieve the required flow rate. In this controller we are designing its circuits and changes it according to our requirement if the required flow is not achieve then flow sensor sense the reading by sensing its flow rate and sends the signal to a controller, if there is some sort of error by completing closed loop feedback signal it can stop the operation or try to solve the problem on that time there is alert indication light and buzzer is provided if it not follow attain the required flow rate so in this case this alert indication can perform its work, so its performs a completely intelligent work.

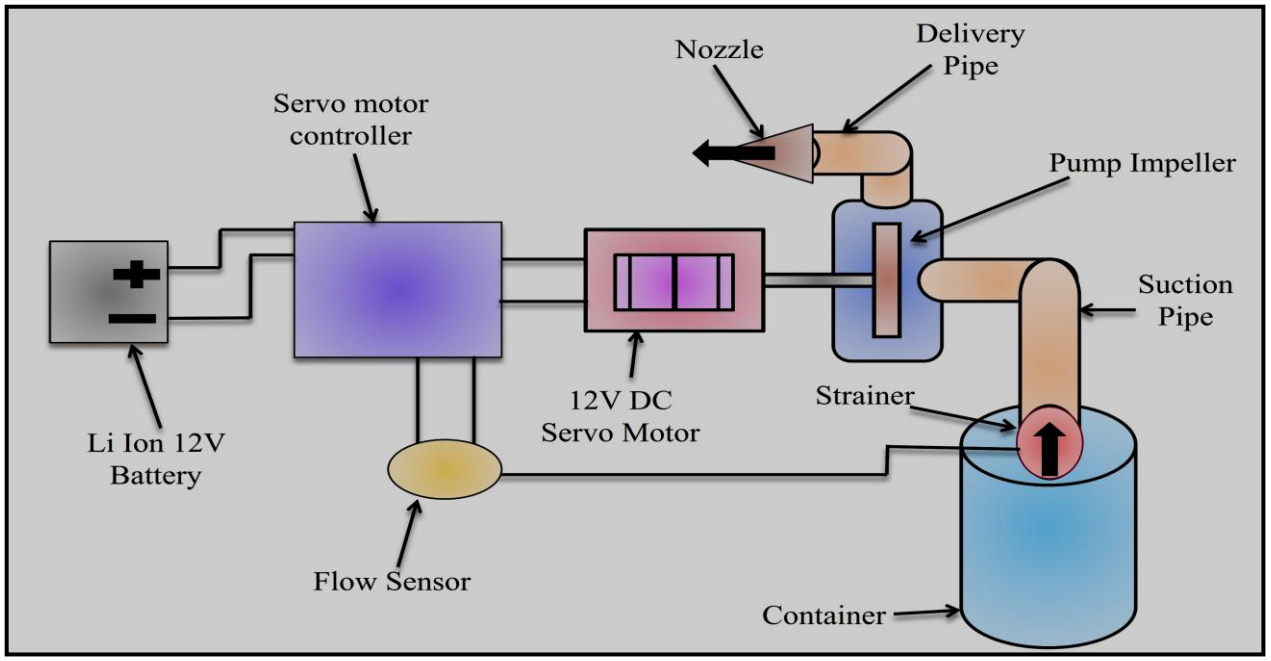
We are selecting a 12V DC Servo motor for full fill our requirement because it is suitable for fluctuating loads, it gives a higher power output and have a high torque capacity in higher speed it has a speed range between 3,180 rpm to 4700 rpm which gives a continuous toque upto 1.70 Nm to 5 Nm and has a terminal voltage 50V to 100V DC due to which we can select this motor and implemented in our system.

After that the flow sensor which is used as a feedback device it sense the physical parameter (i.e.) flow rate of liquid and converts it into equivalent electrical signal and send it to controller for operating the required performance of operation.

For designing this complete barrel pumps we are selecting a centrifugal type of pump in which impeller of the pump which is mounted in the casing it is directly coupled with servo motor shaft and for proper balancing and to reduce the frictional losses the shaft is pass from two bearing one is at casing of pump and another is to near motor coupling. When the shaft of motor is rotate due to which impeller is also rotating continuously which affects that there is a negative vacuum pressure creating inside the pump which can sucks the oil from container and delivers it to required place by means of centrifugal force which is generated inside the casing due to rotation of impeller.

For performing this effectively pumping operation the pump is need to be appropriate in condition it is happen when there is a accessories or safety arrangement of pumps are provided if there is a excess current is pass from controller to motor so it receives a faulty error signals and get a reverse feedback to solve that problem. There is a strainer provided at the bottom of the suction pipe which can filter the liquid from impurities, debris and prevent it from blockages and attach convergent type of nozzle at the end of delivery pipe due to gradually decrease in cross sectional area it pressure goes on decreases and which gives a maximum velocity and flow rate of liquid.

4. FLOW CHART



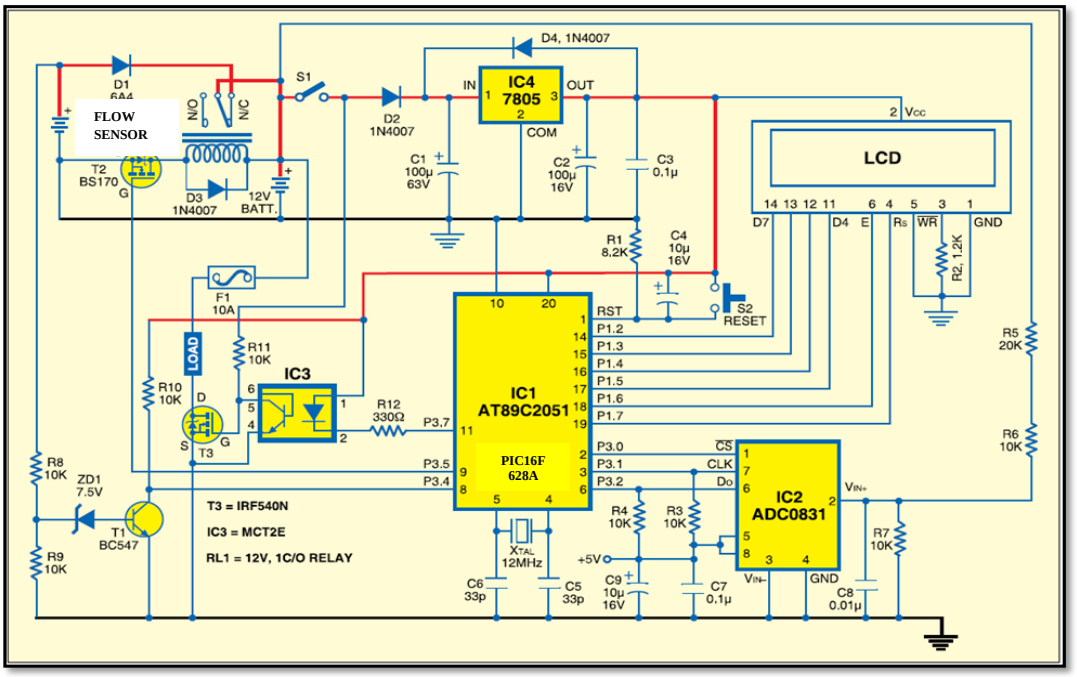
5. SPECIFICATIONS OF THE COMPONENTS

In specification the components which we are using for design a barrel pump has a specific material for which it is to be manufactured and each material has some specific property due to which we can design it for making a component with that material.

Table 3. Specifications and materials of semi-automated barrel pump

SR.NO.	COMPONENTS	MATERIAL OF COMPONENTS
1	Casing	Teflon
2	Impeller	Teflon
3	Impeller Shaft	Stainless Steel
4	Suction and Delivery Pipe	Polypropylene
5	Strainer	Polypropylene
6	Bearing	Stainless Steel
7	Nut Bolts	Stainless Steel Alloy
8	Gasket	Cork/Nitrile
9	Nozzle	Viton
10	DC Servo Motor	Armature is of Laminated Core
11	12v Battery	Lithium Ion
12	Bung Nut	Stainless Steel
13	DC Servo Motor Controller	Circuito De Control Controller Circuit
14	Microcontroller IC	Silicon Doped Semiconductor
15	Voltage Regulator IC	7805 Iconic Regulator IC
16	Crystal Oscillator	Quartz, Polycrystalline Ceramics
17	Power Devices	Silicon Carbide
18	Amplifier	Picking PCB, Tolex and Tweed
19	Bung Nut	Stainless Steel
20	Flow Sensor	Stainless Steel

6. CIRCUIT DIAGRAM



7. RESULT AND CALCULATIONS

For obtaining this required data and calculation, we are performing and solving the vigorous numerical, equations and experimentations due to which we got required values which we want to achieve and that is our final need.

Initially we consider all the assumption which is required to design a barrel pump. Impeller inlet diameter is consider as two times of shaft diameter and the outer diameter of the impeller is approximately three times of inlet diameter of impeller, and always Absolute velocity angle at inlet is consider as 90◦ for better efficiency and entry of flow at inlet.

Table.4. Design and specification of semi-automated barrel pump

SR.NO.	DESIGN SPECIFICATION	NOTATION	CALCULATED VALUES
1	Suction pipe diameter	(D_s)	0.018 m
2	Discharge pipe diameter	(D_d)	0.015 m
3	Inside diameter of impeller	(D_i)	0.016 m
4	Outside diameter of impeller	(D_o)	0.05 m
5	Density	(δ)	960 kg/ m^3
6	Speed	(N)	4000 rpm
7	Discharge	(Q)	0.0005 m^3/sec
8	Blade inlet velocity	(u_1)	3.35 m/sec
9	Blade outlet velocity	(u_2)	10.43 m/sec
10	Specific speed	(N_S)	1200
11	Absolute velocity angle at inlet	(α_1)	90◦
12	Absolute velocity angle at outlet	(α_2)	5.85◦
13	Relative velocity of inlet	(V_{r1})	3.90 m/sec
14	Relative velocity of outlet	(V_{r2})	8.71 m/sec
15	Inlet blade angle	(β_1)	30.83◦
16	Outlet blade angle	(β_2)	44.98◦
17	Overall efficiency	($\eta_{overall}$)	80%
18	Manometric efficiency	($\eta_{manometric}$)	86%
19	Mass flow rate	(m·)	0.418 kg
20	Manometric head	(H_m)	8 m

8. CONCLUSION

On the basis of the results of this research, it can be conclude that the design and development of semi-automated barrel pump is feasible and reliable. We are successfully solve the problem which are normally arises in barrel pumps and achieve the required goal, which we obtained after performing the design and calculations. For obtaining the required parameters we got a lot off difficulties in design and calculation so for that we also assume lot of parameters and try to solve those difficulties and to achieve that required goal, we perform and complete all the work related to design and its manufacturing.

9. ACKNOWLEDGMENT

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AUTHORS PROFILE

Santosh S. Kumar is Assistant Professor in Department Of Mechanical Engineering at J D College Of engineering and Management, Nagpur. He has 4 years of teaching experience at Under Graduate Level. He received his Master's Degree in Design From Priyadarshini College of Engineering and Management, Nagpur in the year 2015.

Prabal G. Meshram is Under Graduate Scholar in Mechanical Engineering at J D College of Engineering and Management, Nagpur.

Shubham R. sahare is Under Graduate Scholar in Mechanical Engineering at J D College of Engineering and Management, Nagpur.

Rajaram B. Janagam is Under Graduate Scholar in Mechanical Engineering at J D College of Engineering and Management, Nagpur.

Kartik V. Gandhare is Under Graduate Scholar in Mechanical Engineering at J D College of Engineering and Management, Nagpur.

