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# An experimental approach for controlling centrifugal pump's cavitation

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**Abstract:**Cavitation phenomenon in the centrifugal pumps is one of the major faults that could lead to many catastrophic effects that would influence negatively on the production and pump's efficiency. Cavitation can be detected, maintained or even controlled. This paper proposed a new controlling method that works based on a simple programming and controlling system. Arduino controller, flow meter sensor, emergency control valve and a centrifugal pump are all used as a one unit where flow rates are continuously sensed and measured, and according to the pre-identified flow rates, system would react accordingly. This work presents such experimental setup to be as a monitoring and controlling system for the centrifugal pumps' cavitation.
**Keywords:**Centrifugal pump, cavitation, emergency control valve, flow rates.

## 1. Introduction

A comprehensive review of relevant research work carried out in the area of avoiding the cavitation due to low suction and to make best performance and efficiency. The simple meaning of cavitation is vaporization of liquid in the pump. When NPSHA (Net Positive Suction Head Available) is less than NPSHR (Net Positive Suction Head Required) the cavitation will occur. Also, can say when the pressure is less the liquid start boiling at room temperature that called cavitation [1].In the centrifugal pumps, the effects of cavitation are hydraulic performance will be reduced, the pump components will damage, high noise and vibration will generate. To prevent pump from these effects, the pumps have to be monitored to detect and diagnosis any problem at an early stage.At the discharge part, the acoustic data was measured and time domain was obtained. By using microphone, the acoustic signals were acquired at the different flow rates. At 200 mm, away from pump discharge port the microphone was placed. The receive signal from the microphone was sampled at 62.4KHz, to amplify the acoustic signal was used amplifier and to remove the signal that don't wanted was used low pass filter. The frequency range of low pass filter was set from 20 KHz to 2 KHz. The acoustic signals were collected at different flow rates. To change the flow rate do throttling on the discharge valves[2].

Chakra bortyet al.(2012) [3] conducted a study and found out that the centrifugal pumps which have impeller blades between 4-12. It has different RPM (2900, 3300, and 3700 rpm). The speed of pump increaseswithmore number of impeller blades.

In the study presented by (Zhang et al. (2014) [4], a study was conducted on the impact of impeller inlet on the pump performance. Different parameterswere designed in the impeller inlet and blade inlet. Positive results of pump performance were found.

Cavitation phenomenon is globally understood like formation of vapor bubbles in the fluid flow from a pressure drop below its vapor pressure. Due to its speedy and complex nature, cavitation detection requires sophisticated methods; otherwise it can only be noticed by its effects on the equipment like unusual noise, vibrations and material damage. In fluid machinery, based on the system physical and working conditions. Cavitation can appear under different forms, which after getting to its full development, present almost similar effects on the system characteristics. In the centrifugal pumps, cavitation performance mostly depends on the impeller geometric design such that, any geometry modification can result in a totally different performance. Therefore, the design process requires a more careful control, such that, through experimental and numerical methods, the centrifugal pumps performance can be well predicted where cavitation can be decreased to acceptable levels if not completely eliminated.

This paper is divided into four parts including introduction, namely, experimental setup, work methodology and conclusion.

## 2. Experimental Setup

The experimental setup is shown in Figure 1. Firstly, centrifugal pump has a power rating of 0.37 KW, head up to 40 m, monomeric suction lift up to 8 m, liquid temperature between -10 °C and +60 °C, ambient temperature up to +45 °C, Max. working pressure is 6.5 bar and the Max. speed for is pump is N = 2900 RPM.

Secondly, two pressure gauges were fixed at the suction and discharge to measure the pressure from both point. Thetwopressure gauges are used to measuring range pressure from 0 to 7 bar / 0 to 100 psi, temperature range is -20 to 60°C, and input size is 1/4" NPT M bottom.

Thirdly, flow meter sensor was fixed in suction to measure the flow rate. It has flow rate range 1 to 60L/min, water pressure: ≤ 2.0MPa, and the size for that flow meter sensor is 1 inch.

Fourthly, emergency control valve was fixed in discharge to avoid any back flow come when the centrifugal pump showdown condition. It has Max. pressure resistance of 1.0 Mpa, operation direct acting, material body is brass, port size is 1 inch and voltage range is ±10%.

Finally, Arduino is connected and programmed to parts like flow meter sensor, emergency control valve and centrifugal pump. Arduino UNO has digital I/O pins 14, Operating Voltage is 5V, analog input pin is 6. In addition, saving capacity is up to 32kb size.

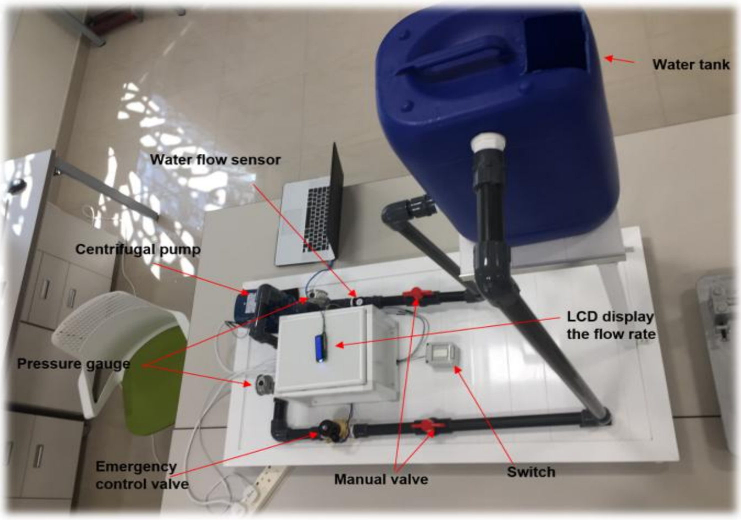


Figure 1: Experimental Setup

## 3. Working Methodology

The working methodology of this work is based on pump cavitation investigation. An emergency control valve is used and connected to Arduino controller. Flow meter sensor is used to measure the flow rate and connected to Arduino controller as well where it senses the flow rates and wherever, the cavitation may occur flow rate would be changed by increasing or decreasing. For this setup, flow rates are identified to be in a good condition when flow rates are from 9 L/min to 35 L/min. Therefore, flow meter sensor would send signals to Arduino and where ever flow rates are sensed at rates of above 35 L/min or below 9 L/min, Arduino would communicate with the emergency control valve. Control valve would give an order to pump to be showdown. Such working methodology is clearly shown in Figure2 and Figure3.

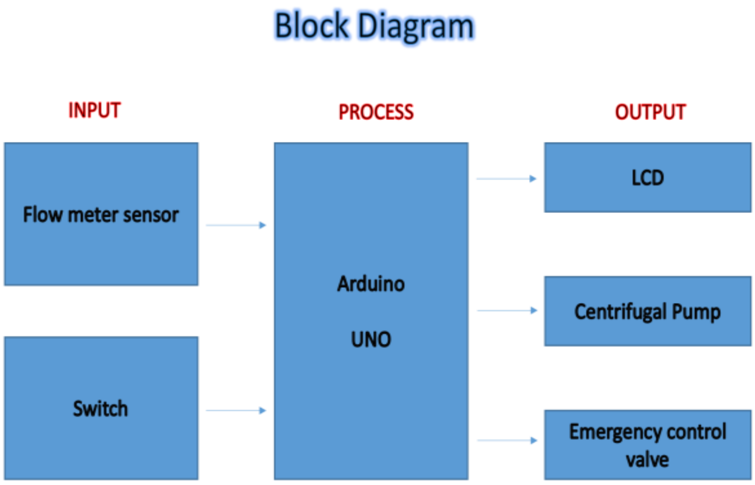


Figure 2: Block diagram of experimental work

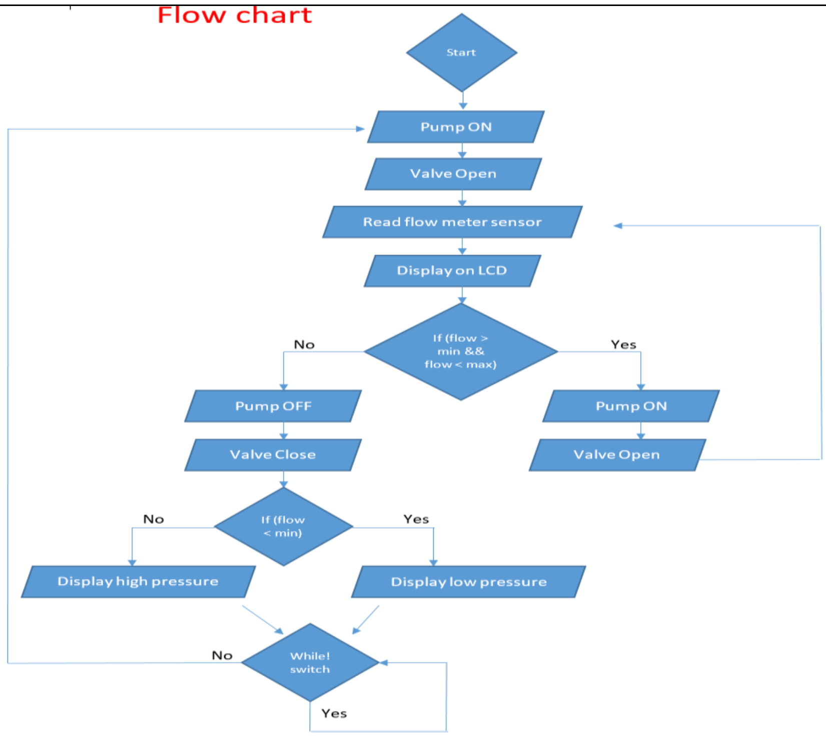


Figure 3: Flow chart of experimental work

## 4. Conclusion

This work has been tested and proved practically using a centrifugal pump experimental setup. The performance of such system was successfully verified to be as an effective cavitation controlling method since flow rates of the pump are continuously monitored to ensure flow rates in a range of 9 L/M to 35 L/M. Emergency control valve worked successfully as it keeps receiving signals from Arduino. Such systems is highly recommended for the centrifugal pumps where changes in flow rates could mean abnormal hydraulic forces such as cavitation.

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