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Modeling of GPM and LPM in Centrifugal Pump for Obtaining HydraulicFlow Pattern Types

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ABSTRACT: The types of hydraulic flow patterns in laboratory testing through the use of physical modeling tools often encounter several challenges when confronted with the use of empirical model scales,namely, the issue of scale. Water structures in the horizontal dimension do not experience highly complex issues because there are many measuring instruments available, whether self-made, home industry-produced, or industrial-grade. The presence of water volume in storage can only be testedat a clear scale, especially when it is already within a water tower (reservoir) installation with a specific height. Determining the need for water storage in a water tower is not an easy task to calculate due to differences in height, diameter, and storage capacity. Hydraulic experts often overlook these differences, which can become a problem when there is a demand for the volume of water during peak flow conditions.

The solution to this issue needs to be verified by conducting model tests using a device known asthe Centrifugal Pump, which has not been previously explored for laboratory research. GPM LPMmodel tests on this device make use of instruments and numerous pressure measuring tools supplied with pressurized water by a pump at specific, measurable volumes. To analyze the flow rate, flow coefficients, flow velocity, Reynolds number, Froude number, and test results with various speeds (speed meter), researchers test and measure the capacity of GPM LPM for each valve opening, starting with openings of 0.5, 0.75, 1.00, reading the instruments, shifting the speedfrom 1, 2, 3, 4, up to the highest speed, which is 12.

A graph is created to display the test results of the GPM LPM speed booster device, which containsan electric motor. The test is conducted with three repetitions for each valve opening, and the speedand travel time values from the instruments on the test device are recorded and mapped. Subsequently, the analysis results of the GPM LPM test are recommended to provide informationto construction planners of water structures. These results show that, under specific conditions ofdifferent speeds and valve openings, there are variations in the volume and travel time values. Thisinformation can be applied to determine the required storage capacity for each water tower buildingwith a hydraulic flow pattern based on Reynolds number (Re) and Froude number (Fr).

KEYWORDS: GPM LPM, Speed Pump Drive, flow pattern.

1. INTRODUCTION

The LPM GPM model in some tests is not as popular as other physical modeling tests in the fieldof research for determining flow patterns in various test equipment. The hydraulic flow patterns inlaboratory tests using physical modeling equipment often face challenges when compared to the use of empirical model scales, particularly with scale-related issues. For water structures in horizontal dimensions, these challenges are not very complex because many measuring instruments are readily available, either self-made or from home industries and industries.

The presence of water volume in reservoirs can only be tested with a clear scale, especially whenit is located within a water tower building (reservoir) at a certain height. The calculation of the water storage needs in a water tower is not easy due to differences in height, diameter, and storage.Hydraulic experts often overlook these differences, which can become a problem when there is a demand for the volume of water during peak flow conditions.

To address this issue, it is necessary to conduct tests using a tool known as the Centrifugal Pump,which has not been explored for laboratory research. The GPM LPM model tests on this equipmentprovide various instruments and numerous pressure measuring devices supplied with pressurizedwater by a pump at a specific volume. To analyze the discharge, flow coefficient, flow velocity, Reynolds number, Froude number, and test results with various speeds (speed meter), researcherstested and measured the capacity of GPM LPM for each valve opening, starting with openings of0.5, 0.75, 1.00, and so on, reading the instruments, shifting from speeds 1, 2, 3, 4, up to the highest speed, which is 12. They created a graph of the GPM LPM test results for the speed controller, which contains an electric motor, and conducted three tests for each valve opening, recording andmapping the speed and travel time values from the instrument on the test equipment.

Furthermore, the research recommends the analysis of the GPM LPM test results to provide information to water structure construction planners that the test results with various speeds and valve openings under specific conditions have different volume values and travel times. This information can be applied to water towers in tall buildings to determine the required storage capacity for each water tower building with hydraulic flow patterns characterized by Reynolds number (Re) and Froude number

2. LITERATURE REVIEW

1. GPM LPM.

GPM LPM is a measurement tool used to transfer liquids in a tube by converting the kinetic energy into pressure energy. This means that the faster the flow generated by the pump, the higher the pressure produced, allowing water to be distributed to other places more quickly and evenly (Hamden, 2012). A centrifugal pump is a device designed to convert rotational energy into kineticenergy. It is used to transport fluids by converting the kinetic energy of rotation into hydrodynamicenergy from the fluid flow. The rotational energy typically comes from an engine or an electric motor. Centrifugal pumps are used to induce flow or increase the pressure of the fluid. The principle of operating this device is to create a pressure difference between the inlet and outlet. Inother words, the pump functions to convert mechanical energy from a source (the driver) into kinetic energy (velocity), which overcomes any obstacles along the flow path. One type of non- positive displacement pump, meaning that centrifugal pumps work by converting the kinetic energy of the fluid into potential (dynamic) energy through an impeller that rotates within a casing.The impeller functions to convert the mechanical energy from the pump into the velocity energy of the continuously pumped fluid that fills the void created by the displacement of the previouslyentered fluid. In the "Centrifugal Pump" device, it can be connected with a speed pump drive andthe GPM LPM vessel in one circuit.

2. Looping Model.

Looping refers to the prediction and modeling of river flood wave propagation after a disaster inthe city of Nimes, France. Using the 1D routing method in a laboratory, the velocity propagation in the Nimes pipe network is simulated unsteadily (Andre Paguler, 1988). Looping involves predicting the propagation of flood waves in cases of dam breaks and calibrating them with 1D experiments in the laboratory at the University of Mississippi, USA. Head loss can be simulated using a variety of valve opening weights (Xinya Ying, 2014). Looping also involves conducting physical flow experiments with wave propagation using finite element methods compared to laboratory experiments. It turns out that the compressible flow method can simulate head loss propagation (A. Kaceniauskas, 2015). Looping the flow of water in a pipe network with various valve openings can detect differences in flow rates based on different valve opening conditions (Irianto, 2011).

3. Spesifik Force.

Specific Force is the force exerted by water on a pipe or a device section due to differences in energy and water pressure when there is a decrease in pressure or an increase in pressure in flow that can be compressed within the pipe (compressible flow).

3. RESEARCH METHODS

The research method is detailed as follows:

1. Setting and Research Characteristics

   The research was conducted on a Centrifugal Pump laboratory apparatus at the WaterEngineering Department of Unesa.

2. Research Procedure

   a. Research Simulation involved conducting flow tests on the apparatus with 2 valve variations. Pressure and suction, GPM and LPM tubes. The research was carried out from Juneto November 2019.

   b. Target points for the apparatus and research steps:

Equipment Used:

1. A set of Centrifugal Pump equipment, Speed meter pump.
2. Stopwatch.
3. Tubes for containing test water.
4. GPM and LPM measuring test tubes to measure volume.
5. Writing materials for recording data.

Working Steps:

1. Prepare the above-mentioned equipment.
2. Prepare the measuring test tubes used to contain water during the research.
3. Measure the diameter and height of the tubes to calculate volume.
4. Set treatments/actions on each pressure/suction valve with combinations of 1 ½ and 3/4openings.
5. Set treatments/actions for the speed meter pump drive with combinations of positions 1, 2,3, 4.

Variables:

Time taken from the speed meter pump to valve 1 with a 1-inch diameter pipe, the distance from the speed meter pump to valve 1 → X1 meters, speed meter pump to valve 2 with a 1-inch diameter pipe, the distance from the speed meter pump to valve 2 → X2 meters.

Observation and Evaluation

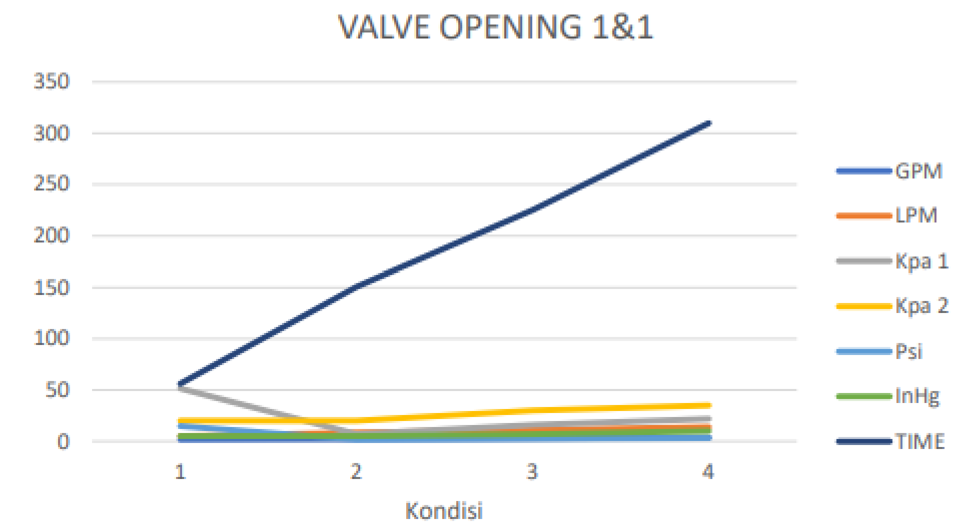
Observation: Observing and creating a data report on constant flow tests with various valve openings in two pressure and suction positions using the Centrifugal Pump apparatus in the Water Engineering Laboratory at Unesa.

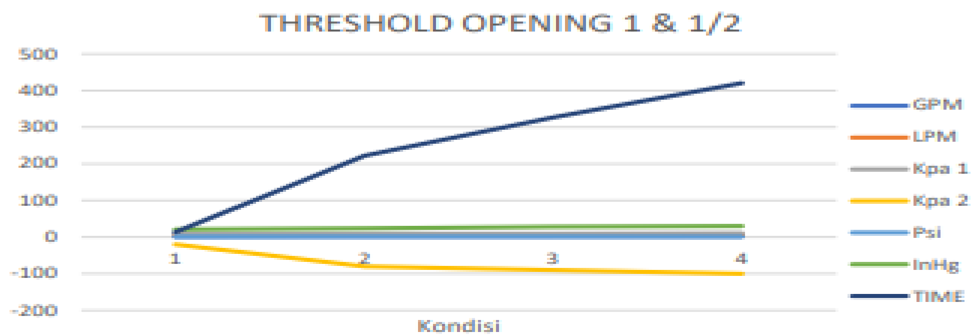
Evaluation: Evaluation is conducted jointly with the research team and water engineering technicians who are competent to participate in water flow testing with the Centrifugal Pump apparatus.

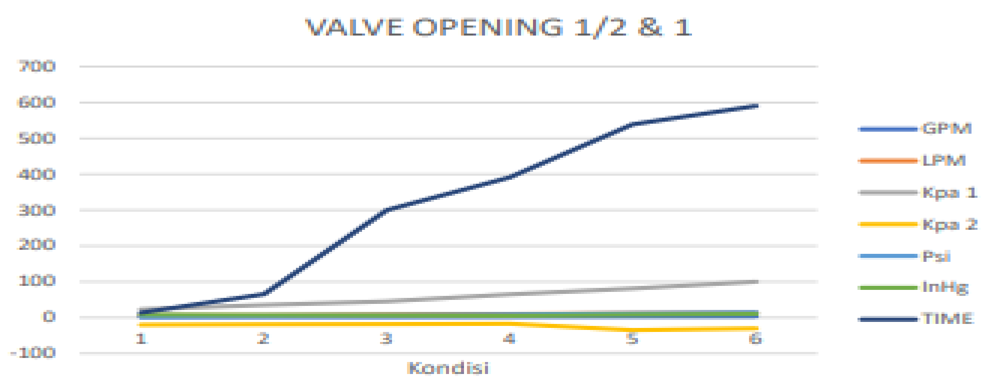
Analysis:

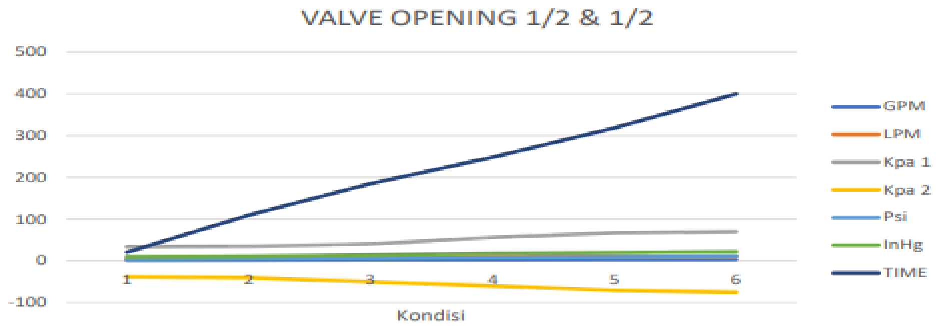
The recorded data is processed and discussed with observers regarding the advantages of GPMand LPM testing using the Centrifugal Pump apparatus in the looping process. This data is thendescribed as material for the preparation of the final report, the creation of a jobsheet, and an online journal called Icracos.

4. RESULTS AND DISCUSSION









CONCLUTION

1. From the three experiments, with valve openings of 1 and 1; 1 and ½; ½ and 1; ½ and ½, thereal flow rates Q were obtained as follows:

Since the pump's Q = 10 - 28 l/minute, then:

- 1 and 1 opening
  Real Q = 1.74 l/minute, which does not fall within the Qpump range, indicating a Head lossevent.
- 1 and ½ opening
  Real Q = 7.06 l/minute, which does not fall within the Qpump range, indicating a Head lossevent.
- ½ and 1 opening
  Real Q = 6.16 l/minute, which does not fall within the Qpump range, indicating a Head lossevent.
- ½ and ½ opening
  Real Q = 4.65 l/minute, which does not fall within the Qpump range, indicating a Head lossevent.

2. From the three experiments, with valve openings of 1 and 1; 1 and ½; ½ and 1; ½ and ½, theReynolds Number (Re) results were obtained as follows:

- 1 and 1 opening
  Re = 2.22, falls into laminar flow because the Re value is < 500.
- 1 and ½ openingRe = 9.08, falls into laminar flow because the Re value is < 500.
- ½ and 1 opening
  Re = 7.70, falls into laminar flow because the Re value is < 500.
- ½ and ½ opening
  Re = 5.98, falls into laminar flow because the Re value is < 500.

3. From the three experiments, with valve openings of 1 and 1; 1 and ½; ½ and 1; ½ and ½, theflow characteristics were determined as follows:

The flow characteristics in the centrifugal pump with valve openings of 1 and 1; 1 and ½; ½ and1; ½ and ½ are categorized as Subcritical Laminar Flow because the Fr value is smaller than 1, and the Re value falls within the laminar range.

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