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The Manufacturing of Installation Series and Parallel Pump Test Tool

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Abstract:- Pumps are one of the most frequently used tools by humans in their daily lives. The function of the pump is to raise a fluid from a low surface to a higher surface. To meet the working pressure and fluid flow capacity requirements in a pump operating system, it can perform single, series and parallel circuits. In the world of education, an educator is said to be successful if it produces quality graduates. Quality means that student graduates can understand and apply all the knowledge gained while working. An engineer must be able to know the characteristics of various types of pumps, one of which is a centrifugal pump. This is done so that the engineer can use the tool according to the needs of the job. This is done so that the engineer can use the tool according to the needs of the job. One way to get this is to provide props or pump test equipment. Therefore, the purpose of this study is to design and build series and parallel pump test equipment that can be used for student practicum. The research methods carried out include the design of 3D series and parallel pump test equipment, the process of manufacturing test equipment, assembling the electrical wiring of pump test equipment and conducting tests. The final result of this study is that series and parallel pump test equipment can be used for practicum testing.

Keywords:- *Pumps; Test Equipment; Series Pumps; Parallel Pumps.*

I. INTRODUCTION

The pump is one of humans' most frequently used tools in their daily lives [1]. Both in the city and in the countryside, pumps are crucial to their existence [2]. A pump's function is to move fluid from a lower surface to a higher surface [3]. The blade's mechanical work allows the fluid entering the pump to move [4]. Industries and homes widely use centrifugal pumps. Centrifugal pumps are chosen because of their simple shape and lower price compared to other pumps [5]. Creating a plumbing system is one way for a pump to perform well. This design has become one of the most important steps when assembling a pump system [6].

The centrifugal pump consists of two parts, namely the impeller and the pump casing. The impeller rotates to create centrifugal force, allowing it to transfer mechanical energy from the pump shaft to the fluid. Meanwhile, the pump casing functions to direct the fluid into the impeller. In addition, it can convert kinetic energy into pressure [7]. To meet the needs of working pressure and fluid flow capacity in a pump operation system, one can arrange them in single, series, and parallel configurations. If the working pressure and fluid flow capacity are below the pump's working pressure and flow capacity, a single centrifugal pump operation can be used. A series pump operation is necessary if a system demands a high working pressure that a single pump operation cannot achieve. If a system requires a flow capacity greater than that of a single pump operation, a parallel pump operation is performed [8][9][5].

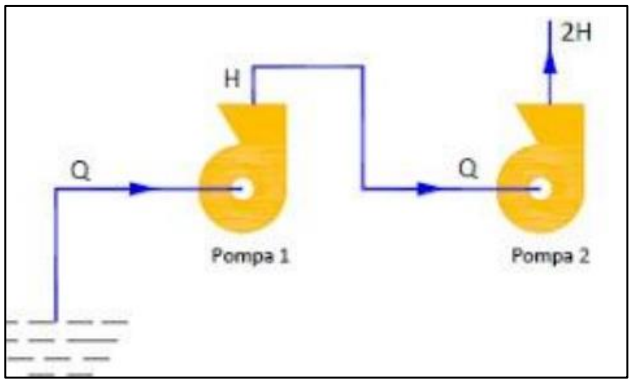

Fig 1: Illustrates the Arrangement of Pumps in Series
Source: [7]

Pumps can operate in parallel in addition to a series arrangement. This arrangement not only increases the flow capacity but also allows for the repair or replacement of a single pump without disrupting the system. Fig. 2 shows the arrangement of the pump circuit in parallel.

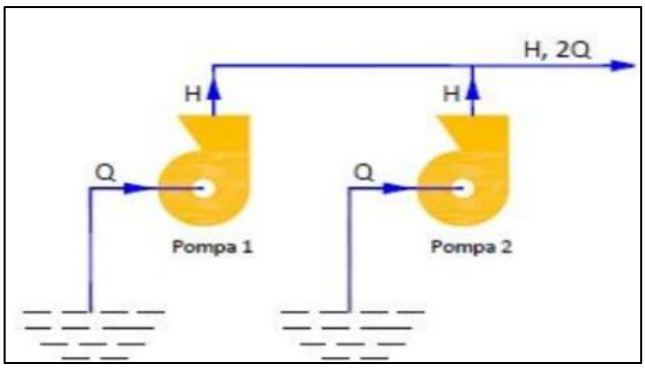

Fig 2: Illustrates the Arrangement of Pumps in Parallel.
Source: [7]

Using the Bernoulli's law formula, we can determine the pump performance as follows [10][1]:

$$\frac{P_1}{\rho g} + \frac{1}{2g}V_1^2 + Z_1 = \frac{P_2}{\rho g} + \frac{1}{2g}V_2^2 + Z_2 = h_p \quad (1)$$

P = Fluid pressure (Watt)
ρ = Density of water (kg/m³)
g = gravitational acceleration (m/s²)
V = fluid flow velocity (m/s)
z = height of the point (m)
h = height of the water pump head (m)

A pump's capacity refers to its ability to flow fluid within a specific time frame. The unit of pump capacity is m3/hour or m3/second. Equation (2) is the formula for pump capacity [7].

$$Q = \frac{v}{t} \quad (m^3/s) \quad (2)$$

Q = pump capacity (m3/s)
V = volume of air being pumped (m3)
t = pump time (s)

The definition of a head pump is the energy per unit weight provided so that the fluid can flow according to the pump system conditions. Head pump can also be defined as the pressure to flow the fluid. This pump head is measured in meters (m). Equation 3 is the formula for the pump head [11].

$$H = h_a + \Delta h_p + h_1 + \frac{v^2 d}{2g} \quad (3)$$

H = Head pump (m)
ha = Head statis (m)
Δhp = The difference in water pressure between two surfaces (m)
h1 = Head loss (m)
v = Average water velocity in the pipe
d = pipe diameter (m)

For the head of a single pump, it is calculated using equation 4. Equation 5 calculates the head of a series pump. Equation (6) calculates the head of a parallel pump [7].

$$H = H_d - H_s \quad (m) \quad (4)$$

$$H_{seri} = (H_{d1} - H_{s1}) + (H_{d2} - H_{s2}) \quad (m) \quad (5)$$

$$H_{paralel} = \frac{(H_{d1} - H_{s1}) + (H_{d2} - H_{s2})}{2} \quad (m) \quad (6)$$

Power is the work done per unit of time. The unit of power is a Watt, or HP. In a pump system, there is hydraulic power and electrical power. The fluid requires hydraulic power to flow. Hydraulic power can be calculated using equation (7). Meanwhile, electrical power is calculated using equation (8). Next, to determine the pump efficiency, it is obtained using equation (9) [7][6][12].

$$P_{pompa} = \rho g Q H \quad (Watt) \quad (7)$$

ρ = fluid density (kg/m3)
g = gravitational acceleration (m/s²)
Q = flow rate (m3/s)
H = pump head (m)

$$P_{listrik} = VI \cos \emptyset \quad (Watt) \quad (8)$$

V = Voltage (V)
I = Electric current (A)
cos Ø = Power factor (value = 0.85)

$$\eta = \frac{P_{pompa}}{P_{listrik}} x100\% \quad (9)$$

P_{pump} = Hydraulic power (Watt)
$P_{electricity}$ = Electric power (Watt)

A successful educator in the world of education is one who produces high-quality graduates. Quality means that graduates can understand and apply all the knowledge they have gained while working. An engineer must be able to understand the characteristics of various types of pumps, one of which is the centrifugal pump. This allows the engineer to utilize the tool in accordance with the job requirements. One way to achieve this is by providing demonstration tools or pump testing equipment. Therefore, this research aims to develop series and parallel pump testing equipment suitable for student practical.

II. RESEARCH METHODS

This research employed an experimental approach. This research led to the creation of a series and parallel pump testing device. Fig. 3 presents the flowchart.

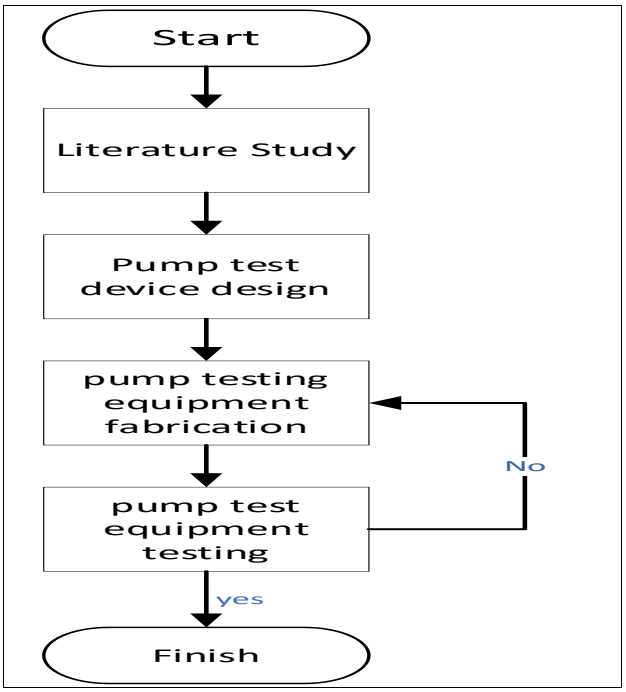

Fig 3: Research Flowchart

The first stage is the literature review. At this stage, the team gathers data and conducts a literature review of several research papers that are pertinent to the upcoming research.

The second stage is the design of the pump testing device. The equipment design phase involves 1) determining the dimensions of the accessories and tools for use, 2) conducting measurement simulations for the equipment frame, 3) designing the system piping, and 4) determining the placement of measuring instruments in the system. The entire design uses Catia software.

The third stage is the construction of the tool. In this stage, the following steps are taken: 1) constructing the test tool frame; 2) assembling the test tool. The pump test tool features the following dimensions:

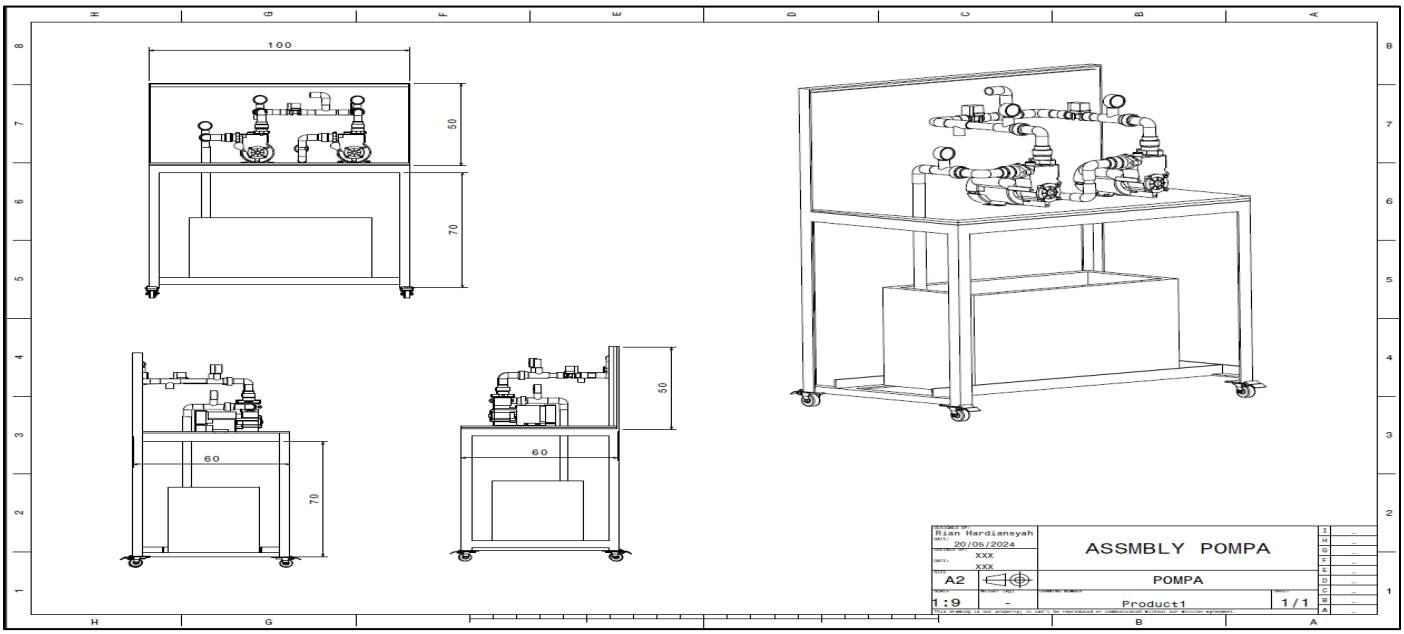

Fig 4: Pump Assembly

The final stage is equipment testing. During this stage, we use the testing equipment to 1) check for leaks in the pump piping system and 2) evaluate the performance of the series and parallel pump circuits.

III. RESULT AND DISCUSSION

➢ *The Results Obtained from this Research are Divided into Three Parts:*

- Manufacturing the pump mounting frame
- Assembly of the pump installation
- Pump testing

Students assisted in the construction of the pump mounting frame for the pump testing process. Figure 5 presents the results of the pump mounting frame making process, Fig. 6 details the pump testing equipment assembly process, and Fig. 7 details the pipe leakage testing.

Fig 5: Process of Making the Pump Mount Frame

➢ *The Stages Involved in the Process of Making the Pump Mounting Frame are:*

- Measurement and cutting of angle iron according to the working drawing.
- Cutting plywood and acrylic according to the working drawings.
- Welding the angle iron according to the working drawing.
- Painting the pump mounting frame.
- Installation of plywood and acrylic on the frame.

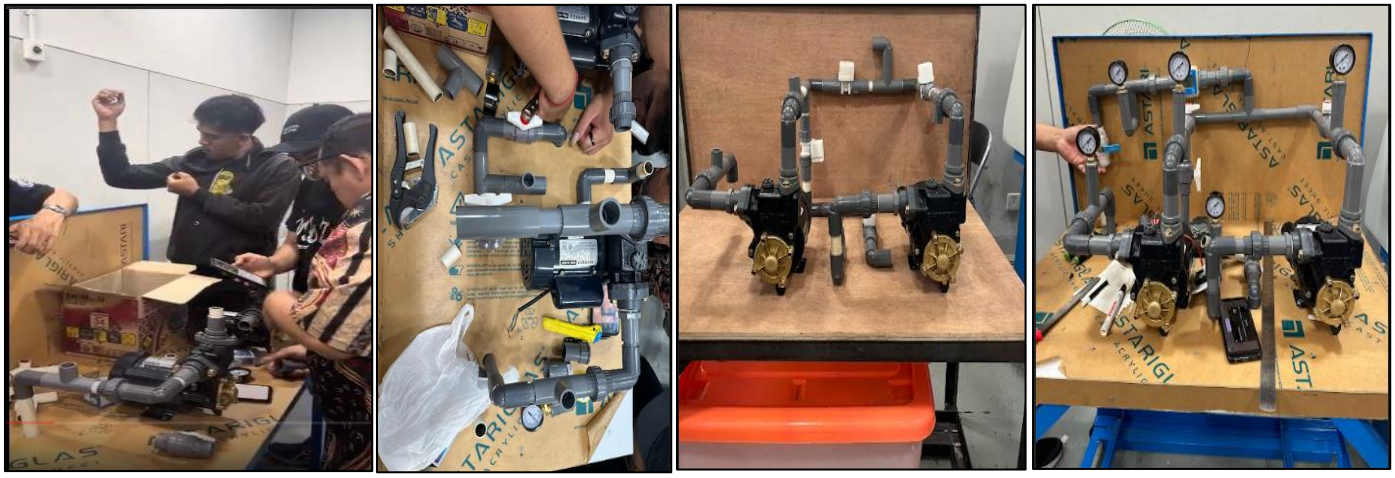

Fig 6: Pump Test Equipment Assembly Process

➢ *The Pump Test Equipment Assembly Process Involves the Following Stages:*

- Conduct measurements for the necessary measuring instruments, pumps, and pipes.
- Conducting the arrangement of measuring instruments and pipes.
- The task involves assembling measuring instruments, pumps, pipes, and other supporting accessories.
- Tightening pipes with measuring tools, pumps, and other accessories

The final stage is the testing of the measuring instrument. The testing is conducted in two phases. The first stage involves conducting a pipe leak test. The results indicate the presence of a single leak point. The solution to this problem is to add a seal and adhesive and let it sit for 1 x 24 hours. The next day, a leak test was conducted again, and the result showed that there were no leaking pipes. The second stage involves testing the operation of the tool. Valve openings were performed according to both series and parallel circuits. As a result, the system operated according to the working principles of series and parallel pump circuits.

Fig 7: Leak Testing Process for Pump Test Equipment

Fig 8: Final Results of the Pump Testing Equipment

IV. CONCLUSION

The conclusion of this research is that the research team was able to create a testing device for series and parallel pumps. This series and parallel pump testing device have been tested and can be used for testing both series and parallel pump circuits. The recommendation for future research is to conduct a continuation study on the analysis of the characteristics of water pump properties—whether the pump operates individually, in series, or in parallel.

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