Implementation of Microcontroller in Lubricant Viscosity Measurement Tool

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Abstract*—Viscosity Measurement Tool is a measuring instrument model used to measure the viscosity of a liquid and in this case is a lubricant. The Viscosity Measurement tool is equipped with a mechatronic system that uses a free-falling steel ball to measure the viscosity of the lubricating oil. This study uses research and development methods, namely the research methods used to produce and test the effectiveness of these products. In this project, the Arduino Mega microcontroller is used as a controller to measure the fall of the ball from the top to the bottom of the tube; the sensor will detect the ball in the tube where the sensor will activate and turn off the time. The ball travel time data that has been stopped by the sensor system on the Arduino Mega microcontroller is then entered into the viscosity time value on the Liquid Crystal Display (LCD) screen. The lubricants to be measured are multigrade lubricants commonly used by Pertamina Shell Tellus S3 M 46, Shell Tonna S2 M 68, Pertamina RORED EPA 90 in the laboratory maintenance area. The results of this study are close to accurate and stable values.

Keywords—viscosity, viscosity measurement tool, mechatronics, falling ball method.

I. INTRODUCTION

Viscosity is a method used to measure the viscosity of a liquid flow. This type of liquid is said to have a low viscosity if the substance is easy to flow, whereas if it is difficult to flow, this type of liquid has a high viscosity [1]. The viscosity value of lubricating oil in manufacturing industrial machines is very important because it determines the flow rate of lubricating oil related to the speed of the manufacturing industry engine [2], the quality of the engine itself, and also the viscosity value which can be measured by using a viscosity meter or viscometer [3]. The use of the viscometer itself has been applied to one of the maintenance practices at the Astra Manufacturing Polytechnic manually by using the operator's hand where the ball is dropped into the tube and the stopwatch must be pressed simultaneously as shown in Fig. 1.

Fig. 1. The process of measuring viscosity using the manual method

The following are the results of measurements made by several operators. It was found that different measurements were made because they were carried out by the manual method by alternating operators so that the results were said to be almost inaccurate, while the required results would later be used to determine the suitable lubricant for a machine. Measuring the speed of a falling ball is usually done by recording the time it takes to cover a certain distance [4-6].

The objectives of this work are.

- To develop a measuring tool for viscosity measurement that can improve accurate measurement results.
- This tool works automatically, measuring by using sensors.
- To develop a falling ball viscometer for measuring lubricating oil viscosity.
- To determine the value of viscosity of the lubricant oil.

II. RESEARCH METHODOLGY

A. *Research Design*

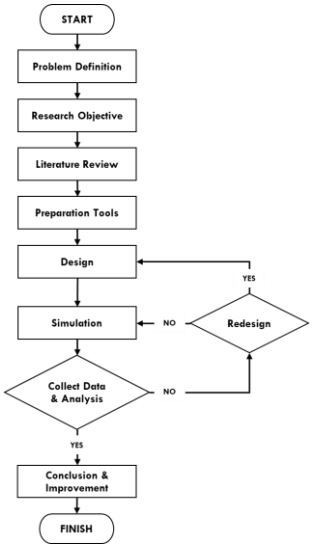

Fig. 2. Research strategy flowchart

Referring to Fig. 2, this research begins with field observations of the problems that occur in the field, especially in measuring the viscosity of the oil in the lubricants and the practicum lubricants. From the findings of the existing problems, one problem was taken for research. The initial step is searching and deepening the literature related to the research to be carried out. The next step is to design measuring and simulation tools with simulations for simulation and data analysis. If there is a mismatch in the simulation, then an analysis related to the design of the tool and the data processing will be carried out.

B. *Design Viscosity Measurement Tool*

The design of the device consists of a microcontroller and other various electrical and mechanical components such as steel balls, transparent glass tubes, and acrylic frames as shown in Fig. 3.

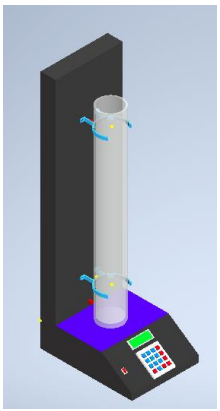

Fig. 3. 3D lubricating oil viscosity measurement tool design

C. *Tool & Material*

1. Arduino ATmega2560.

   Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input / output pins (15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 16 MHz crystal oscillator, USB connection, power jack, ICSP header and reset button.

2. Inductive Proximity Sensor.

   One component in this study namely Proximity Switch or Proximity Sensor is a detection device that works based on the object's distance to the sensor. Inductive proximity functions to detect iron/metal objects. Even though it is blocked by non-metal objects, the sensor will still be able to detect as long as it is within the normal sensing distance (value) or its range.

3. LCD.

   This research uses lcd display. LCD 16X2 Green Black 16x2 I2C IIC is a type of display or media display of liquid crystal material as the main performer.

D. *Wiring Diagram.*

Fig. 4 is showing a wiring diagram for a viscosity measurement tool.

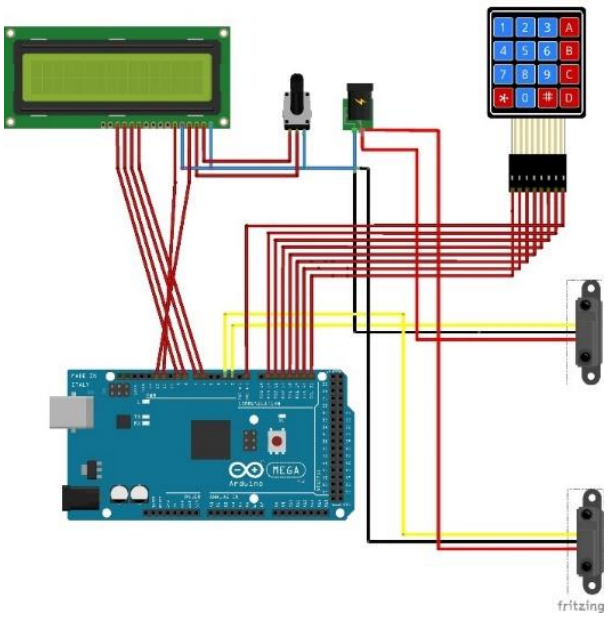

Fig. 4. Wiring Diagram

E. Flow Diagram

Fig. 5 and Fig. 6 are showing a flow diagram and viscosity measurement tool.

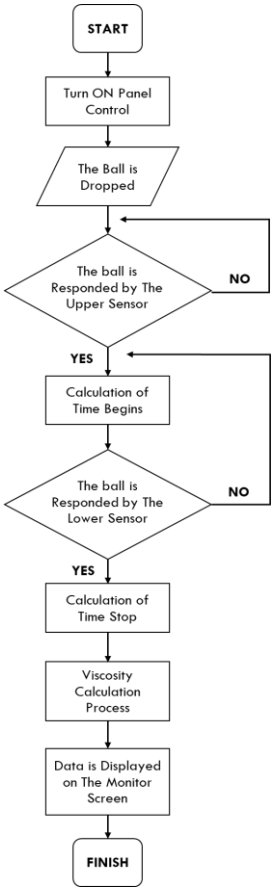

Fig.5. Flow diagram.

III. RESULTS AND DISCUSSIONS

A. *The Results of Viscosity Measurement Tool Design*

The lubricant viscosity measurement tool consists of two parts, namely the measuring tube and the timer section.

The following is a work system that takes place on a viscosity measuring instrument:

1. Program Arduino with the Viscosity formula
2. Receiving input from Numpad for input of measured oil density
3. The LCD display is the result of the Viscosity Coefficient

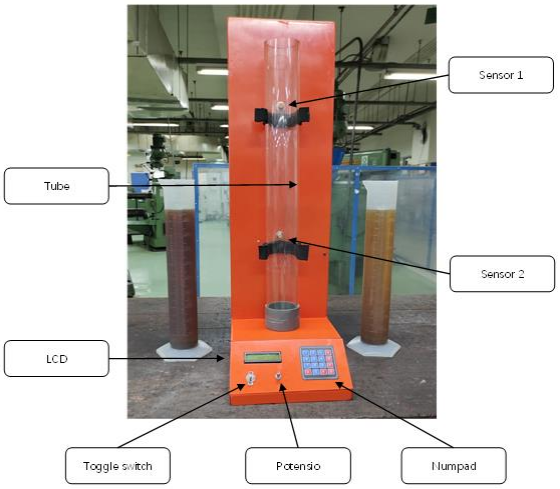

Fig. 6. Viscosity measurement tool

B. *Viscositymeter Performance System*

In the process, the design of the falling ball viscometer measuring instrument was tested, it was carried out to determine the relationship between the falling time and the speed of the ball. So that the ball terminal velocity will be obtained and used to calculate the viscosity value of the fluid being tested. As for what can be seen in this test is the time (t) the ball fell as measured using an inductive proximity sensor.

The test procedure performed at the time of data collection is as follows:

1. The solid iron ball is put into a tube containing 1 L of oil.
2. Enter the density of the solid ball used to measure the viscosity.
3. The amount entered will be displayed on the LCD.
4. The ball touches the first sensor, the sensor works and activates Arduino to start timing.
5. The ball touches the second sensor, the sensor works and stops the timer on the Arduino and displays on the LCD output along with the result of the viscosity coefficient.
6. The results of the calculation according to the viscosity formula above will be displayed on the LCD.

C. *Analysis Data*

After testing, the test results data will be analyzed and compared with the graph of the relationship between the time and the speed of the ball falls as shown in Fig. 7 and Fig. 8.

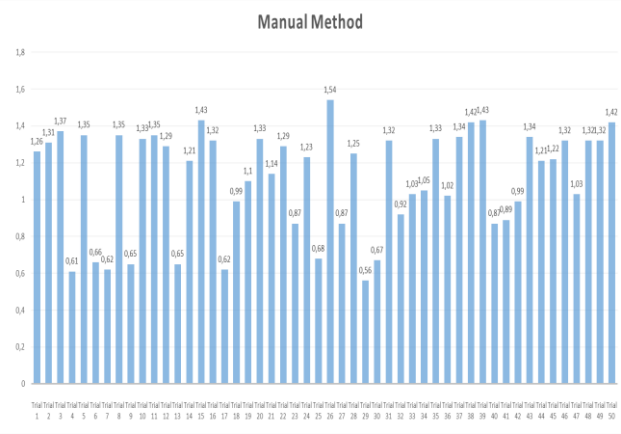

Fig. 7. The manual method measurement with a standard deviation of 27%

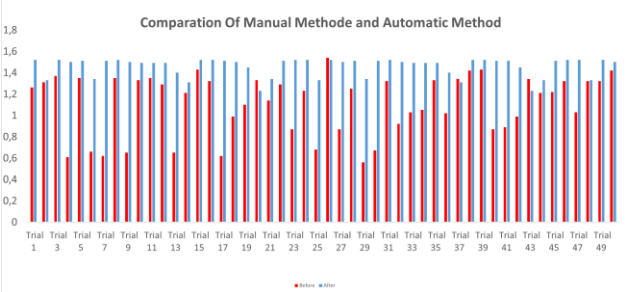

Fig.8. An automatic method measurement with a standard deviation of 8%

D. Discussions

The experimental process was carried out after the tools were assembled and programmed. Experiments were carried out in actual conditions where the tool would be used for Polman Astra practicum students to measure the viscosity of the oil. During the experiment, several previously unexpected conditions were discovered. Oil was spilt when poured leaking the seat part from the tube, thus cleaning was performed when measuring 1 lubricant, and will be used for other lubricants. To overcome this problem, corrective action was taken by providing additional tools in the form of seals and placing a position lower than the practicum student.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- This study has developed a lubricating oil viscosity measurement tool using a microcontroller based free-falling ball.
- The viscosity measurement tool that has been made consists of two parts, namely the measuring tube and the timer section. The tube section has the main frame components, glass tube, upper proximity sensor, lower proximity sensor. The timer section has several components such as a power terminal, LCD screen, reset button, sensor connector socket, and microcontroller circuit.

Recomendations

- Viscosity measurement can be done by scanning in a liquid with a high color density. The next viscometer made is better to use a metal detector sensor so that steel balls are used.
- It can be done in a variety of ways. Further research can be carried out by varying the weight of the steel ball and by varying the distance between the sensors.

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