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Heavy Dusty Over Head Stirrer Design and Construction

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Abstract. This study aims to evaluate the performance of a designed overhead stirrer, specifically focusing on the accuracy of rotational speed (RPM) and time control (timer). Speed testing was conducted using a Fluke 931 tachometer as a reference instrument, while a digital stopwatch was used for time measurement. Speed tests were carried out at four levels: 500 RPM, 1000 RPM, 1500 RPM, and 2000 RPM, with three repetitions for each. The results showed error percentages of 1.27%, 0.033%, 0.133%, and 0.1165%, respectively. All values remained within the acceptable error tolerance of ±10%, indicating that the speed control system operates accurately and consistently. Timer functionality was tested at preset durations of 3 minutes (180 seconds), 6 minutes (360 seconds), and 9 minutes (540 seconds), each repeated three times. The test results showed a time deviation of 0.34 seconds at 3 minutes, no deviation at 6 minutes, and a deviation of 2.67 seconds at 9 minutes. These results indicate that the timer also performs with a high level of precision. Overall, the tested overhead stirrer has met the standards for measurement accuracy in both speed and time. This demonstrates that the device is suitable for laboratory or research applications that require controlled mixing of liquids with precise timing and speed regulation measurement area.

Keywords: overhead stirrer, speed testing, timer, accuracy, tachometer, stopwatch

1. Background

Laboratory field chemistry need ingredients mixer Which added into the solution/substance chemistry which will be studied. In order for the substances liquid can be mixed evenly so that homogeneous properties can be obtained, a stirrer is needed that can mix these liquids. Many industries process materials that have high viscosity such as pastes, gels, resins, and other thick liquids. Ordinary stirrers (light stirrers) are unable to handle this load, so a high-powered stirrer (heavy duty) is needed . Conventional stirrers are only suitable for small volumes and thin liquids. When used for heavy materials, motor wear, overheating, or uneven mixing often occurs. Therefore, an overhead stirrer with a strong motor and high torque was created.

However, in reality, not all overhead stirrers are capable of handling materials with high viscosity or large volumes. Conventional tools generally have limitations in motor torque and mechanical durability, making them ineffective when used to mix viscous solutions, such as resins, pastes, chemical sludge, or cosmetic raw materials (Nasir et al., 2021). This can hamper the production or research process and even damage the tool if used continuously beyond its capacity. Therefore, a tool is needed that is able to work stably under heavy load and high viscosity conditions , known as the Heavy Duty Overhead Stirrer . This tool is designed with high-powered motor specifications, variable speed drive, and cooling and overload safety systems. This tool is important not only in industry, but also in engineering education for research, practicum, and prototype purposes.

A Stirrer tool is required with a stirrer speed setting and a timer. With the stirring time setting, it is expected to make it easier for users to set the sample stirring time so that users no longer need to estimate the sample stirring time. After the user has set the stirrer speed and time setting, the user can let tool the Work until stirring from sample the has been completed in accordance with the specified time period .

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2. Research Methods

The benefit of this research is that by adjusting the stirrer speed and stirring time, it is expected to help make it easier for laboratory staff to mix a solution consistently and for the right amount of time so that laboratory staff no longer need to use time estimates to determine the length of time for stirring the solution.

The third research by Isti'ah Ira (2017) in the research on "Design and Construction of Magnetic Stirrer Hotplate Based on Atmega8 Microcontroller". In this research, the hotplate is equipped with a temperature and rotation speed regulator which is controlled by pressing the up or down button, but this determination has not been carried out yet. equipped with thermometer automatic Which can measure direct temperature changes in the solution.

Study Second Alona Situmeang, ST., MT And Rika Daily (2016) in a study entitled "Design of Magnetic Stirrer With Solution Options Using Arduino Uno Based Controller System". In this study, the options used are less using LM35 sensors so that the sensor is still in direct contact with the solution being mixed .

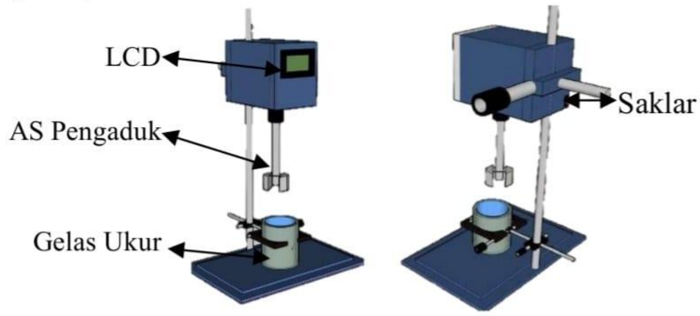


Figure 1 Heavy Dusty Over Head Stirrer

Supporting Technology Components

- Nextion LCD
- DC Motor
- Buzzer
- Arduino UNO Microcontroller
- O ptocoupler sensor
- On/Off Switch
- Power Supply

3. Research Methods

Mixing done with or without a stirring rod, usually stirring without a stirring rod is done by shaking the liquid container left and right repeatedly, Stirring can be done manually (moved by hand) or automatically (using electronic equipment). One of the electronic stirring machines that is often used in research laboratories, especially research using liquids/chemicals, is the hot plate magnetic stirrer.

Hot plate magnetic stirrer is a laboratory equipment used to heat and stir one solution with another solution which aims to make a homogeneous solution with the help of a magnetic rod (stir bar) stirring. The vessel or measuring cup containing the solution is placed on the plate and stirred by the stir bar. In this study, a Hot Plate Magnetic Stirrer tool was made which can control the stirring time, the desired solution temperature and the stirring rotation speed as desired. In controlling the time, temperature and speed can be adjusted via a 4x4 keypad.

3.1 System Design

Block diagram functioning For make it easier somebody in understand how Work tool That Alone. Picture 1 shows the block diagram of the overall design stage of the components used in the manufacturing process of the heavy dusty over head stirrer design. The Arduino Uno-based control system uses a 220V AC power supply which is reduced to 12V DC via a power supply, then regulated again using the LM2596 module to produce a 5V voltage to supply the optocoupler sensor and the Nextion screen. The LCD functions as an input that provides data or commands to be processed by the Arduino Uno to drive the DC motor, the LCD also functions as output Which will display results read sensor optocoupler Which already processed on arduino uno

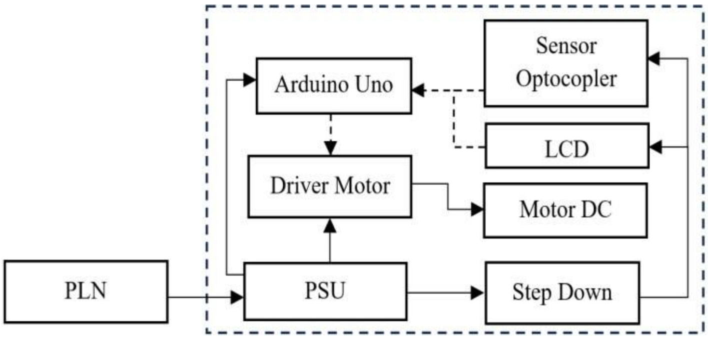


Figure 2 Block diagram

3.2 Program Algorithm (Flowchart)

Flow Chart or flow diagram is a diagram with symbols. graphic which states the flow of an algorithm or process which displays the steps Which in symbolize in form box box along with order by connecting each step with an arrow. To find out the working principle of the heavy dusty over head stirrer.

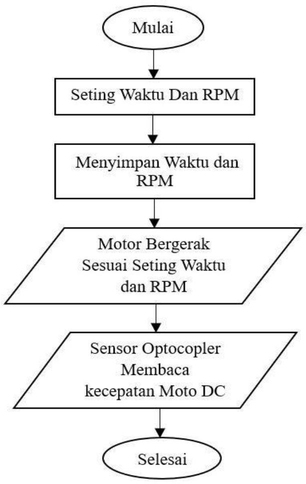


Figure 3 Flowchart of programming flow

3.3 Overall Circuit and Tool Design

All components are arranged in a closed system using a heat-resistant metal frame. The position of the control buttons, LCD, and heater are arranged ergonomically.

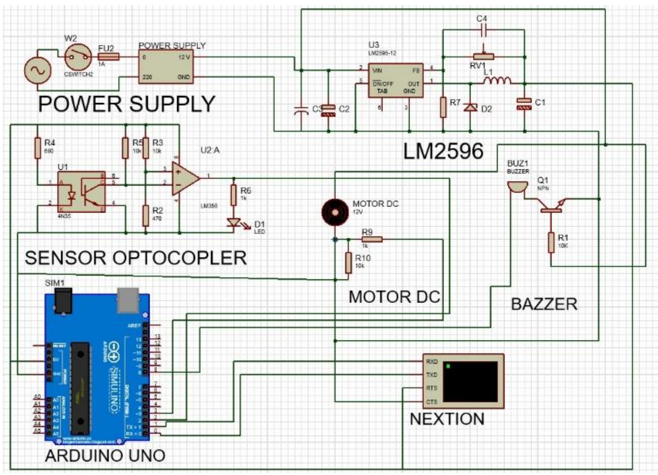


Figure 4 Overall circuit

4. Results And Discussion

Testing speed use comparator tachometer Fluke type 931 with a speed setting of 500 rpm for 3 repetitions, 1000 rpm for 3 repetitions 3 time repetition,1,500 rpm as much as 3 time repetition, and 2000 rpm as much as 3 time repetition Results from measurement can seen on the following table:

Table 1. Test function rpm 500

Testing speed (rpm)		
	Tool design build	a tachometer
1.	500	493.5
2.	500	496
3.	3.	500
	Average	493.67

Tingkat eror alat(rpm) pada rpm 500

$$\% \text{ Kesalahan} \left|\frac{\text{Hasil ukur} - \text{hasil teori}}{\text{hasil teori}}\right| \text{x } 100\%$$
$$= \left|\frac{493{,}67 - 500}{500}\right| \text{x } 100\%$$
$$= 0{,}01272 \text{ x } 100\%$$
$$= 1{,}272 \ \%$$

From results analysis data test function rpm 500, presentation error as big as 1.27%. The results of this error percentage are obtained from the results of the author's theory and measurement results, and are calculated using the error percentage formula which is still within the error tolerance of ± 10% which indicates a normal indicator. The following are the results of the 500 rpm function test image .

Table 2. Test function rpm 10 00

Testing speed (rpm)		
	Tool design build	a tachometer
1.	1000	1000
2.	1000	997
3.	1000	1002
	Average	999.67

Tingkat eror alat(rpm) pada rpm 1000

$$\% \text{ Kesalahan} \left|\frac{\text{Hasil ukur} - \text{hasil teori}}{\text{hasil teori}}\right| \text{x } 100\%$$
$$= \left|\frac{999{,}67 - 1000}{1000}\right| \text{x } 100\%$$
$$= 0{,}00033 \text{ x } 100\%$$
$$= 0{,}033 \ \%$$

From results analysis data test function rpm 1000, presentation error as big as 0.033% . The results of this error percentage are obtained from the results of the author's theory and measurement results, and are calculated using the error percentage formula which is still within the error tolerance of ± 10% which indicates a normal indicator. The following are the results of the rpm 1000 function test image.

Table 3. Test function rpm 15 00

Testing speed (rpm)		
	Tool design build	a tachometer
1.	1500	1502
2.	1500	1500
3.	1500	1504
	Average	1502

Level error tool(rpm) on rpm 1500

% Error| Measurement results theory |x 100%

results theory

= | 1502−1500 |x 100%

1500

= 0.00133x 100%

= 0.133 %

From the results of the analysis of the rpm 1500 function test data, the error presentation is 0.133%. The results of this error percentage are obtained from the results of the author's theory and measurement results, and are calculated using the error percentage formula which is still within the error tolerance of ± 10% which indicates a normal indicator. The following are the results of the rpm 1500 function test image .

Table 4. Test function rpm 20 00

Testing speed (rpm)		
	Tool design build	a tachometer
1.	2000	2002
2.	2000	2000
3.	2000	2005
	Average	2002.33

Level error tool(rpm) on rpm 2000

$$\% \text{ Error} \left| \frac{\text{Measurement results theory}}{\text{results theory}} \right| \text{x } 100\%$$

$$= \left| \frac{2002.3-2000}{2000} \right| \text{x } 100\%$$

$$= 0.001165 \text{x } 100\%$$

$$= 0.1165 \%$$

From the results of the analysis of the function test data rpm 20 00, the error percentage is 0.1165%. The results of this error percentage are obtained from the results of the author's theory and measurement results, and are calculated using the error percentage formula which is still within the error tolerance of ± 10% which indicates a normal indicator. The following are the results of the function test image rpm 20 00 .

The time on the overhead stirrer tool that has been designed is then tested using stopwatch comparator with 3 minute time settings for 3 repetitions, 6 minutes for 3 repetitions 3 time repetition, 9 minute as much as 3 time repetition. The results of the measurements can be seen in the following table :

Table 5 Test timer 3 minute

Arrangement time 3 min/180 Second		
	timer Tool (seconds)	stopwatch (Second)
1.	179	180
2.	180	180
3.	180	180
	Average	179.66

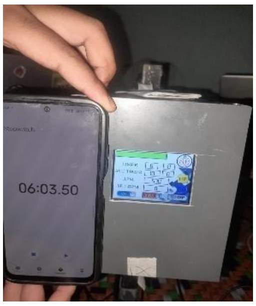
The table is the data of the time test results using a stopwatch as a comparison with a time setting of 180 seconds with 3 repetitions. The deviation is 0.34 seconds in the 180-second time test. The following the result image

Picture 5 Test stopwatch 3 minute

Table 6 Test timer 6 minute

	Arrangement time 6 min/360 Second	
	timer Tool (seconds)	stopwatch (Second)
1.	363	360
2.	360	360
3.	357	360
	Average	360

The table is the data of the time test results using a stopwatch as a comparison with a time setting of 360 seconds with 3 repetitions. There was no error in the 360 second time test. The following the result image



Picture 9 Test 6 minute stopwatch

Table 7 Test timer 9 minute

	Arrangement time 9 min/540 Second	
	timer Tool (seconds)	stopwatch (Second)
1.	545	540
2.	542	540
3.	541	540
	Average	542.67

The table is the data from the time test results using a stopwatch as a comparison with a time setting of 540 seconds. second with repetition as much as 3 time. The intersection 2.67 seconds in the 540-second time test. Here's the result image

Picture 10 Test 9 minute stopwatch

Conclusion

laboratory tools or instruments used to stir several solutions or samples until homogeneous using high speeds from manual stirring. In this article, the author will discuss some important things about overhead stirrers . Overhead stirrers have parts that help their work process. Inside the head there is a motor system that will send a signal so that the stirring rod can rotate to stir the solution. At that time, you can set the speed according to your needs. Usually for medium or small amounts you can use a speed of 50 rpm - 500 rpm. Meanwhile, for large amounts of material you can set the speed up to 2000 rpm . The Heavy Dusty Over Head Stirrer tool was successfully designed using an Arduino microcontroller, with a Nextion screen-based user interface and equipped with speed and work duration (timer) control features. The design of the tool takes into account ease of use, resistance to dusty environments, and flexibility in setting work parameters.

The test results show that the tool is able to regulate and display speed. motor (RPM) in a way accurate And stable in various setpoint (500, 1000, 1500, and 2000 RPM), with an error percentage of <1.3% which is still within the tolerance limit of ±10%. The timer function also shows a good level of precision, with a small time deviation. in all intervals testing (3, 6, And 9 minutes), shows reliable tool for working time management.

5. Conclusion And Suggestions

After completing the manufacture of the Heavy Dusty Over Head Stirrer , starting from field observations, literature studies, planning, experiments, data collection, and data analysis, the author draws the following conclusions:

a. The Heavy Dusty Over Head Stirrer tool was successfully designed using an Arduino microcontroller, with a Nextion screen-based user interface and equipped with speed and work duration (timer) control features. The tool design considers ease of use, resistance to dusty environments, and flexibility in setting work parameters .
b. The test results show that the device is able to regulate and display motor speed (RPM) accurately and stably at various setpoints (500, 1000, 1500, and 2000 RPM), with an error percentage of <1.3% which is still within the tolerance limit of ±10%. The timer function also shows a good level of precision, with small time deviations at all test intervals (3, 6, and 9 minutes), indicating that the device is reliable for setting working time.

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