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DESIGN AND CONSTRUCTION OF MIXER WITH VARIABLE SPEED FOR MANUFACTURING NANOPARTICLE COMPOSITE MATERIALS

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Abstract

Variable speed mixer machine is a tool to help stir and mix resin with nanoparticles, design and build of the mixer plan the design of the variable speed mixer which aims to make the resin viscosity more evenly distributed in the manufacture of composites and determine the performance of the equipment produced by the variable speed mixer. This is because in manual mixing the mixed materials such as resin nanoparticles have not been mixed evenly or homogeneously. This mixer design tool can be used as a basis for developing work in the field of composite mixing, problems in composite manufacturing include; resin flow control and how to prevent the occurrence of white spots (white dots in the composite). y designing and using this variable speed mixer machine, the results of designing a mixer image with variable speed control using solid works software is the first step in working on a mixer design with variable speed control, after having data in the form of design drawings, a product design in the form of a mixer with variable speed is obtained. . speed control. It is known that the specifications of the mixer with variable speed for composites and nanoparticles are known, it is known that the working principle of a mixer with variable speed control for composites and nanoparticles can make the viscosity mixed more evenly. because the stirring speed regulated by the speed control has a constant speed. The results of testing the mixer machine with speed control, namely the motor can work according to the design plan, where the motor can produce rotation with the required variations and can be adjusted as needed.

Keywords: *Design, Mixer, Viscosity, Speed Control, Composite*

Introduction

In the industrial world, the production process is done manually using human labor services resulting in a slow production process and less economical production results. Therefore, it requires a production process that is carried out automatically using machines as a substitute for human services. The benefit for the author is that this research is conducted to deepen and also apply the knowledge that has been gained during college, especially in terms of product design.(Hati and Subari 2018)

Benefits for the community this tool can be used as a basis for developing work in the field of composite mixing, problems in composite manufacturing include; resin flow control and how to prevent the occurrence of white spots (white spots in the composite), also on the ratio of fibers or particles and resin which is not yet stable, and the uneven viscosity of the resin is still an important problem for the quality of the resulting composite. These factors affect the quality of the composite material produced therefore, a mixer is designed to do an even distribution in mixing fiber and resin.

Literature Riview

Mixer or stirring is a surgical activity of mixing 2 or more substances in order to obtain homogeneous combination results. In liquid phase media, stirring is intended to obtain a turbulent (turbulent) condition. Mixing can be established by the method of bringing up motion in the material which causes parts of the material to move one after another, so that stirring surgery is only one of the methods for mixing surgery.(Wahid 2020)

Design is a process that aims to analyze, assess and compile a system, both physical and non-physical systems that are optimal for the time that will come using the available data. Another interpretation of design" Design is a stage of design (design) has the aim of designing a new system that can solve problems experienced by the industry obtained from the selection of the best system alternative".

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(Nur 2017)

Mixer Tube

The crucible mixer tube is made of black iron plate with a thickness of 2 mm. Calculating the volume of the tube to calculate the maximum volume of crucible material that can be stirred. Calculating the surface area of the mixer tube to determine the weight/mass of the crucible mixer tube.(Anam Moh Khairul 2020).

Electric Motor

An electric motor is a device for converting electrical energy into mechanical energy. The electric motor serves as the main driver for the crucible material mixer machine. Considering the performance of the crucible mixer machine so that it functions optimally based on the electric motor on the market, the electric motor chosen is a single phase electric motor, with a power of 370 watts / 0.5 HP, a voltage of 220 volts, and a rotation of 1400 RPM.(Anam Moh Khairul 2020)

Table 1. Electric Motor

Transmitted Power	Correction factor (Efficiency)
Average Power Required	1,2-2,0
Maximum Power required	0,8-1,2
Normal Power	1,0-1,5

Axis

Shaft is part of a rotating machine element whose function is to transmit power from one place to another. In its application the shaft is varied with pulleys, bearings, gears, and other elements. Meanwhile, to help the shaft work, the shaft can be combined with pegs.(Anam Moh Khairul 2020)

Table 2. Axis

Group	Rate C (%)
Mild Steel	-0,15
Clay Steel	0,2 - 0,3
Slightly Hard Steel	O,3 - 0,5
Hard Steel	0,5 - 0,8
Very Hard Steel	0,8 - 1,2

Speed Control

Speed control serves to regulate the speed of the motor. The speed of the motor is determined by the frequency of the voltage and the number of poles of the motor. This speed control router works with universal brush type AC or DC motors rated at 15 amperes or below. The result is longer life and better results depending on the desired spin. There is a dial to control the speed of the router when the motor is working by changing the frequency of the electric current so that it can adjust the speed, shown in Figure 2.3 Speed Control below.(Septyayu Catur Pamungkas 2017)

Paddle Strrier

The paddle stirrer is usually used at low speeds between 20 and 200 rpm. Two or four-leaf flat paddles are commonly used in a kneading process. The total length of the paddle stirrer is usually 60 - 80% of the tank diameter and the width of the leaf is 1/6 - 1/10 of its length, shown in Figure 2.4 of the paddle stirrer below. (Septyayu Catur Pamungkas 2017)

Frame

Engine Frame, serves as the main support for all components that make up the system in a machine device, as well as a place for the components of the engine to be installed, as shown in Figure 2.5 below. (Zulnadi, Indovilandri 2016)

Welding

Welding is a permanent connection which results from the fusion of two parts joined together, with or without the use of pressing and filling materials. The heat needed to melt the material comes from the flame in the carbide welding and the electric arc in the electric welding. (Anam Moh Khairul 2020)

Hypothesis

The data taken regarding the speed of the motor in rpm units is the data of the state of the motor before using automatic motor control to find out the real change in speed when loading. The design and build stage of this mixer starts from the design of the mixer, assembly of components of the mixer parts, looking for the rotation speed of the motor using speed control. (Arifin and Kasim, n.d.)

Desaign Material

1. Grinder
2. Meters
3. Welding Equipment
4. Hand Drill
5. Power Supply
6. Lathe
7. Vise
8. Safety Glasses
9. Soldering Iron
10. Lead
11. Combination Pliers
12. Pliers
13. Screwdriver (+/-)
14. Cutter
15. Sandpaper
16. Vernier Calipers
17. L Key
18. File Half Circle
19. Peg/Pin
20. Avometer
21. Tachometer
22. Senai
23. Miiling Machine
24. Hammer

Desaign Tools

1. Electric Motor
2. Flexible Coupling
3. Pillow Block
4. Axis Diameter 12mm
5. Iron Elbow 30 x 30 x 2,5
6. Strip Plate Iron 3 x 2,5
7. Control Speed
8. Calbe 2 x 2,5 (1m)
9. Cable 2 x 2,5 (6m)
10. MCb
11. Capacitor
12. Terminal Block 6 Pin
13. Cable Skun 1,5 (20)
14. Cable Skun 2,5 (20)
15. Cable Insulation
16. Screw 6 x 5/8 (20)
17. Screw 6 x 1 ¼ (20)
18. Bolt 10mm 3cm (4)
19. Electrical terminal 10mm
20. Board 30 x 12 x 1,5 (2)

Flowcharts

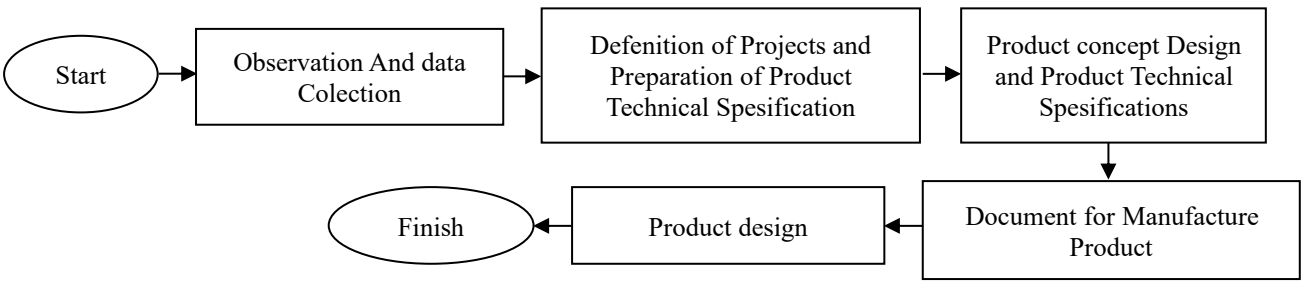

Figure 1. Flowcharts

Design Method

The product technical specifications resulting from the first phase of the design process become the basis for the next phase, namely the product concept design phase. The purpose of this phase is to generate as many alternative product concepts as possible. The product concept produced in this phase is still in the form of a schematic or in the form of a sketch. In principle, all alternatives of all product concepts meet the product technical specifications. At the end of the product concept design phase, an evaluation of the product concept design results is carried out to select one or several best product concepts to be developed in the third phase of the product design phase.

Product Design Phase Product design is an alternative development in the form of a schematic or sketch into a product or engineering object whose shape, material and dimensions are determined. The design phase of the mixer machine begins with adjusting the requirements, then initial sketches / drawings are carried out, ending with the detailed design of product elements, which are then poured into detailed drawings for the manufacturing process.

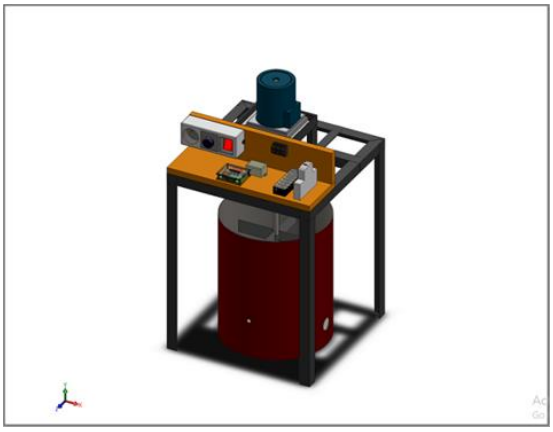

Figure 2. Design Mixer

Results and Discusions

Design and Build a Mixer Using the Solid Works Application

In the picture below, you can see the design of the mixer which was designed using solid works software for designs such as tubes, blades, motors, frames, pillow blocks, axles and couplings. image design is the first step in starting a design, here is an image designed using solid works

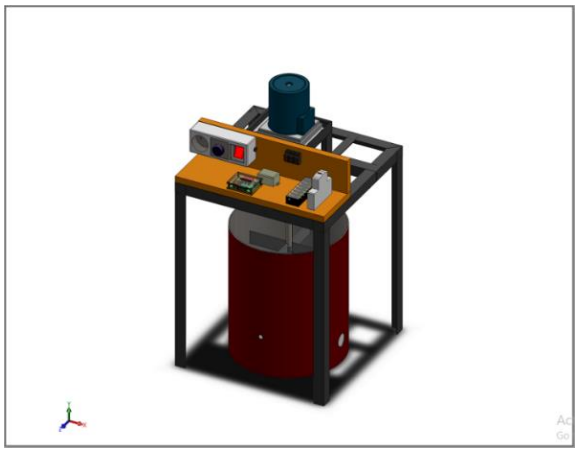

Figure 3. Design and Build a Mixer Using the Solid Works Aplication

Motor Specification

The specifications of the motor used in the design of the mixer with variable speed in this study are as follows:

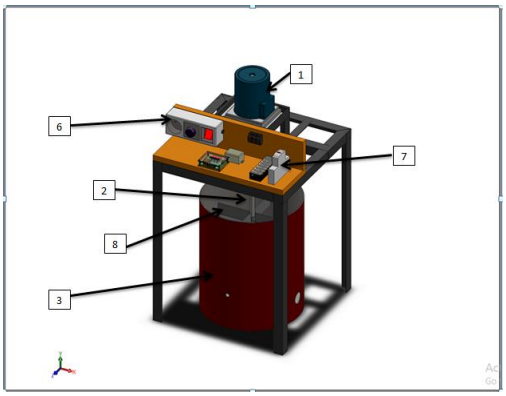

Figure 4. Motor Specification 1

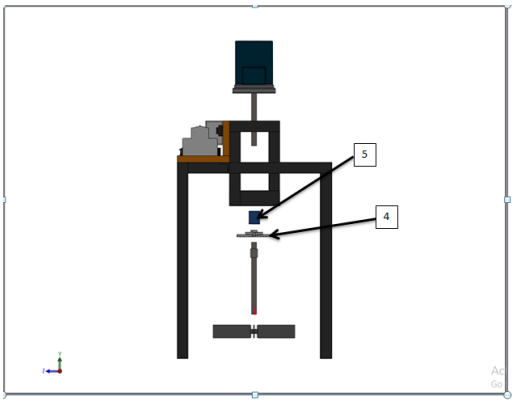

Figure 5. Motor Specification 2

Figure 6. Real mixer design

From the description of Figures 3 and 4 above, it can be seen the description of the motor specifications in table 4.1.

Table 3. Specification Mixer

Tool	Specification
Motor	Ac motor 220/230 Volt 25 Watt 1400/1650 RPM
Axis	Axis Size 22 mm Length 17 cm
Cube	High 20 cm Diameter 10 Inci Thick 3 mm
Pillow Block	Inner Diameter 12 mm Zinc Alloy Material
Flexible Coupling	Shaft 12 mm x 12 mm Aluminium Material Outside Diameter 25 mm Length / high 30 mm
Speed Control	Input AC 110/220 Volt Output Adjustable 15 ~ 99 % Current Output 12 A Cable Length 5 Meter SUNFREE SNI Brass cable
MCB	10 Ampere
Blade	Length 7 Cm Heigth 3 Cm
Capacitor	Capacity 8 uF/mfd Diameter 35 mm Length 71mm Double Insulation Connector

The following table below is the function of the circuit taking into account the concept that will be designed and in accordance with the design needs, which consists of motors, axles, tubes, Flexible Coupling, Pillow blocks, Speed Control, MCB, Blade, Capacitors

Table 4. Function Mixer

Description	Function
Motor	Propulsion
Axis	Turning Blade
Tube	Shelters
Flexible Coupling	Transmits Force and Motion from Motor to Shaft
Pillow Block	As Mounts / Shafts
Speed Control	Sets the Speed Generated By the Motor
MCB	As protection in Electrical Installations in Case of Overload and Short Circuit
Blade	For Stirring Ingridients and Mixing Ingridients
Capacitor	Store Electric Charge
Machine Frames	Support Machine

The selection of materials and specifications of this mixer machine is in accordance with the design needs, this is to facilitate the design of the mixer that is carried out.

Motor Power Using Speed Control

The table shows the power generated by the motor before and after using speed control at indicators 0.1,2,3,4,5,6,7,8,9 for use on a mixer using speed control. The following is a table of the power generated on the motor.

Figure 7. Speed control

Table 5. power Motor Mixer

Variable Speed Control	**Power Motor**
0	210 V
1	211.5 V
2	213 V
3	214.5 V
4	216 V
5	217.5 V
6	219 V
7	220.5 V
8	222V
9	222V

In the table above, it can be seen that the motor power generated on the motor after being installed with speed control, there is a change in the motor power generated on each indicator. The power generated by the motor using speed control is obtained from measurements through a digital avometer conducted in the production laboratory located on the STTKD Yogyakarta Campus.

Working Principle of Mixer Speed Control For Nano Particle Composite Mixer

The following is the working principle of the speed control mixer for nanoparticle composite stirrer in the design of this research:

1. This machine uses a mixer tube with a maximum capacity of 4 kg, with a rotation speed of
2. This machine uses an electric motor that is used is a 1 Phase electric motor with a power of 0.5 HP with a speed of 1400/1650 RPM, using variable speed control with 9 variations of rotation speed.
3. The US is made of lathe iron.

4. The tube is made of cut iron pipe.
5. This machine uses Speed Control to adjust the engine rotation speed.
6. Mixer using paddle type blade
7. The process of stirring the mixer speed is regulated by the speed control by turning the speed control indicator to determine what speed is needed in the use of the mixer.
8. The mixing function is carried out so that homogeneous mixing of the material being tested occurs.

From the working principle of the mixer machine above, the following is the workflow of a mixer machine with speed control so that it can mix and mix nano-particle composite materials.

1. The power mixer cable is connected to the power supply to produce electricity which is delivered to the motor and speed control.
2. The use of capacitors in this single-phase mixer motor is for initial start because the single-phase mixer motor cannot start on its own, for that a capacitor of the appropriate size is needed for starting the single-phase mixer motor.
3. From the electricity the motor can move and generate rotation on the blade.
4. Then after the mixer is powered, the speed control works to adjust the speed as needed.
   The following is a diagram of the wearing that is used on a variable speed mixer.

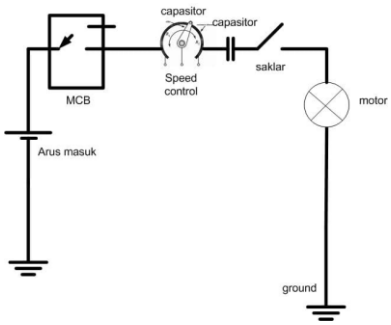

Figure 8. wearing Mixer

Mixer Speed Control Speed No Load

In the design of the mixer, a no-load engine rotation speed test is carried out which is useful for finding out how much engine speed is produced using a mixer with speed control, the following test is carried out by adjusting the speed using speed control by turning the speed indicator on the speed control.

This test is carried out to find out how much the engine rotation speed is balanced and at what speed the mixer engine is unbalanced, here is a table of speed results obtained by performing these tests.

Table 6. Mixer Speed Control Speed No Load

Speed Control Indicator	Rotation Speed (RPM)	Balance	Unbalance
0	0	√	
1	42	√	
2	156	√	
3	302	√	
4	458	√	
5	614		√
6	770		√

Speed Control Indicator	Rotation Speed (RPM)	Balance	Unbalance
7	926		√
8	1082		√
9	1238		√

From the table above, it can be concluded that the motor speed can be adjusted using speed control, the motor speed can be adjusted as desired by turning the indicator on the speed control with an example turning in indicator 1. the speed control will produce a rotation of 42 RPM and will increase the rotation if rotated above indicator 1, the resulting mixer rotation is a no-load rotation speed.

At speeds above 614 RPM there is an unbalance of the axles because the motor rotation is too high, this happens because the axle turning process is not balanced.

Comparison of Using Mixer and Manual Mixing Machine

In this study, testing was carried out using a mixer machine and manual stirring method to obtain a comparison that was produced in the tests carried out, this test used materials in the form of PA resin and iron sand, each of which used a mixer and manual mixing machine. in the test using a mixer machine used a mixer speed of 156 RPM with a constant speed, the stirring time is 6 minutes and the manual stirring is done at an erratic speed.

The following is the resulting test in the form of a comparison of mixing resin and iron sand using a mixer machine and manual mixing.

Figure 9. Mixing Resin and Iron sand Using a Manual Mixing

Figure10. Mixing Resin and Iron sand Using a Mixer Machine

In the picture above, you can see the difference between mixing using a mixer machine and manual mixing by hand, a very clear difference can be seen visually, you can see the even distribution of mixing between resin and iron sand. In manual mixing the iron sand is not mixed evenly and the iron sand falls to the bottom, while in mixing using a resin mixer machine the iron sand is mixed evenly. therefore the mixing between these materials using a mixer machine results in better results compared to manual mixing.

Conclusions

The research that has been carried out on the following mixer design to determine the image design of the mixer and to determine the best resin viscosity using variable speed can be concluded as follows:

The first step in working on the design of a mixer with Variable speed control is to design an image of a mixer with variable speed control using solid works software. After having data in the form of a design image, a product design is carried out in the form of a mixer with variable speed control to mix nanoparticle composites that are convenient for operators and easily adapted to the workspace. The resulting design product is a mixer machine with certain specifications accompanied by variable speed control which can make the viscosity mixed more evenly, because the stirring speed regulated by the speed control has a constant speed.

From the results of testing the mixer machine with speed control, the motor can work according to the design plan, where the motor can produce rotation with the required variations and can be adjusted according to needs. An experiment was carried out to mix resin and iron sand, a comparison was made between manual stirring and mixing using a mixer machine.

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