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Design Of Semi Automatic Jominy Test For Metal Hardness Testing Practice

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A B S T R A C T

The design itself consists of various points of view called The Four C's of Design, namely: Creativity, Complexity, Choice, and Compromise. The Jominy Test tool is a tool for testing the hardenability of steel which is carried out by a cooling process (Quenching). The planning of the jominy test tool (Hardenability Jominy Test) is based on the ASTM A255 standard. Testing the semi-automatic jominy test tool on variations in valve openings against pressure height gets an average result, namely a valve opening angle of 15 ° as high as 0 mm, 30 ° as high as 5.3 mm, 45 ° as high as 27.3 mm, 60 ° as high as 48.3 mm, 75 ° as high as 62 mm, and 90 ° as high as 85 mm. This test shows that the greater the valve opening angle, the higher the water jet emitted. The height of the water jet has passed the desired standard of 63.5 mm, so that the valve angle reference can be taken between the angles of 75 ° and 90 °. The closest angle to the height of 63.5mm is 75° as high as 62mm, so to determine the height of 63.5mm to increase the angle. In the experiment conducted using angles of 76°, 77°, and 78°. The results obtained are at an angle of 76° as high as 63.5mm, 77° as high as 64°mm and 78° as high as 64.5°mm.

Keywords: Jominy, Metal Hardness, Semi Automatic, Design.

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1. Introduction

Steps that must be taken in the design before being manufactured. The first design step is the concept design (Conceptual Design), this stage requires high creativity in conceptualizing the design and considering it. The second step is the design of the form (Embodiment Design) where at this stage the initial layout form begins, then is selected according to the specifications and is good and reviews the occurrence of failure. The third step is detailed design (Detail Design), which is a check in a design that will be manufactured.

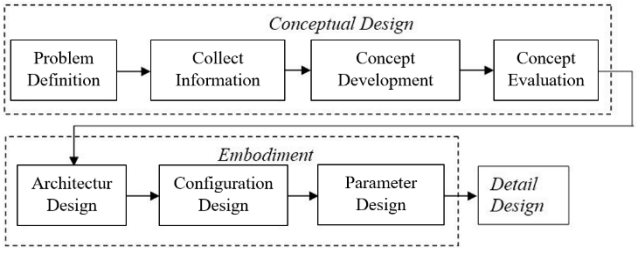

Figure 1. Planning Design Stage

1.1. Jominy Test

The Jominy Test tool is a tool for testing the hardenability of steel which is carried out by a cooling process (Quenching). The planning of the jominy test tool (Hardenability Jominy Test is based on the ASTM A255 standard. The parts contained in the jominy test tool are the frame, water reservoir, specimen support, water pump, pipe and so on. The frame functions to hold and accommodate the components contained in the jominy tool, the water reservoir functions to store water, the specimen support functions to support the specimen, the water pump and pipe function to channel water from the reservoir to the specimen as cooling.

Jominy Test is used to measure the hardenability of a specimen due to changes from austenite to martensite either in whole or in part. The study was conducted by applying the parameters of austenitization temperature, holding duration and cooling media. The results obtained from the study, namely the higher the austenitization temperature and the longer the holding duration, the higher the hardness level.

1.2. Quenching *Process*

Quenching is a process of heat treatment of steel by heating it at a certain temperature, depending on the carbon content of the steel itself, then

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after reaching the specified maximum temperature, it is held for a while, then cooled suddenly with a cooling medium such as water, oil, salt water, oil or other coolants.

Quenching itself is a part of the hardening process. Quenching is done to obtain high wear resistance, strength, and better strength. The resulting hardness also depends on the carbon content and the hardness that occurs depends on the heating temperature, holding time, cooling rate and sample thickness. To obtain good hardness (hard martensite), the austenite structure must be achieved during heating, because only austenite can transform into martensite.

Hardening heat treatment is a combination process between heating and cooling of a metal or its alloy in a solid state to obtain certain properties. Heat treatment requires heating the workpiece to the hardening temperature, an adequate stopping period at the hardening temperature and subsequent rapid cooling (shock) at a critical cooling rate. As a result of the cold shock from the hardening temperature area, a forced state is achieved for the steel structure that stimulates hardness, therefore this hardening process is called shock hardening.

The next hardening process will be the cooling process. Quench is a rapid cooling of a metal by immersion in a cooling medium. Maximum hardness can occur by suddenly cooling the heated sample, resulting in changes in the microstructure. The cooling rate depends on several factors, namely the temperature of the medium, specific heat, heat of vaporization, thermal conductivity of the medium, viscosity, and agitation (flow of the cooling medium). The cooling rate depends on several factors, namely the medium, specific heat, heat of vaporization, thermal conductivity of the medium, viscosity, and agitation (flow of the cooling medium). The cooling rate with water is greater than cooling with oil, while cooling with air has the slowest speed.

2. Research Methods

2.1. Research Procedure

To obtain appropriate research results, this research is divided into several stages, namely:

1. Literature study on the design and manufacture of jominy test hardenability tools in accordance with ASTM A255.
2. The design process of a semi-automatic jominy test tool using Autodesk Inventor software.
3. Preparation and design of a jominy test tool to analyze the hardness of the material after cooling in the Automation and Robotics Systems laboratory, UTM Mechanical and Industrial Engineering.
4. Testing the Jominy Test tool with a coolant velocity of 0.6 m / s against the fluid pressure head for 60 seconds.
5. Testing the Jominy Test tool with a coolant velocity of 0.8 m / s against the fluid pressure head for 60 seconds.
6. Testing the Jominy Test tool with a coolant velocity of 1.0 m / s against the fluid pressure head for 60 seconds.
7. Processing test result data to obtain data on the characteristics of the coolant velocity against the pressure head.

2.2. Research Flowchart

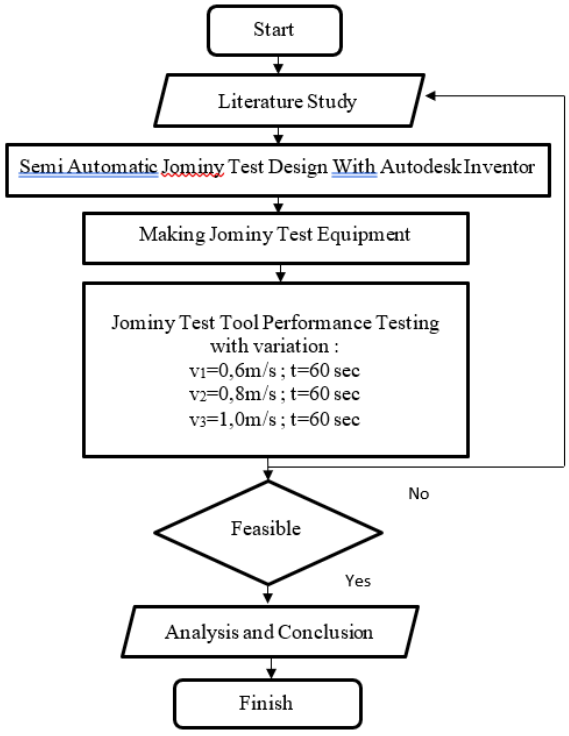

Figure 2. Research Flowchart

2.3. *Semi Automatic Jominy Test Design*

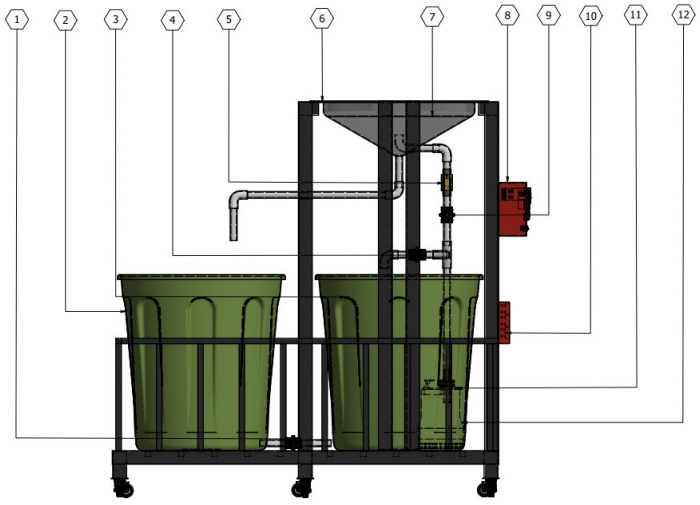

Figure 3. Semi Automatic Jominy Test Design

Specification :

1. Faucet 1
2. Tank-A
3. Frame
4. Control Valve
5. Digital Flowmeter
6. Holder
7. Funnel
8. Box Control
9. Faucet 2
10. Box Power
11. Submersibel Pump
12. Tank-B

3. Results and Discussion

3.1. Semi *Automatic* Jominy Test Tool Design Results According to ASTM A255-02

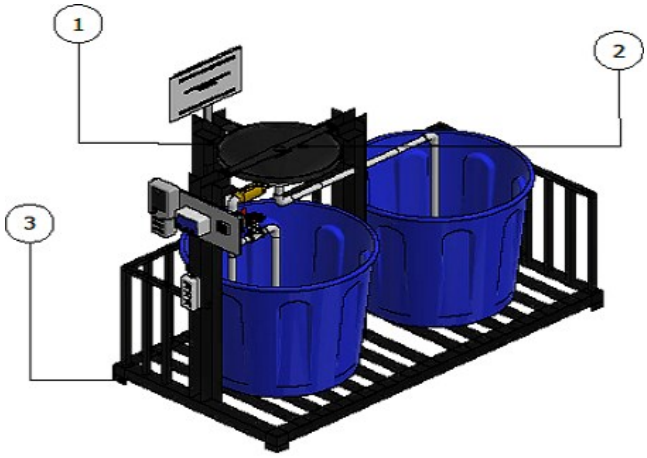

Figure 4. Semi Automatic Jominy Test Design Result Using Inventor

Specification :

1. Holder ; 2. Funnel ; 3. Frame

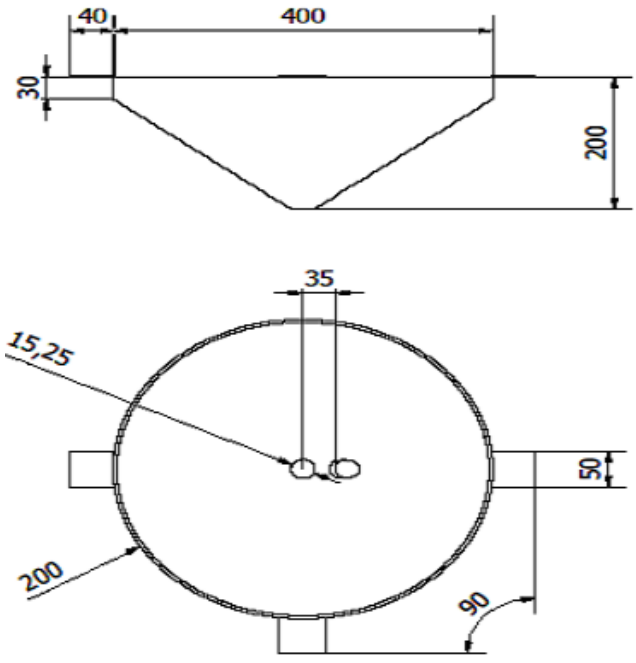

Figure 5. Funnel Design Using Inventor

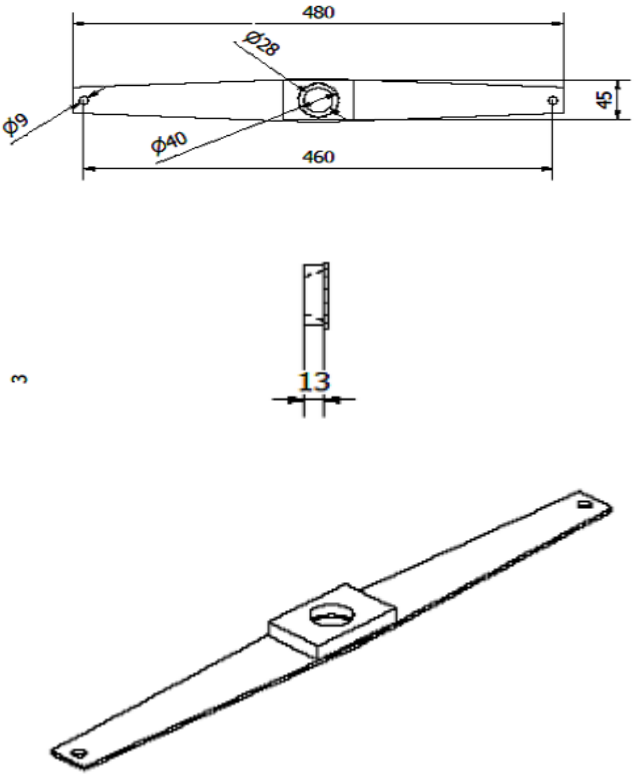

Figure 6. Holder Design Using Inventor

Figure 7. Semi Automatic Jominy Test Tool Design Results

3.2. Testing *The Head Value Of The Valve Opening Angle*

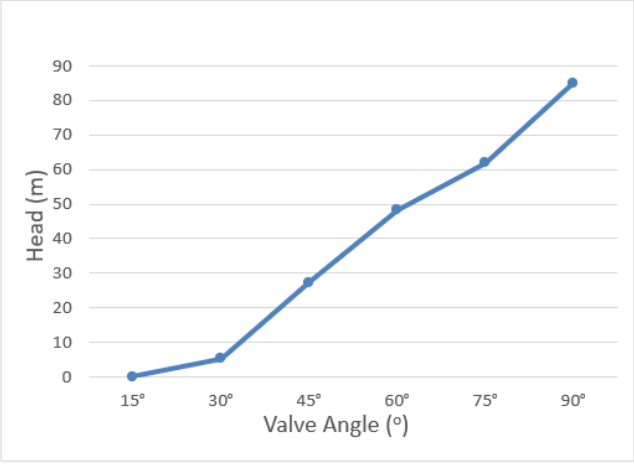

Figure 8. Test graph of head value against valve opening angle

Semi-automatic jominy test tool testing on valve opening variations against pressure height obtained average results, namely valve opening angle 15 ° as high as 0 mm, 30 ° as high as 5.3 mm, 45 ° as high as 27.3 mm, 60 ° as high as 48.3 mm, 75 ° as high as 62 mm, and 90 ° as high as 85 mm. This test shows that the greater the valve opening angle, the higher the water jet emitted. The height of the water jet has passed the desired standard of 63.5 mm, so that the valve angle reference can be taken between the angles of 75 ° and 90 °. The angle closest to a height of 63.5 mm is 75 ° as high as 62 mm, so to determine the height of 63.5 mm to increase the angle. In the experiment conducted using angles of 76 °, 77 °, and 78 °. The results obtained are at an angle of 76° as high as 63.5mm, 77° as high as 64°mm and 78° as high as 64.5°mm. So, this semi-automatic jominy tool can be used according to the ASTM A255-02 standard.

3.3. Testing Pressure Drop Value Against The Valve Opening Angle

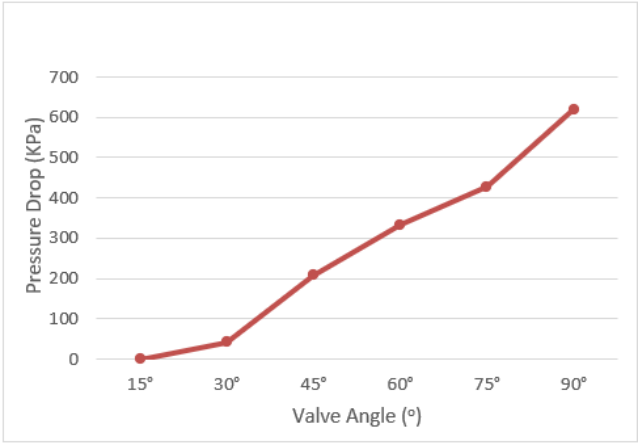

Figure 8. Test graph of head value against valve opening angle

Testing of the semi-automatic Jominy test tool on the variation of valve openings against pressure drop obtained average results, namely a valve opening angle of 15° of 0 kPa, 30° of 42.2 kPa, 45° of 207.5 kPa, 60° of 332.5 kPa, 75° of 427.4 kPa, and 90° of 620.1 kPa.

Based on this study, the results showed that the semi-automatic jominy test tool is in accordance with the design that has been made and can be operated according to the ASTM A255-02 standard. There are supporting tools, namely Time Delay Relay, Digital Flow Meter, and Digital Thermometer Thermocouple so that the tool works optimally as expected.

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