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Mekanika: Majalah Ilmiah Mekanika

Simulation of The Pressure Vessel Saddle Thickness Effect to Stress Distribution

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Cylinder pressure vessel is a device that is used to process industry, power industry, oil industry, and gas industry. Structure of pressure vessel has complex design that is used to accommodate force, temperature, internal pressure loading, etc. Pressure vessel loading is supported by two saddle. Loading pressure vessel is distributed to saddle as stress. Stress distribution can be checked by finite element software. Autodesk Inventor 2019 is a software that used finite element basic. This research aims to get the effect of pressure vessel saddle width to maximum stress at pressure vessel.

1 Introduction

Pressure vessels consisting of cylindrical shell components can be found in processing, electrical generator, oil, and gas industries [1]. The pressure vessel contains a fluid with a liquid or gas phase [1]. One type of pressure vessel is a horizontal pressure vessel. The shape of the pressure vessel structure is very complicated because it can withstand force loads, temperature, pressure from the fluid, and the other loads [2]. The pressure vessel load is held by a component called a saddle. There are two saddles used to withstand the load [3]. The pressure vessel load will be distributed to the two stops [4]. The finite element method can be used to solved stress distribution cases [5]

This study aims to obtain the stress distribution in horizontal pressure vessels which has saddle thickness variations. The stress distribution simulation in this study uses Autodesk Inventor 2019 software based on finite elements.

2 Experimental Methods

The geometry of the pressure vessel was created by Autodesk Inventor 2019 software. The geometry in this study is presented in Figure 1. The finished geometry is loaded and then meshed. One of the mesh results in this study is presented in Figure 2. The design data in this study are presented in Table 1.

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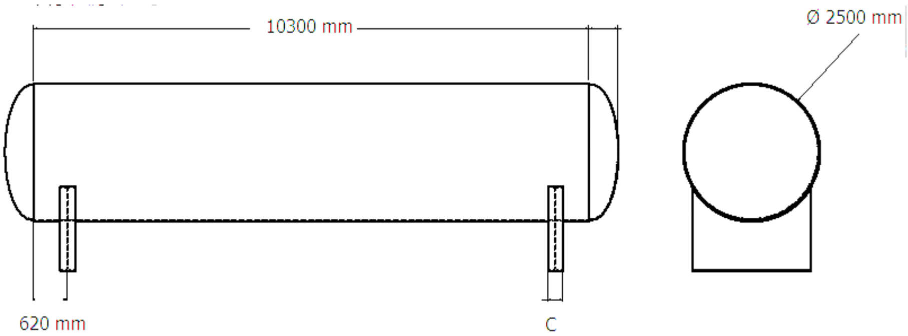

Figure 1. Pressure Vessel Geometry.

Figure 2. Mesh of pressure vessel geometry.

The design data is presented in table 1. The design data is adjusted to the function of the pressure vessel and also the standards that have been determined for the design of the pressure vessel. The function of the pressure vessel is knock out drum equipment in hydrocarbon industry which has density 725.96 km/m^3.

Table 1. Design data.

No	Description	Value
1	Shell Thickness	22 mm
2	Head Thickness	12 mm
3	Joint Efficiency	1
4	Internal Pressure	0.21 MPa
5	Internal Design Pressure	60^o C
6	External Design Pressure	25^o C

This study uses 8 variations of the saddle thickness. The variations are considered by standard document which is used to design pressure vessel. The variations of the saddle thickness are presented by Table 2.

Table 2. Saddle thickness variations.

No	Saddle Thickness
1	300 mm
2	310 mm
3	320 mm
4	330 mm
5	340 mm
6	350 mm
7	360 mm
8	370 mm

The geometry that has been created is then given a load force according to the design data. Then the Geometry is meshed. The meshing results that have been made are then checked for quality. If the quality of the mesh is good, the next step is to simulate the loading of the geometry.

3. Result and Discussion

Hasil dari analisis distribusi tegangan menggunakan perangkat lunak Autodesk Inventor 2019 pada penelitian ini tersaji pada Gambar 3.

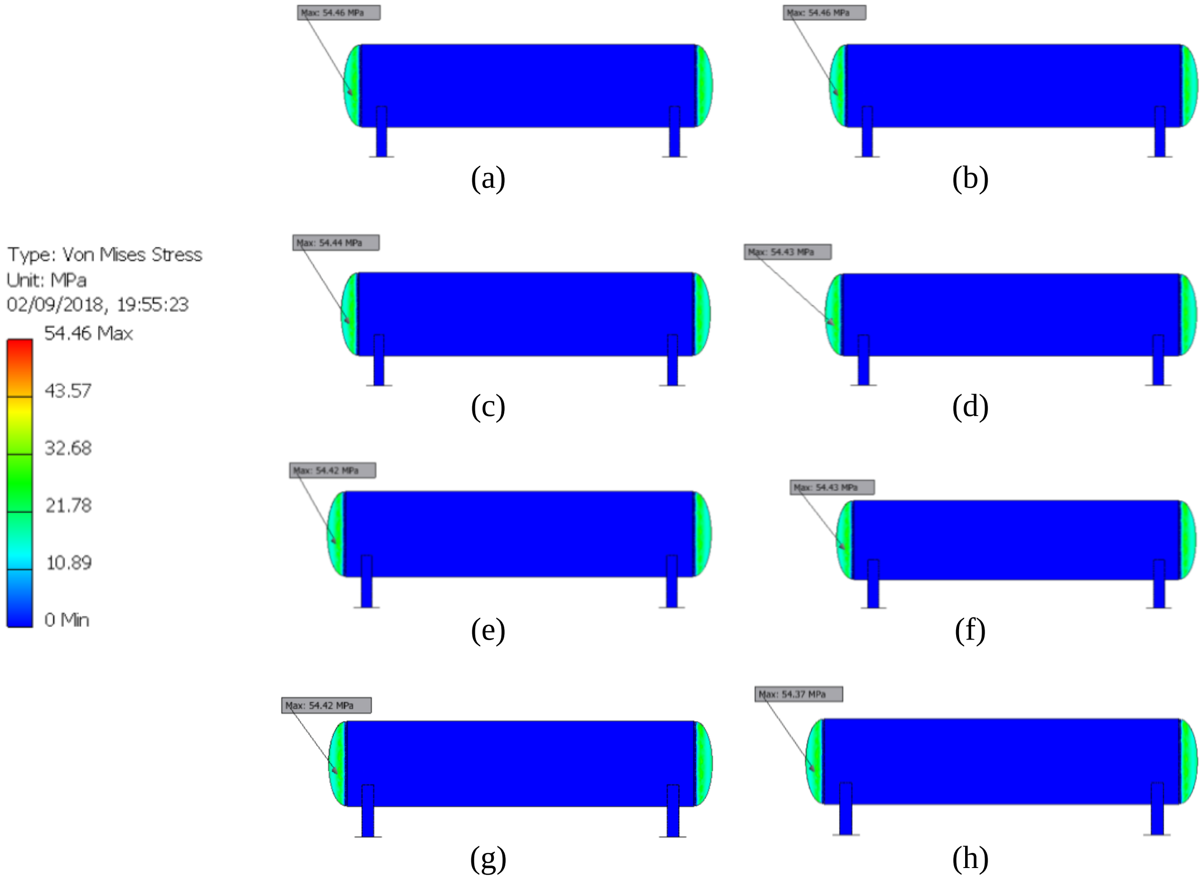

Figure 3. Stress distribution in pressure vessel which uses thickness saddle (a) 300 mm, (b) 310 mm, (c) 320 mm, (d) 330 mm, 340 mm (e), 350 mm (f), 360 mm (g), and 370 mm(h)

The result of the simulation is stress distribution and maximum stress in the pressure vessel. The maximum stress is presented in Table 3, and then the data are used to make a graph of the relationship between the thickness of the pressure vessel saddle to the maximum stress that occurs. This graph is presented in Figure 4.

Table 2. Pressure vessel maximum stress

No	Saddle Thickness	Maximum Stress
1	300 mm	54.46 MPa
2	310 mm	54.46 MPa
3	320 mm	54.44 MPa
4	330 mm	54.43 MPa
5	340 mm	54.42 MPa
6	350 mm	54.43 MPa
7	360 mm	54.42 MPa
8	370 mm	54.37 MPa

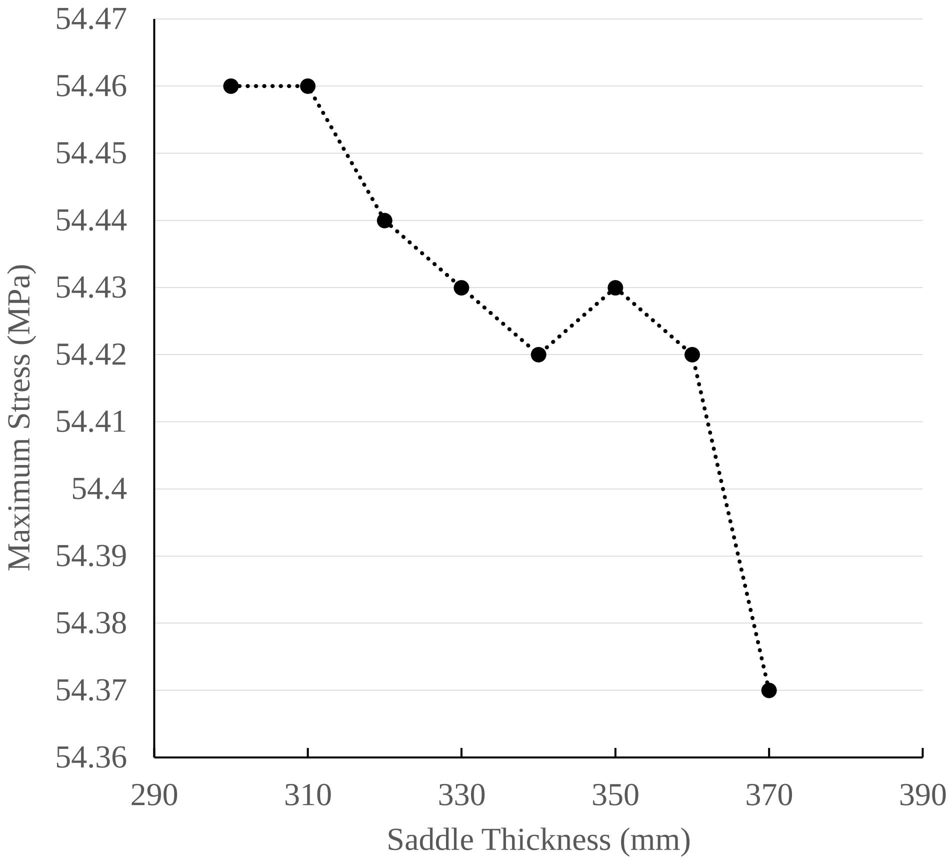

Figure 3. The saddle thickness vs maximum stress

The maximum stress that occurs in a pressure vessel that has a saddle thickness of 300 mm and 310 mm is 54.46 MPa, and the maximum stress value that occurs in a pressure vessel with a saddle with 320 mm, 330 mm, and 340 mm is lower than the maximum stress that occurs at Pressure vessels with saddle thickness are thinner. However, a different trend occurs in pressure vessels, which have a saddle thickness of 350 mm. The maximum stress that occurs is higher than the maximum stress that occurs in the pressure vessel with a saddle with a thickness of 340 mm, namely 54.43 MPa. The trend that occurs in saddle thickness variations of 360 mm and 370 mm is the same as the trend that occurs in saddle thicknesses of 310 mm to 330 mm. The maximum stress in a pressure vessel 360 mm is lower than the maximum stress that occurs in a pressure vessel with a saddle thickness of 350 mm, which is 54.42 MPa. The value of the maximum stress in a pressure vessel with a saddle of 370 mm is the smallest value compared to other test variations, namely 54.37 MPa. From the graph, it is shown that the average maximum stress value decreases when the thickness of the pressure vessel saddle gets thicker.

4. Conclusion

The results of this study show that in general, the higher the saddle thickness value, the maximum stress that occurs will decrease, and the greatest maximum stress value occurs in a pressure vessel with a saddle with a thickness of 300 mm with 54.46 MPa while the smallest maximum stress value occurs in a pressure vessel which has the saddle with a thickness of 370 mm, namely 54.37 MPa.

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