Journal Of Metallurgical Engineering And Processing Technology, Vol. 4, No. 1
August 2023, pp. 17-22
P-ISSN: 2723-6854, E-ISSN: 2798-1037

Design Of Lifting Aid Materials To Optimize Waste Loading Into Sealed Containers

Supriyadi

Department of Mechanical Engineering, Faculty of Engineering, Soerjo University, Ngawi
Jl. Cepu No.km. 3, Ngawi, East Java 63218
Email: supriyadi.bapak2017@unsoer.ac.id or supriyadihse3@gmail.com

ABSTRACT

Waste management in a field from 2016 to 2017 carried out using closed containers can only load 10 Jumbo Bags with an average weight of 6.74 tons per container. While the waste management cost component, 51.7% is influenced by the cost of transportation through containers. The problem of loading waste during handling is greatly influenced by the lifting aids used for loading so that it can maximize the loading of waste into closed containers which are transportation tools used to transport waste. This study will focus on designing lifting aid materials for loading waste into sealed containers.. The material used is 6" sch 40 pipe and 3"sch 40 pipe. The design was first simulated using stress analysis software to determine the threshold of *yield strength* of the material used. After production of the lifting aid, the welded joints was tested with magnetic testing which shows no defect.. The lifting aid is able to optimize the loading of waste as much as 1968 tons using 130 containers where each container contains 15 jumbo bags and weighs 15.14 tons. This can reduce the number of containers that are a major cost component in transporting waste.

Keywords: *Forklift, Container, Jumbo bag, Stress Analysis, Yield Strength*

Journal Of Metallurgical Engineering And Processing Technology, Vol. 4, No. 1
August 2023, pp. 17-22
P-ISSN: 2723-6854, E-ISSN: 2798-1037

INTRODUCTION

In the process of oil and gas production, it will produce waste. Waste must be transported and managed at a waste management company(Shah & Upadhyay, n.d.). Waste management requires a lot of money. In waste transportation, the transportation cost component consists of waste management costs, waste handling costs and transportation costs. Transport costs have a portion > 50% of the total transportation costs.(Hosford & Caddell, 2007)

Based on waste transportation data from 2016 to 2017 using closed containers, it can only load 10 jumbo bags of waste with an average weight of 6.74 tons per container.(Chen et al., 2021; Wang et al., 2023) The loading of this waste into the container is not optimal due to the use of lifting equipment as a means of loading waste into the container using a *truck crane* (*BASIC ENGINEERING PLASTICITY*, n.d.). The limitations of truck cranes cannot optimize the space in the container, making jumbo bag waste only arranged in one layer Another lifting equipment, namely forklifts, also has a problem, because it does not have arms like truck cranes, so it cannot load waste into containers.(Hachette pratique. & Macrolibros), 2018; Petroleum Institute, 1999)

Based on these problems, the idea emerged is to modify the lifting equipment to be used to optimize the loading of waste into containers. Tools that can be (Zhang et al., 2023)made using pipe materials that have better strength and are available in adequate quantities in the field.

METHODS

At the design stage of lifting aid, the design refers to material strength, container dimensions, jumbo bag dimensions and capacity, forklift capacity and available materials.(Oyedepo & Fakeye, 2021; Shah & Upadhyay, n.d.)
The method of designing lifting aids is carried out through several stages and represented in the flowchart shown in Fig.1

1. Stage of making tool design
2. Stages of making auxiliary tools
3. Inspection stage and function tests
4. use of assistive devices

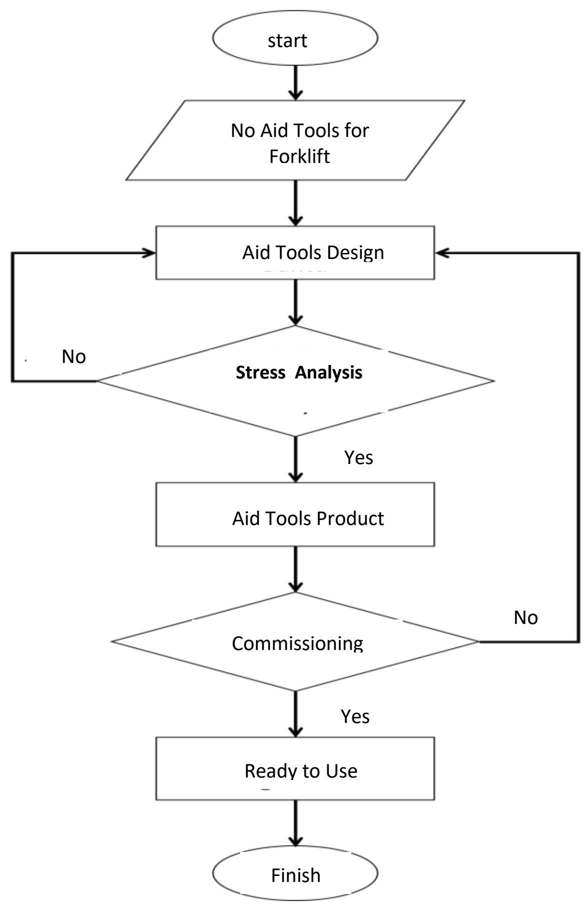


Fig. 1 Lifting aid manufacturing flow chart

Journal Of Metallurgical Engineering And Processing Technology, Vol. 4, No. 1
August 2023, pp. 17-22
P-ISSN: 2723-6854, E-ISSN: 2798-1037

The container used for waste transportation is a 20 ft container with details as in Table 1.

Table 1. Container Type

Information		Container 20 ft
Outer Dimension	Length	6,058 m
	Width	2,438 m
	Height	2,591 m
Inner Dimension	Length	5,898 m
	Width	2,352 m
	Height	2,385 m
Door Opening	Width	2,343 m
	Height	2,280 m
Volume		33,1 m3
Gross Weight		30.480 kg
Empty Weight		2.400 kg
Nett Weight		28.080 kg

The dimensions of this container determine the *length* of the tool manufactured. Then for the jumbo bag used has dimensions of 1mx1mx1m with a capacity of $1m^3$. Jumbo dimensions are used to determine the area used when loading into a 20 ft container.

Forklifts that are available and used for waste loading are forklifts with a capacity of 5 tons. The basic capacity used in determining the strength of the forklift refers to the results of the last inspection, which is 3 tons.

The material used is 6“sch 40 pipe and 3“sch 40 pipe. The pipe specifications used refer to *Mill's Inspection Certificate* data of 6“sch 40 pipe issued by the manufacturer. The benchmark of the pipe specification is *yield strength*. Yield strength is the stress boundary between elastic and plastic deformation or the stress at which the material starts deforming plastically... The yield strength of the 6“sch 40 pipe is 245-393 MPa.

After designing of the tool, then it is tested using stress snalysis simulation to find whether or not the design of the tool exceed the yield strength of the 6” sch 40 pipe material.

At the stage of manufacturing the auxiliary tools, welding practice uses the procedure of WPS-PQR-011r-API-1104 . The next stage is inspection and functional testing . Magnetic test is an inspection method used in accordance with NDT Level 2 ASME V art.7 &; ASME VIII Div.1 App.6 standards (*Nondestructive Examination SECTION V 2019 ASME Boiler and Pressure Vessel Code An International Code from IHS*, n.d.; Society of Mechnical Engineers, n.d.). Then, based on the acceptance criteria as reference value, it is declared that it is free from welding and material defects, the lifting aids are carried out Function and Load Test using a Jumbo Bag that contains waste weighing 1.1 tons and a Forklift lifting equipment with a capacity of 5 tons.

Lifting aids that have been made and have been suitable are then used in scheduled loading and transporting waste. Forklift loading and operating standards refer to ASME B56.1-6 and OSHA Operating the Forklift. (*ASME B56.1*, n.d.; *Division 3 SECTION VIII R Ules for Construction of Pressure Vessels 2019 ASME Boiler and Pressure Vessel Code An International Code*, n.d.)

RESULTS

Design of lifting aids after obtaining dimensional data of containers, jumbo bags, forklifts and available materials as shown in Fig.2.

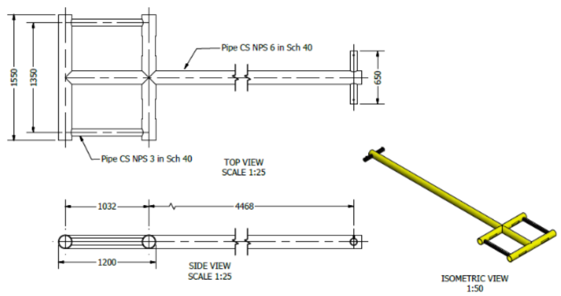


Fig. 2 Lifting aid design

According to the picture above, the design of the lifting aid uses a 6 inch sch 40 pipe as the main line and a 3 inch sch 40 pipe as a support line, with a total length of 5.6 m and a width of 1.55 m.
To find out the strength of the design of the tools that have been made, then a simulation is carried out using *Stress Analysis* with results as shown in Fig.3.

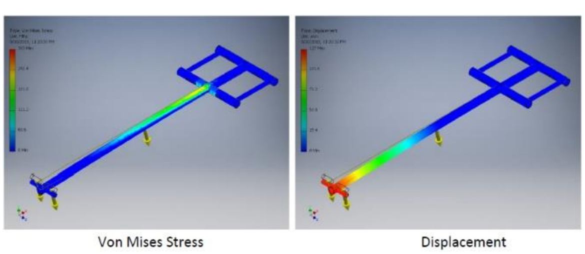


Fig. 3 Results of lifting aid design simulation

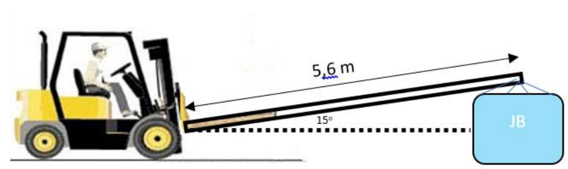
Some parameters of the simulation results are as listed in Table 2.

Table 2. Simulation result parameters

Name	Minimum	Maximum
Volume	33217200 mm3	
Mass	260.755 kg	
Von Mises Stress	0.0022534 MPa	302.962 MPa
1st Principal Stress	-26.1148 MPa	274.483 MPa
3rd Principal Stress	-305.682 MPa	24.9729 MPa
Displacement	0 mm	127.018 mm
Safety factor	0.796523 ul	15 ul

Based on data in the table2 , it can be seen that the results of the *Stress Analysis* simulation of lifting aids produce a maximum stress of 303.0 MPa where the results are still in the yield strength range of 6” sch 40 pipes, which is 245-393 MPa.

In addition to the strength of the auxiliary design, the calculation of the maximum load that can be lifted by the hood forklift is 5 tons. Using Newton's Laws, a simple formula is obtained as shown in Fig.4.



$$Wmax = Wforklift\ x \sin 15$$

Fig. 4 Forklift operational calculation simulation

Based on the ability of the forklift according to the results of the last inspection where the forklift is 3 tons, while the angle of 15o is the maximum elevation ability of the forklift. Therefore, based on calculations, it produces a Wmax jumbo bag that can be lifted, which is 1.87 tons.

The design of the lifting aids is then made by welders with Welder 3 SMAW, 6G certification and using the WPS-PQR-011r-API-1104 procedure. The finished lifting aid, then checked for welding defects and material through a magnetic test with the result *that there is no crack* in the welds or auxiliary materials. The tool made weighs 380 kg. When the function test and load test are carried out using a jumbo bag of waste weighing 1.1 tons, the forklift can lift well without any indication of overload.

Furthermore, in the application of the results of the design of lifting aids, a test of use was carried out in the field, namely during the transportation of waste from 2018 to 2019 with the results at that time the waste that was successfully transported was 1,968 tons. The 1,968 tons of waste was transported using 130 containers where each container could contain 15 jumbo bags and 15.14 tons of waste.

CONCLUSIONS

The use of this lifting aid can maximize the loading of jumbo bag waste into containers. In the transportation of waste that has been carried out in the period 2018 to 2019 managed to load 15 jumbo bags with a total weight of 15.14 tons in each container (previously only loaded 10 jumbo bags with an average weight of 6.74 tons). By optimizing the loading of waste in one container, less transport is used so that cost efficiency can be generated in transporting waste.

Tools made of 6“sch 40 pipe main line and 3 “sch 40 support line are simple tools that can be made using pipe materials that are available quite a lot in the oil and gas field.

REFERENCES

ASME B56.1. (n.d.).

BASIC ENGINEERING PLASTICITY. (n.d.).

Chen, L. Y., Liang, S. X., Liu, Y., & Zhang, L. C. (2021). Additive manufacturing of metallic lattice structures: Unconstrained design, accurate fabrication, fascinated performances, and challenges. *Materials Science and Engineering: R: Reports*, *146*, 100648. https://doi.org/10.1016/J.MSER.2021.100648

Division 3 SECTION VIII R ules for Construction of Pressure Vessels 2019 ASME Boiler and Pressure Vessel Code An International Code. (n.d.). https://www.asme.org/shop/certification-accreditation.

Hachette pratique., & Macrolibros). (2018). *Les carrés d'Art Thérapie Winnie L'ourson : [Album à colorier]*. Hachette Livre - Département Pratique.

Hosford, W. F., & Caddell, R. M. (2007). *Metal forming : mechanics and metallurgy*. Cambridge University Press.

Nondestructive Examination SECTION V 2019 ASME Boiler and Pressure Vessel Code An International Code from IHS. (n.d.). https://www.asme.org/shop/certification-accreditation.

Oyedepo, S. O., & Fakeye, B. A. (2021). Waste heat recovery technologies: pathway to sustainable energy development. *Journal of Thermal Engineering*, *7*(1), 324–348. https://doi.org/10.18186/THERMAL.850796

Petroleum Institute, A. (1999). *By Authority Of THE UNITED STATES OF AMERICA Legally Binding Document*.

Shah, U. V, & Upadhyay, G. H. (n.d.). Optimization of Hydraulic Cylinder Design used for container lifting device using Genetic Algorithm. *International Journal of Engineering and Techniques*, *4*. http://www.ijetjournal.org

Society of Mechnical Engineers, A. (n.d.). *ASME B31.4: Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*.

Wang, Z., Tan, Y., & Li, N. (2023). Powder Metallurgy of Titanium Alloys: A Brief Review. *Journal of Alloys and Compounds*, 171030. https://doi.org/10.1016/j.jallcom.2023.171030

Zhang, X., Liu, H., Li, S., AL-Ammari, A., Liu, H., Hong, Y., Ren, L., Yao, H., & Yang, K. (2023). Corrosion behavior of laser powder bed fusion manufactured Cu-bearing titanium alloy in artificial saliva. *Materials Letters*, 134817. https://doi.org/10.1016/j.matlet.2023.134817