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Design of Laboratory Scale Oil Distillation Machine

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ABSTRACT

In Indonesia there are 4,000 old oil wells are not exploited again by Pertamina because it is not economical, some old wells exploited and processed in the traditional way. Their traditional oil processing has not significantly give a role to the income of local communities, as the mining process that is not managed by modern technology resulting in a weak bargaining position. This study aims to participate in the welfare of the community in areas rich in oil resources and also support the energy security by developing technologies distillationof crude oil into diesel by exploiting oil wells parents who are not exploited again by Pertamina that will improve the bargaining position (bargaining power), increase revenue, reduce unemployment and poverty and has created a system of social safety nets and insurance against society.The method used is the method of Pahl and Beitz, which consists of the Planning and Task Clarification, Conceptual Design, Embodiment Design, and Detail Design.The results of the research are the best variant for the design of machines fractional distillation of petroleum laboratory scale variant 1 (Boiler cylinder - 0.5 inch Pipe - Tubes distillation cylinder - gas stove), by reason of the appropriate size pipe diameter and more secure than the variance other variants. While the dimensions obtained from the draft is 1.31 m 2 for a total dimension of the tower area (A_T) and 408 mm for diameter Total Tower (D_T), and 3 mm for the reactor tube wall thickness. In addition, the test results of oil that has been processed using distillation machine laboratory scale show still makes diesel specifications in accordance with standards established by the Government, namely the specifications for specific gravity, viscosity, water content, maximum heating and visual appearance.

Keywords:*Design, Distillation, Laboratory Scale, Oil*

1. INTRODUCTION

Petroleum is a viscous liquid, dark brown, or greenish flammable, which is in the upper layers of the few areas in the earth's crust. The use of this energy source in our daily life is very broad in scope and quite an important role or dominate the life of many people. For example, petroleum and natural gas are used as an energy source that is widely used for cooking, motor vehicles, and the industry, two fuels derived from weathering of the remains of organisms so-called fossil fuels. Based on the model OWEM (OPEC's World Energy Model), world oil demand in the medium-term period (2002-2010) are expected to increase by 12 million barrels per day (bpd) to 89 million bpd, or grow an average of 1.8% per year. While the next period (2010-2020), demand rose to 106 million bpd to 17 million bpd growths.

Indonesia's natural resource wealth is abundant cause Indonesia was colonized for centuries by the Dutch, French and Japanese. One of the natural resources is owned by oil and gas, mining (Oil and Gas), which belongs to a class of non-renewable resources (non-renewable). Oil and gas sector is one of the mainstays for generating foreign exchange in the context of sustainable development of the country. In Indonesia there are 4,000-an old oil wells are not exploited again by Pertamina because it is not economical, some old wells exploited and processed in the traditional way.Their traditional oil processing has not significantly give a role to the local people's income, because the treatment process is not managed by modern technology resulting in a weak bargaining position.

Research distillation machine of petroleum is expected to participate in the welfare of the community in areas rich in oil resources and also support the energy security by developing technologies distillation of crude oil into diesel by exploiting oil wells parents who are not exploited again by Pertamina thereby increasing the bargaining position, increase revenue, reduce unemployment and poverty and has created a system ofsocial safety nets and insurance against society.

Fig. 1. Distillation processing has traditionally

2. METHODS

The research methodology used is a method Pahl and Beitz with Quality Function Deployment (QFD), argued that a design is a creative process, but if it is not directed systematically the possibility to issue the results of the design through the creative process will be limited.

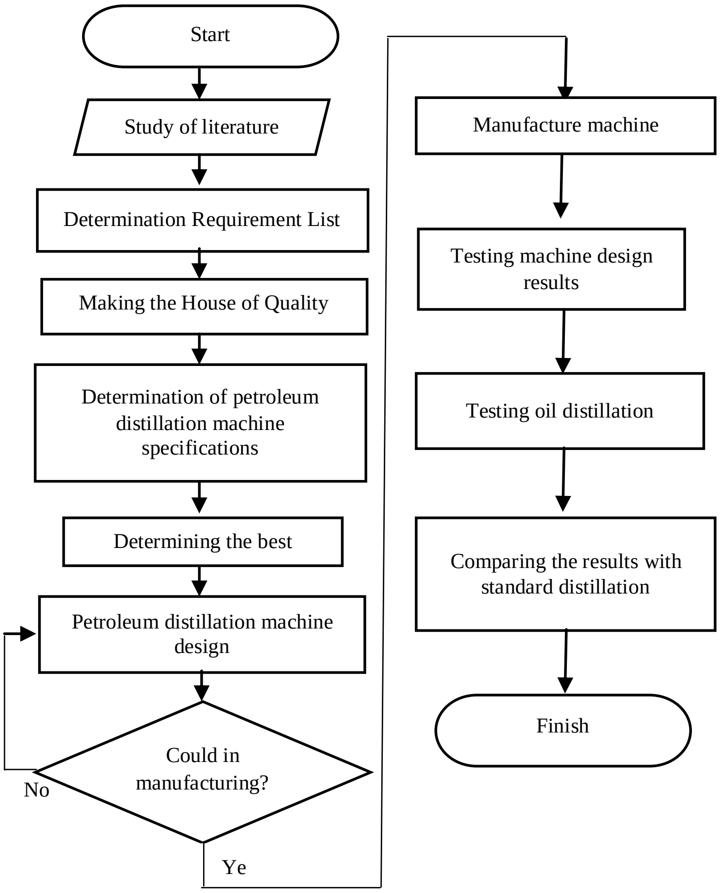


Fig. 2. Flowchart of Research

3. RESULTS

3.1 Determination Requirement List

Table1. Requiment List

Requiment List		**Description**	**W = Wishes D=Demans**
functional	Work system	Able to transform into diesel oil by distillation	D
Geometry	materials Testing	The test material is crude oil	D
	Capacity	Once the process capacity 10 Liter	D
	Dimensional space heating furnaces	Optimal and able to carry 10 liters of crude oil	D
	Dimensions distillation chamber	Optimal and capable of storing steam heating	D
	dimensions cooling	Optimal and suitable	D
	dimension framework	Optimal and able to withstand the load	D
Material	Material space heating crude oil	The material is relatively cheap	W
		Good conductor of heat	D
		Heat resistant(500 °C)	D
	Material furnaces distillation	Can store hot steam	D
		The material is relatively cheap	W
		Corrosionresistant	W
		Heat resistant	D
	material frame	robust	D
		The material is relatively cheap	W
		Heat resistant	D
		Easy to obtain	D
Production process	Component	Using standard components	D
	Cost	The material is relatively cheap	W
Assembling	Process	Assembly process using standard equipment	W
Transportation	Placement	easily moved	W
Operation	Operation of heating	Optimal operation and cost-efficiently as possible	D
	cost of operation	Cheap	W
Environment	Environmentally friendly	distillation machine does not pollute the environment	W
The final result	Safety	Able to withstand the load and secure	D
	Friendly	Easy to use by operators	D
	Optimal	Can distilling optimally	D

In this phase, we will clarify what needs to design a machine fractional distillation of petroleum laboratory scale. Based on a predefined task, then prepared a technical specification of the product contained in the list of requirements. List of Requirement is used as a guideline to design machines fractional distillation of petroleum laboratory scale. Besides, the list of requirements drawn up based on the needs of the completion of the task, so some requirements such as the calculation of the manufacturing cost cannot be calculated or determined.

This stage describes and defines the task in a manner that task outlines into the requirements list, contains restrictions that must be met (demands) and restrictions are expected to be fulfilled (wishes). Here, in table 1 of the requirements outlined in the design of the machine list fractional distillation of petroleum by Pahl and Beitz method.

3.2 Making the House of Quality

House quality or commonly called the House Of Quality (HOC) is the first stage in the application of QFD methodology. Broadly speaking, this matrix is an attempt to convert the voice of the customer directly to the technical requirements or the technical specifications of the products or services produced

Based on the above list of requirements, then made a priority basis and House of Quality for machine design fractional distillation of petroleum laboratory scale.

xx = Very touching once
x = Related
~ = Not related
~~ = Unrelated

Machine distillation of petroleum to diesel		Weighting interests	The temperature needed	Load structure	The noise level	Precise manufacture	Size needed	Number of components
Unit			°C	Kg	Db	Jt	m^2	#
Target								
functional	Produce solar	5	9	3				
Structure	Capable of supporting the load	5		9		3		
Dimension	Laboratory scale	3					9	
Operation	Capable of being operated 1 person	3						9
Material	Able to withstand heat temperature	5	9			1		
Safety	Not to hurt the operator	3	3		9			
Maintenance	Easy to maintain	1					1	3
Operating costs	Inexpensive	1				9	1	3
Operating time	4 hours	3	9					
Score			30	12	9	13	11	15
Percentage %			33	13	10	14	12	17
Ranking			1	4	6	3	5	2

Relasi
9 = Powerful relationships
3 = Average
1 = Less

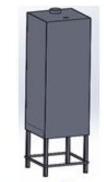
Weighting interests
5 = Perfect
3 = Ok
1 = Less

Fig. 3. Design of House of quality

3.3 Determining the Best Variant

In the design, some components have variants which have drawbacks and advantages, to obtain the right design for hybrid-type grain drying machine, it will be elaborated several variants of the components used as well as several variants formed.

Table 2. Variant shape

No.	Variant	A	B
1	Boiler	 Reactor cylinder	 reactor beam
2	Pipe	0.5 inch.	1 inch.
3	tube distillation	 Distillation tube cylinder	 Distillation tube beam
4	Fuel	Gas stove	Coal

Variant 1 : (1A-2A-3A-4A); Variant 2 : (1A-2A-3B-4A)
Variant 3 : (1A-2B-3A-4A); Variant 4 : (1A-2B-3B-4A)
Variant 5 : (1B-2A-3A-4A); Variant 6 : (1B-2A-3B-4A)
Variant 7 : (1B-2B-3A-4A); Variant 8 : (1B-2B-3B-4A)
Variant 9 : (1A-2A-3A-4B); Variant 10 : (1A-2A-3B-4B)
Variant 11 : (1A-2B-3A-4B); Variant 12 : (1A-2B-3B-4B)
Variant 13 : (1B-2A-3A-4B);Variant 14 : (1B-2A-3B-4B)
Variant 15 : (1B-2B-3A-4B); Variant 16 : (1B-2B-3B-4B)

The results of the research are the best variant for the design of machines fractional distillation of petroleum laboratory scale variant 1 (Boiler cylinder - 0.5 inch Pipe - Tubes distillation cylinder - gas stove), by reason of the appropriate size pipe diameter and more secure than the variance other variants.

3.4 Specifications Data Design

dH	: Hole Diameter	= 0,5 in
σ	: Surface Tensin	= 29 dyne/cm
ρL	: Liquid Dendity	= 53,1 lb/ft³
ρG	: Vapour Density	= 2,478 lb/ft³
S	: Height	= 39,4 in
H_{ct}	: Clear Liquid Height	= 2 in

3.5 Calculation of Factor C On Flow (C_{SB})

Using the usual correlation calculation methods, but the method often used. How else to minimize the trial, the author uses the previous estimate by using the correlation flow. Correlation is used to determine the area and diameter tray area(Kister, 1990).

$$C_{SB} = 0{,}144 \left[\frac{d^2 .\ \sigma}{\rho L}\right]^{0{,}125} \left[\frac{\rho G}{\rho L}\right]^{0{,}1} \left[\frac{S}{Hct}\right]^{0{,}5} \quad (1)$$

$$C_{SB} = 0{,}144 \left[\frac{0{,}5^2\ .\ 29}{53{,}1}\right]^{0{,}125} \left[\frac{2{,}478}{53{,}1}\right]^{0{,}1} \left[\frac{39{,}4}{2}\right]^{0{,}5}$$

$$C_{SB} = 0{,}37 \text{ ft/s} = 0{,}11 \text{ m/s}$$

3.6 Calculation of Speed Flow (U_N)

To calculate the flow rate of steam distillation pipe used formula 2 (Kister, 1990).

$$U_N = C_{SB}\sqrt{\frac{\rho L - \rho G}{\rho L}} \quad (2)$$

$$U_N = 0{,}37 \sqrt{\frac{53{,}1 - 2{,}478}{2{,}478}} = 1{,}66 \text{ ft/s} = 0{,}51 \text{ m/s}$$

3.7 Calculation of Net Area (A_N)

To calculate the net area of the flow velocity derating factor is used. For crude towers, SF = 1. CFS = 13,58 ft^3/s.Also requires a security boundary, in this case assumed tubes designed for 80 percent of the flow(Kister, 1990).

$$A_N = \frac{CFS}{(SF)(0{,}8)(UN)} \quad (3)$$

$$A_N = \frac{13{,}58}{1{,}0 \,.\, 0{,}8 \,.\, 1{,}66} = 10{,}29 \text{ ft}^2 = 0{,}96 \text{ m}^2$$

3.8 Calculation of Downcomer Area (AD)

To calculate the value of the downcomer area (AD) can use the table Tower Design Summary, with a maximal diameter of tower 6 ft(Kister, 1990).

$A_D = 3{,}80 \text{ ft}^2 = 0{,}35 \text{ m}^2$

3.9 Calculation of Total Tower Area (A_T)

To calculate the total area of the tower, required data are AN and AD, then summed (Kister, 1990).

$$A_T = A_N + A_D \quad (4)$$

$$A_T = 10{,}29 \text{ ft}^2 + 3{,}80 \text{ ft}^2 = 14{,}09 \text{ ft}^2 = 14{,}09 \text{ ft}^2 = 1{,}31 \text{ m}^2$$

3.10 Calculation of Diameter Total Tower (D_T)

Having obtained the total area of the tower, then can be searched how the diameter required for the distillation tube may be used formulas 5 (Kister, 1990).

$$D_T = \sqrt{\frac{0.4}{\pi} A_T} \quad (5)$$

$$D_T = \sqrt{\frac{0.4}{\pi} 14{,}09} = 1{,}34 \text{ ft} = 408 \text{ mm}$$

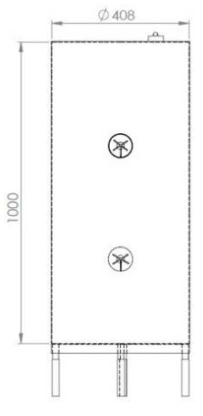


Fig. 4. Dimensions of distillation tube (millimeters)

3.11 Calculation of Reactor Tube Wall Thickness (t)

Calculating the reactor tube wall thickness by using the formula 6.

$$t(in) = 1{,}456 \times 10^{-4} (H-1)(ft) \,.\, D(ft) + 0{,}125 \quad (6)$$

Where:
H =High of tank= 16,4 ft
D = diameter tank = 0,58 ft
Corrosion allowance = 0,125

$t(in) = 1{,}456 \times 10\text{-}4\ (16{,}4 - 1) \,.\, 0{,}58 + 0{,}125 = 0{,}126$ in
$t(in) = 3$ mm

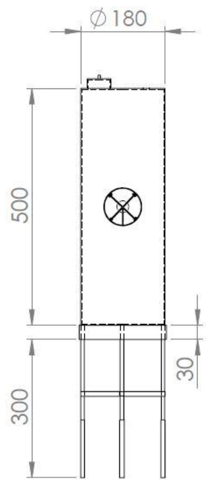


Fig. 5. Dimensions of reactor tube with maximal capacity 5 Liter (millimeters)

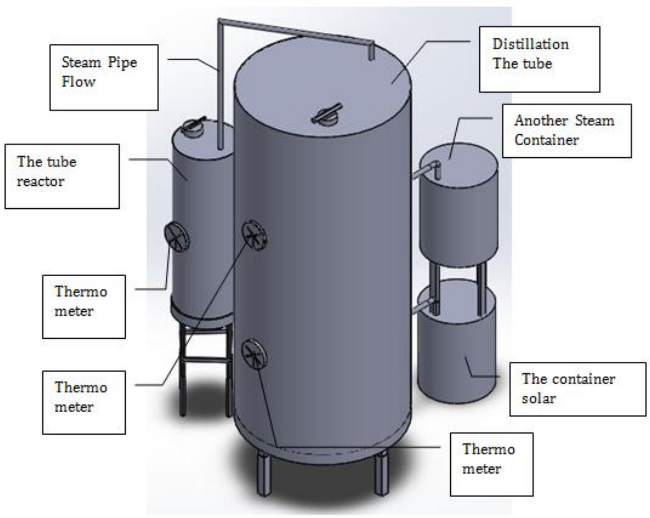


Fig. 6. Design of Laboratory Scale Oil Distillation Machine

3.12 Comparison between the oil distillation results with standards established by the Government

From the test results in the distillation of oil, which can be viewed at table 3.

Table 3. Comparison between the oil distillation results with standards established by the Government

No.	Characteristics	Unit	Result	Standard
1	Specific Gravity	Kg/m^3	863	815 - 870
2	Viscosity	mm^2/s	3,14	2.0 – 5.0
3	Water Content	mg/Kg	72,77	Max. 500
4	Maximum Heating	°C	370	Max. 370
5	Visual Appearance	Clear and Light		Clear and Light

The test results of oil that has been processed using distillation machine laboratory scale show still makes diesel specifications in accordance with standards established by the Government, namely the specifications for specific gravity, viscosity, water content, maximum heating and visual appearance.

4. CONCLUSIONS

Based on the analysis of data and the previous discussion, it can be concluded: The results of the research are the best variant for the design of machines fractional distillation of petroleum laboratory scale variant 1 (Boiler cylinder - 0.5 inch Pipe - Tubes distillation cylinder - gas stove), by reason of the appropriate size pipe diameter and more secure than the variance other variants. While the dimensions obtained from the draft is 1.31 m 2 for a total dimension of the tower area (A_T) and 408 mm for diameter Total Tower (D_T), and 3 mm for the reactor tube wall thickness.In addition, the test results of oil that has been processed using distillation machine laboratory scale show still makes diesel specifications in accordance with standards established by the Government, namely the specifications for specific gravity, viscosity, water content, maximum heating and visual appearance.

5. ACKNOWLEDGMENTS

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