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# Design of Three-Phase Separator in the Domain of Pressure Vessel Design

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**ABSTRACT:** This project showcases the systematic engineering and manual construction of a three-phase separator, designed and built in accordance with ASME standards as part of a capstone project. It represents the culmination of integrated education by combining theoretical knowledge with hands-on fabrication. A comprehensive literature review is included, examining the functions, applications, and design methodologies of distillation columns in line with established industrial standards. The report further discusses the increasing importance of distillation units in the future of the energy sector, highlighting the necessity for strict compliance with safety and quality regulations to ensure operational excellence and environmental stewardship. In addition to technical discussions, the report clearly outlines all design goals, such as improving product yield, optimizing energy consumption, and minimizing environmental impact. Emphasis is placed on how scholarly research was thoughtfully integrated with real-world practices to achieve a balanced, practical design. The project demonstrates a strong understanding of crude distillation processes and provides a bridge between academic study and industrial application. Ultimately, this document not only serves as a technical report but also illustrates the vital role of engineering principles in creating safe, efficient, and sustainable solutions for oil processing systems. This Project highlights the step-wise engineering of a three-phase separator, which was designed for a capstone project and manually constructed according to ASME standards.

## I. INTRODUCTION

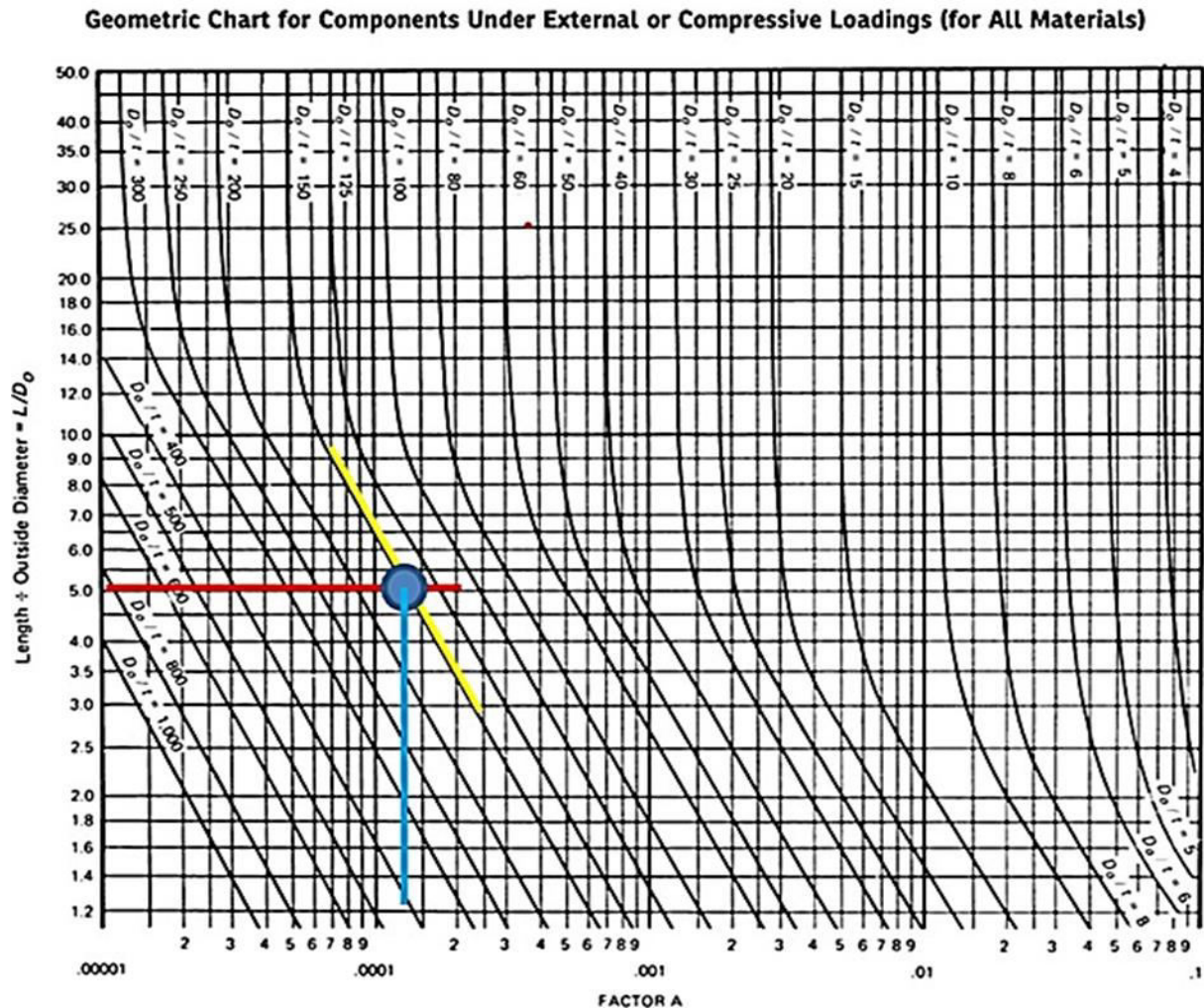
This three-phase separator, designed and built in accordance with ASME standards as part of a capstone project. It represents the culmination of integrated education by combining theoretical knowledge with hands-on fabrication. A comprehensive literature review is included, examining the functions, applications, and design methodologies of distillation columns in line with established industrial standards. The report further discusses the increasing importance of distillation units in the future of the energy sector, highlighting the necessity for strict compliance with safety and quality regulations to ensure operational excellence and environmental stewardship. In addition to technical discussions, the report clearly outlines all design goals, such as improving product yield, optimizing energy consumption, and minimizing environmental impact. Emphasis is placed on how scholarly research was thoughtfully integrated with real-world practices to achieve a balanced, practical design. The project demonstrates a strong understanding of crude distillation processes and provides a bridge between academic study and industrial application. Ultimately, this document not only serves as a technical report but also illustrates the vital role of engineering principles in creating safe, efficient, and sustainable solutions for oil processing systems. The design of a three-phase separator is a critical task within the broader domain of pressure vessel engineering, particularly in industries such as oil and gas production, chemical processing, and petrochemicals. A three-phase separator is responsible for efficiently separating a mixture of oil, gas, and water into distinct phases, ensuring that each component can be processed or transported appropriately. Successful separator design requires a deep understanding of both fluid dynamics and mechanical engineering principles, with particular attention to parameters such as flow rates, fluid properties, pressure and temperature conditions, and separation efficiency. Pressure vessels, including three-phase separators, must be designed according to established codes and standards, most notably the ASME Boiler and Pressure Vessel Code (BPVC). These standards dictate material selection, wall thickness calculations, nozzle design, safety factors, and testing procedures to ensure that vessels can operate safely under expected service conditions. Factors such as corrosion allowance, thermal stresses, and dynamic loading must also be considered during design to ensure a long and reliable operational life.



## II. SYSTEM MODEL AND ASSUMPTIONS

				Rev
Applicable to: <input checked="" type="checkbox"/> Enquiry <input type="checkbox"/> Purchase <input type="checkbox"/> As built		Equipment No.		V-2402
Client		Qty.		1
Service		Location		Gujrat
Size		Orientation/Support		Horizontal / Saddle
<b>MECHANICAL DATA</b>				
Design Code		ASME Section VIII Div.1 2019 Edition		
Content		Well fluid		
Design Pressure (Internal/External)		kPa (g)	1750 / FV	
Design Temperature		°C	200	
Operating Pressure		kPa (g)	1000	
Operating Temperature		°C	150	
Hydrotest Pressure		kPa (g)	As per code	
Density (Vapour / Light liquid / Heavy liquid)		kg /m <sup>3</sup>	5.65 / 898 / 964.5	
Capacity		m <sup>3</sup>	250	
Corrosion Allowance		mm	3	
MDMT		°C	-29	
Joint Efficiency (Shell / Head)		1.0 / 1.0		
Radiography (Shell / Head)		Full / Full		
PWHT		As per code		
Insulation (Hot)		mm	Yes (80 mm)	
Fireproofing		No		
Painting		Yes		
Pickling & Passivation		Yes (For SS internals only)		
Inspection By		Company / TPI		
Code stamp		No		
Wind Data		As per note 15		
Seismic Data		As per note 16		
Empty Weight		kgs	To be provided	
Operating Weight		kgs	To be provided	
Hydrotest Weight (Shop)		kgs	To be provided	
<b>MATERIAL SPECIFICATION</b>				
Shell	SA 516 Gr 70	Internals	NA	
Dished Ends	SA 516 Gr 70	External Attachments	SA 516 Gr 70 /SA 36	
Nozzle Necks (Fab.)	SA 516 Gr 70	Internal Bolting / Nuts	NA	
RF Pad	SA 516 Gr 70	Nozzle Bolting / Nuts	SA193 B7M /SA194 Gr 2HM	
Nozzle Pipes	SA 106 Gr B	Gaskets	SS 316 Spiral wound with graphite filler with SS inner & outer ring	
Nozzle Flanges	SA 105			
Pipe Fittings	SA 234 Gr WPB			
Support	SA 516 Gr 70			
Name Plate	SS 316			
Earthing Boss	SS 316 /Brass			
Anchor Bolt	SA 307 Gr B			
Weir (Baffle) plate	SA 516 Gr 70			

Figure G



### III. RESULT AND DISCUSSION

The three-phase separator was successfully designed by applying ASME Section II and VIII standards. Manual calculations were validated using PV Elite software, ensuring the design met internal and external pressure requirements. The shell, dish ends, and nozzles were optimized for structural safety, with proper material selection enhancing overall reliability. Critical areas like nozzle reinforcement and manway access were verified for compliance. Final analysis demonstrated the separator's robustness under operational stresses, confirming its alignment with industrial standards. This integration of theoretical and software-based methods resulted in a safe, efficient, and code-compliant pressure vessel design. The design of the three-phase separator was carried out using ASME Section II and VIII standards, with calculations performed manually and cross-verified through PV Elite software. The material selected, SA 516 Gr 70, met the required strength and corrosion allowances for safe operation. Thickness calculations for the shell, dish ends, and nozzles ensured the vessel's integrity under both internal and external pressures. Nozzle reinforcement and manway designs were critically assessed to guarantee structural safety and functionality. The PV Elite model confirmed the accuracy of the manual calculations, showing consistency in stress distribution and compliance with design criteria. Challenges such as dish-end thinning and external pressure resistance were addressed by adjusting nominal thicknesses to ensure safety margins were maintained. The results demonstrate that the separator design is robust, reliable, and fully adheres to ASME standards. This approach reinforces the importance of combining manual engineering practices with software analysis for optimal design validation.

#### IV. CONCLUSION

This paper presents the design of the three-phase separator using PV Elite software examined alongside calculations done manually. The detailed analysis included parameters like internal and external pressure for the shell as well as both the elliptical dish ends to check the feasibility and safety limits of operation for the separator. Moreover, the calculations from the nozzles were done for compliance and alignment with standards of design and operations.

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