

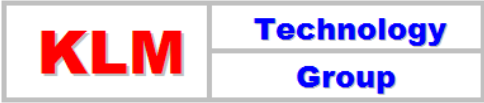
<p>KLM Technology Group</p> <p>Practical Engineering Guidelines for Processing Plant Solutions</p>	 <p>Engineering Solutions</p> <p>Consulting, Guidelines and Training</p> <p>www.klmtechgroup.com</p>	<p>Page : 1 of 120</p>
		<p>Rev: 03</p>
		<p>Rev 01 Oct 2012 Rev 02 Sept 2014 Rev 03 June 2021</p>
<p>KLM Technology Group P. O. Box 281 Bandar Johor Bahru, 80000 Johor Bahru, Johor, West Malaysia</p>	<p>The Kolmetz Handbook of Process Equipment Design</p> <p>COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING</p> <p>(ENGINEERING DESIGN GUIDELINES)</p>	<p>Co Author:</p> <p>Rev 01 Aprilia Jaya Rev 02 Yurika P.M. Rev 03 Utami Ledyana</p> <p>Author Editor Karl Kolmetz</p>

TABLE OF CONTENT

TABLE OF CONTENT	1
INTRODUCTION	6
Scope	6
General Design Consideration	7
DEFINITIONS	10
NOMENCLATURES	14
THEORY	19
Coalescer	20
The Function of Coalescers	22
Coalescing media	23
Contact Angle	23
Slip length	24
Coalescer Design	25
Some Definitions	25

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 2 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

Media Selection as Function of interfacial tension (IFT)) and Other Fluid Properties	27
Mat Thickness	29
Coalescing Dispersions of Lower Interfacial Tension	29
Densities of Coalescing Material and Susceptibility to Compaction	31
Velocity, Residence Time and Orientation	31
Basis for Sizing and Selection	34
Stokes Settling With Coalesced Droplets	38
Type of Coalescer Media	42
Media Selection	42
Plate Coalescer	42
Matrix Coalescer	46
Sizing	47
Polypropylene Packs	48
Installation Options	51
Inlet Zone	51
Separation Zone	51
Outlet Zone	52
Mesh Coalescer	52
Coalescer and Separator Cartridges	55
Selection Criteria	56
Cost of Filtration Separation	56
Coalescer Cartridges	57
Liquid-liquid coalescer	61
Operating principles of a liquid-liquid coalescer	62

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 3 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

Droplet Capture	63
Droplet Coalescence	65
Liquid-Liquid Coalescer Design	69
Stokes Settling	69
Intra-Media Stokes Settling	73
Direct Interception	75
Gravity Separation Downstream of a Coalescer Element	79
Liquid-Gas Coalescer	82
Ratings/Sizing	86
Formation of Fine Aerosols	90
Liquid-Gas Coalescer Design	95
Gravity Settling	96
Media Velocity	101
Annular Velocity	102
Application	108
Example 1: Liquid-Gas Horizontal Coalescer Design	108
Example 2: Liquid-Gas Vertical Coalescer Design	110
Example 3: Liquid-Liquid Coalescer Design	112
Example 4 Liquid – Liquid Coalescer	115
Example 5 Liquid-Gas Coalescer	118
REFERENCES	16

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 4 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

LIST OF TABLE

Table 1 The effectiveness of various physical coalescing methods	21
Table 2 Coalescing media	23
Table 3 Rising or Settling Velocity in water hydrocarbon system	32
Table 4 Superficial Velocities in vertical coalescers	33
Table 5 Comparison Between Separation time and Droplet Size	35
Table 6 performance of several media type coalescer	50
Table 7 Coalescing media and their applications	68
Table 8 Typical sources and characteristics that can generate dispersion	73
Table 9 Type of coalesce with their coefficient	77
Table 10 Types of Liquid/Gas Separators	84

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 5 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

LIST OF FIGURE

Figure 1 Vertical coalescer	8
Figure 2 Horizontal coalesce	9
Figure 3 Coalescing in the medium	39
Figure 4 Horizontal liquid–liquid coalescer configuration	40
Figure 6 Vertical liquid–liquid coalescer configuration	Error! Bookmark not defined.
Figure 7 Plate Coalescer pack	43
Figure 8 Several Type of Plate Coalescer	45
Figure 9 Matrix Coalescer Packs	46
Figure 10 Typical arrangement of Polypropylene Coalescer	49
Figure 11 Placement of the Packs of Coalescer	52
Figure 12 Media Mesh Coalescer	53
Figure 13 Typical Dual Mesh Coalescer Pack	54
Figure 14 Four Step of The Coalescing Process into Cartridge Coalescer	59
Figure 15 Colaescer Cartridge	60
Figure 16 Three steps coalescing	63
Figure 17 Zones where different coalescing mechanisms apply	64
Figure 18 Forces on a light droplet dispersed in a heavy liquid	70
Figure 19 Volume Fraction Frequency Distributions For Dispersion Of Various Maturities	71
Figure 20 Droplet Size Distribution Curve	79
Figure 21 Liquid Gas Coalescer Design View	83
Figure 22 Coalescer Efficiency Change VS Gas Flow Rate	87
Figure 23 Effect of Chemical Treatment on Coalescer Performance	89
Figure 24 Aerosol Sizes	91
Figure 25 High efficiency liquid-gas coalescer	94
Figure 26 Mechanism in liquid-gas coalescer	95
Figure 27 Forces on Liquid Droplet in Gas Stream	97
Figure 28 Drag coefficient of rigid sphere	98
Figure 29 Effect of surface treatment on annular velocity (a) surface treated and (b) untreated	106

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 6 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

INTRODUCTION

Scope

This guideline covers the basic elements of coalescer design in sufficient detail to allow a practicing engineer to design a coalescer with the suitable size including diameter, length media velocity, and terminal settling velocity.

For coalescers, as with any process equipment, successful sizing and selection is always a combination of empirical observation/experience and analytical modeling. Of the three steps in coalescing – droplet capture, combining of the collected droplets, and gravity separation of the enlarged droplets – the first and the last can be modeled with good accuracy and repeatability. The modeling of the middle and the actual coalescing step is a complex function of surface tension and viscous effects, droplet momentum, and the dynamics of the sizes of the droplets in the dispersion.

The design of coalescer may be influenced by factors, including process requirements, economics and safety. In this guideline there are tables that assist in making these factored calculations from the various reference sources. Include in this guideline is a calculation spreadsheet for the engineering design. All the important parameters used in this guideline are explained in the definition section which helps the reader understand the meaning of the parameters and / or the terms used.

The theory section explains source, type of coalesces and its characteristic of droplet, treated and untreated coalescer and how to calculate sizing and selection of the coalescer. The application of the coalescer theory with an example will help the practicing engineer understand the coalescer and be ready to perform the actual design of the coalescer.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 7 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

General Design Consideration

The biggest development in recent years is the widespread recognition that the actual performance of a separator may fall far short of the theoretical performance due to the actual flow patterns within the vessel being far from the ideal. It has, however been helped by two visualization techniques computational fluid dynamics (CFD) and physical modeling, which vividly show what can go wrong and how to correct it.

The following factors must be determined before beginning separator design.

1. Gas and liquids flow rates (minimum, average, and peak).
2. Operating and design pressures and temperatures.
3. Surging or slugging tendencies of the feed streams.
4. Physical properties of the fluids, such as density, viscosity, and compressibility.
5. Designed degree of separation

The most important areas to ensure a separator performs to design are as follows.

1. Correct inlet nozzle sizing and a good inlet device (momentum breaker).
2. Primary fluid distribution—distribution plates to translate the reduced but still high velocities from the inlet device into quiescent flows in a liquid–liquid separator body, or distribution plates either side of a vane pack (downstream is best as upstream ones shatter droplets unnecessarily) or other gas demister.
3. Intermediate fluid distribution when necessary.
4. Exit devices: vortex breakers and anti-liquid–pickup details.

Coalescer is a mechanical process vessel with wet-able, high-surface area packing on which liquid droplets consolidate for gravity separation from a second phase (for example

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 8 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

gas or immiscible liquid), where small particles of one liquid phase must be separated or removed from a large quantity of another liquid phase. The coalescers might be designed vertically or horizontally.

The vertical design is used to separate water from hydrocarbons when the interfacial tension is greater than 3 dyne/cm. The separation stage is achieved using hydrophobic separator cartridges that provide an effective barrier to aqueous coalesced drops, but allow hydrocarbon to pass through them. The separator cartridges can be stacked below the coalescers for the most efficient utilization of the separator medium. This configuration only applies to the separation of water or aqueous contaminants from hydrocarbons.

After leaving the coalescing stage, the large aqueous coalesced drops and hydrocarbon then flow axially in a downward direction and the flow direction is from the outside of the separator to the inside. The large coalesced drops are repelled by the separators and are collected in the bottom sump. The purified hydrocarbon passes through the separators and exits at the top of the housing. The aqueous phase in the collection sump can be drained manually on a periodic basis or equipped with an automatic level control and drain system.

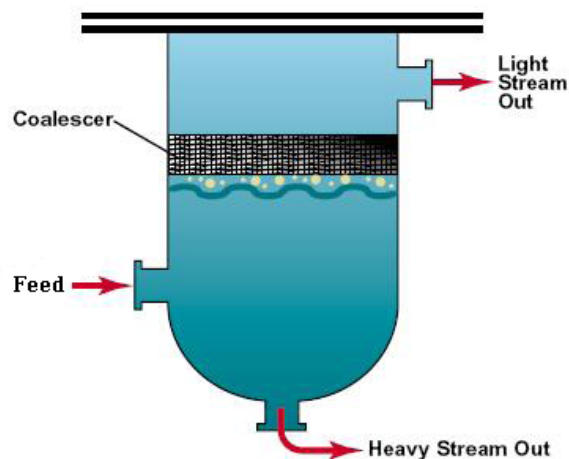


Figure 1 Vertical coalescer

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 9 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

In the horizontal configuration, a settling zone achieves separation by gravity. This configuration is used when the interfacial tension is less than 3 dyne/cm or for the separation of oil from the water phase. The coalescer housing contains a settling zone that relies on the difference in densities between the coalesced droplets and the bulk fluid

This configuration can be used for both hydrocarbon from water and water from hydrocarbon separation, but the location of the collection sump and outlet nozzle will need to be reversed. For the case of removal of hydrocarbon from water, a collection sump is located at the top of the housing and the purified water leaves at the bottom outlet nozzle. The sump can be drained manually on a periodic basis or equipped with an automatic level control and drain system.

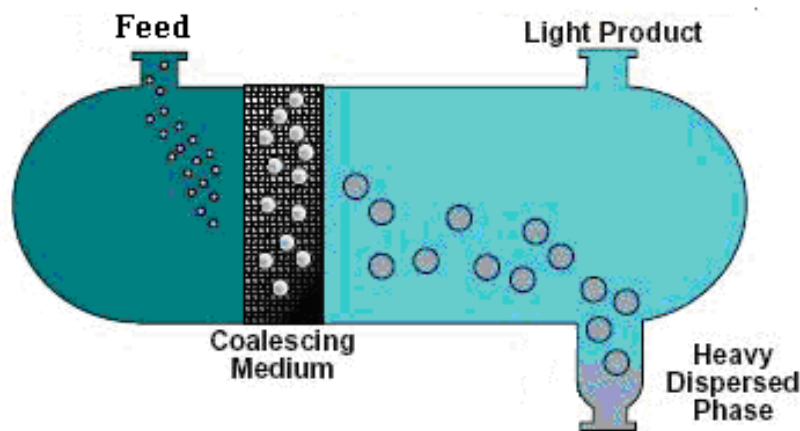


Figure 2 Horizontal coalesce

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 10 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

DEFINITIONS

Air standard - Air having a temperature of (20°C), a relative humidity of 36 percent, and under a pressure of 14.70 PSIA. The gas industry usually considers (16°C) as the temperature of standard air.

Annular velocity - the actual flow rate divided by the annulus area. Modeled as a linear function with vertical distance, and the annular velocity is zero at the bottom of the cartridge and increases to a maximum value at the top of the cartridge.

Annulus - A ring-like part or, the orifice of a hollow die, through which extruded metal flows from the press.

Coalescence - Liquid particles in suspension that unite to create particles of a greater volume.

Coalescer - a mechanical process vessel with wettable, high-surface area packing on which liquid droplets consolidate for gravity separation from a second phase (for example gas or immiscible liquid), where small particles of one liquid phase must be separated or removed from a large quantity of another liquid phase.

Control Volume- A certain liquid volume necessary for control purposes and for maintaining the velocity limit requirement for degassing and to counter foam in separators.

Conventional Gas-Liquid Separator - In this Standard, the term "Conventional Gas-Liquid Separator" is referred to vertical or horizontal separators in which gas and liquid are separated by means of gravity settling with or without a mist eliminating device.

Corrosion – The gradual destruction of materials, by chemical reaction with its environment.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 11 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

Critical Diameter- Diameter of particles larger than which will be eliminated in a sedimentation centrifuge.

Demister Mist Extractor- A device installed in the top of scrubbers, separators, tray or packed vessels, etc. to remove liquid droplets entrained in a flowing gas stream.

Disengaging Height- The height provided between bottom of the wire-mesh pad and liquid level of a vapor-liquid separator

Entrainment - A process in which the liquid boils so violently that suspended droplets of liquid are carried in the escaping vapor.

Extraction column - Vertical-process vessel in which a desired product is separated from a liquid by countercurrent contact with a solvent in which the desired product is preferentially soluble.

Filter- A piece of unit operation equipment by which filtration is performed.

Gas filter - A device used to remove liquid or solid particles from a flowing gas stream

Hold-Up Time- A time period during which the amount of liquid separated in a gas-liquid separator is actually in the vessel for the purpose of control or vapor separation.

Hydrocarbon – An organic compound consisting entirely of hydrogen and carbon.

Immiscible - Not capable of mixing (as oil and water)

Interfacial tension - the accumulation of energy and the imbalance force at the interface of two different phases such as liquid–solid

Knock-Out - A separator used for a bulk separation of gas and liquid.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 12 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

Line Drip- A device typically used in pipelines with very high gas-to-liquid ratios to remove only free liquid from a gas stream, and not necessarily all the liquid.

Liquefied Natural Gas – Natural gas which predominantly methane that has been converted to liquid form.

Laminar flow - Streamlined flow of a fluid where viscous forces are more significant than inertial forces, generally below a Reynolds number of 2000.

Liquid-liquid extraction - The removal of a soluble component from a liquid mixture by contact with a second liquid, immiscible with the carrier liquid in which the component is preferentially soluble.

Media velocity - the actual flow rate divided by the coalescer filter area.

Mesh- The "mesh count" (usually called "mesh"), is effectively the number of openings of a woven wire filter per 25 mm, measured linearly from the center of one wire to another 25 mm from it.

Mercury – Chemical element with the symbol Hg, commonly known as quicksilver.

mmscfd - Abbreviation for million standard cubic feet per day; usually refers to gas flow.

Mud sump - Upstream area in a process vessel where, because of a velocity drop, entrained solids drop out and are collected in a sump.

Overflow- The stream being discharged out of the top of a hydrocyclone, through a protruding pipe, is called "overflow". This stream consists of bulk of feed liquid together with the very fine solids.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 13 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

Process analyzer - An instrument for determining the chemical composition of the substances involved in a chemical process directly, or for measuring the physical parameters indicative of composition.

Regenerative Process – A process that utilizes silver on molecular sieve to chemisorb elemental mercury while providing dehydration at the same time.

Surge tanks- These are storage tanks between units, and can serve a variety of purposes. They can dampen fluctuations in flow rate, composition or temperature. They can allow one unit to be shut down for maintenance without shutting down the entire plant.

Separator - a cylindrical or spherical vessel used to isolate the components in mixed streams of fluids.

Stokes' law - the law that the force that retards a sphere moving through a viscous fluid is directly proportional to the velocity of the sphere, the radius of the sphere, and the viscosity of the fluid.

Suspension - a system consisting of a suspension of solid particles in a liquid

Terminal Velocity - The velocity at which a particle or droplet will fall under the action of gravity, when drag force just balances gravitational force and the particle (or droplet) continues to fall at constant velocity.

Target Efficiency- The fraction of particles or droplets in the entraining fluid of a separator, moving past an object in the fluid, which impinge on the object.

Underflow- The stream containing the remaining liquid and the coarser solids, which is discharged through a circular opening at the apex of the core of a hydrocyclone is referred to as "underflow".

Vapor Space- The volume of a vapor liquid separator above the liquid level.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 14 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

NOMENCLATURE

$ \Delta\rho $	Absolute value of the difference between the densities of the continuous and dispersed phase, lb/ft ³
A	Cross sectional area, ft ²
A_{ann}	Cross sectional annular area, ft ²
A_{med}	Media area for one coalesce, ft ²
C'	Drag coefficient.
C1	Sheet coefficient
d	Droplet Diameter, in
d	Droplet Diameter, microns
D_c	Diameter of house, ft
d_p	Droplet diameter, microns or ft
E	Effective Length Multiplier
g	Gravitational constant, ft/s ²
h	Corrugated plate spacing or structured packing crimp height, in
K	Kuwabara's Hydrodynamic Factor
L	Element length required for removal of all droplets, in
M	Mass flow at standard condition, lb/s
N	Number of coalescers
Q_a	Actual system flow rate, ft/s
Q_l	Liquid/liquid emulsion flow, US GPM
Q_s	Standard system flow rate, ft/s
R_c	Radius of coalescer end cap, ft
R_h	Radius of the housing, ft
S_g	Specific gravity
t_{dr}	Droplet Rise Time, s
t_r	Droplet Residence Time, s
V_c	Coalescer volume, ft ³
v_{max}	Emulsion velocity, ft/s
v_s	Superficial Velocity, ft/s

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 15 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

v_t	Terminal Settling Velocity, ft/s
α	Volume Fraction of Fibers or Wires
ΔS_g	Specific Gravity Difference between the Continuous and Dispersed
η_D	Collection Efficiency of a Single Target by Direct Interception
η_s	Fractional Collection Efficiency by Stokes Settling, typically 0.999

Greek Letters

μ	Continuous Phase Viscosity, cP
ρ_{air}	Density of air at standard temperature and pressure, lb/ft ³
ρ_g	Density of gas, lb/ft ³
ρ_L	Density of liquid, lb/ft ³
Σ	Overall collection efficiency by direct interception

Superscript

A	Cross sectional area, ft ²
E	Effective Length Multiplier
F _g	Fibreglass
K	Kuwabara's Hydrodynamic Factor
L	Element length required for removal of all droplets, in
M	Mass flow at standard condition, lb/s
M	minimum
N	Number of coalescers
pl	polyester I
plII	polyester II

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 16 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

REFERENCES

1. K Kolmetz et al, Kolmetz Handbook of Process Equipment Design, Separator Vessels Selection, Sizing, And Troubleshooting, Engineering Design Guidelines, 2014
2. K Kolmetz et al, Kolmetz Handbook of Process Equipment Design, Pressure Vessels Selection, Sizing And Troubleshooting, Engineering Design Guidelines, 2020
3. K Kolmetz et al, Kolmetz Handbook of Process Equipment Design, Piping Fluid Flow Sizing and Selection, Sizing And Troubleshooting, Engineering Design Guidelines, 2018
4. K Kolmetz et al, Kolmetz Handbook of Process Equipment Design, Filter Separator Selection, Sizing And Troubleshooting, Engineering Design Guidelines, 2020
5. K Kolmetz et al, Kolmetz Handbook of Process Equipment Design, Demister Pads Selection, Sizing And Troubleshooting, Engineering Design Guidelines, 2020
6. Adamson, AW., Physical Chemistry of Surfaces, John Wiley and Sons, New York 1976:pgs. 18-40.
7. Belk, T.E., Effect of Physical Chemical Parameters on Coalescence, Chemical Engineering Progress, Vol. 61, No.10, October 1965:pp.72-76.
8. Chambers, D.B., "Oil-Water Separations Using Fibrous Materials," Chemistry and Industry, Vol. 21, November 4, 1974:pp.834-837.
9. Davies, GA., Jeffrcys, G.V., Azfal, M., "New Packing for Coalescence and Separation," British Chemical Engineering and Process Technology, Vol. 17, No. 9, Sept. 1972 :709-714.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 17 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

10. Davies, GA., Jeffreys, G.V., Ali, F. and Afzal, M., The Chemical Engineer, October 1972:392-396.
11. Dell, F.R., and Pratt, H.R.C., Trans. Inst C/. E., Vol. 29, 1951:pp. 89 and 270.
12. Fowkes, F.M., Anderson, F.W. and JE. Berger, "Bimetallic Coalescers," Environmental Science and Technology, Vol. 4, No.6, June 1970:510-514.
13. Hazlett, RN., "Fibrous Bed Coalescence of Water", I+E.C. Fundamentals, Vol.8, No.4, November 1969:p.633-640.
14. Hazlett, R.N., Fibrous Bed Coalescence of Water, I&EC Fundamentals, Vol. 8, No. 4, Nov. 1969:625-632.
15. Hazlett, RN., Carhart, 11W., "Removal of Water from Fuel Using a Fibrous Bed," Filtration and Separation, July/August, 1972:456-465
16. Hu, S., and Kintner, R.C. "The Fall of Simple Liquid Drops Through Water," AIChE Journal, Vol.1, March 1955:p.42.
17. Jordan, G.V., "Coalescence: Porous Materials," Chemical Engineering Progress, Oct.1965:pp. 64-71.
18. Jordan, G.V., "Separation of Immiscible Liquids by Means of Porous Membranes;" Trans. ASME, April 1955:pp.393-400.
19. Gayler, R., and Pratt, H.R.C., Trans. Inst Ch. E., Vol. 29, 1951:p.110 and Vol. 31, 1953:p. 69.
20. Kintner, R.C., Drop Phenomena Affecting Liquid Extraction, Advances in Chem. Eng., Vol 4, Drew, TB. et al, Editors, Academic Press, 1963.

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.

KLM Technology Group Practical Engineering Guidelines for Processing Plant Solutions www.klmtechgroup.com	The Kolmetz Handbook of Process Equipment Design	Page 18 of 120
	COALESCER SYSTEMS SELECTION, SIZING AND TROUBLESHOOTING	Rev: 03
	ENGINEERING DESIGN GUIDELINES	July 2020

21. Langdon, W.M.; Fochtman, E.G.; Stark, L.L.; Grant, MG.; Petro/Chem Engineer, November 1963:p.34-40.
22. Lewis, J.B., Jones, J., and Pratt, H.R.C., Trans. Inst. Ch. E., Vol. 29, 1951:p. 126.
23. Mokhatab and friends. 2006. Hand Book of Natural Gas Transmission and Processing. Chapter 5. Elsevier, inc. USA
24. Moore, Wi., Physical Chemistry, Prentice Hall, New Jersey, 1972:pg.476
25. Redmon, C., "Cartridge Type Coalescers," Chemical Engineering Progress, Vol. 59, No.9, 1963:pp.87-90.
26. Sareen, S.S., Rose, P.M., Gudesen, R.C., and Kirtner, R.C., Coalescence in Fibrous, AIChE J, Vol. 12, No.6, Nov. 1966:1045-1050.
27. Towler & Sinnott. 2008. Principles, Practice and Economics of Plant and Process Design. Chapter 10. Elsevier, inc. USA
28. Wines. T. High Performance Liquid/Gas Coalescers for Compressor Protection. Pall Corporation. Presented at the 1999 Compressor Workshop, Lambton College, Sarnia, Ontario.
29. Wines, T.H., and Brown, R.J., "Minimizing Liquid Contaminants in Natural Gas Liquids," Paper Presented to the Gas Processors Association, 75th Annual Meeting,
30. Wines and friends. High Efficiency Coalescers Increase On-Line Process Analyzer Sensor Reliability. Pall Corporation. Presented at the Analysis Division 48th Annual Spring Symposium, Calgary, Alberta Canada, April 27-30, 2003

These design guideline are believed to be as accurate as possible, but are very general and not for specific design cases. They were designed for engineers to do preliminary designs and process specification sheets. The final design must always be guaranteed for the service selected by the manufacturing vendor, but these guidelines will greatly reduce the amount of up front engineering hours that are required to develop the final design. The guidelines are a training tool for young engineers or a resource for engineers with experience.

This document is entrusted to the recipient personally, but the copyright remains with us. It must not be copied, reproduced or in any way communicated or made accessible to third parties without our written consent.