

MESH BLANKETS

1. PURPOSE

**2. THEORY AND TYPICAL
INSTALLATIONS**

3. SIZE CRITERIA

4. EFFICIENCY

5. PRESSURE DROP

6. TYPES

7. FABRICATION AND INSTALLATION

8. MATERIAL OF CONSTRUCTION

9. FABRICATORS

10. SAMPLE PROBLEM

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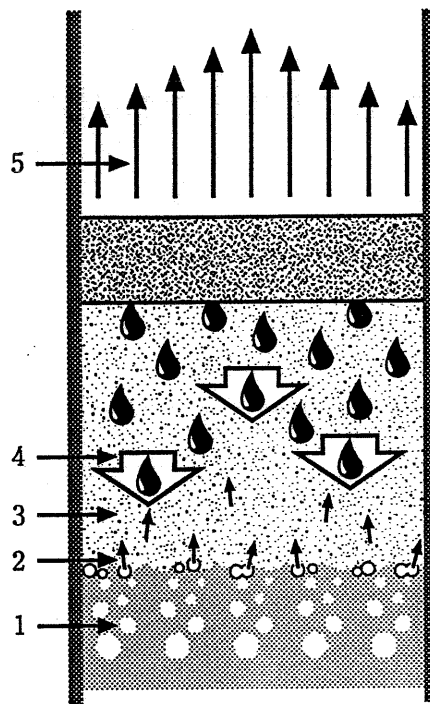
MIST ELIMINATORS

**USED FOR ENHANCING SEPARATION
OF**

- 1.LIQUID DROPLETS FROM VAPOR**
- 2.LIQUID FROM LIQUID**

ADVANTAGES OF MIST ELIMINATORS

**MIST ELIMINATORS ALLOW HIGHER VAPOR
VELOCITIES AND THEREFORE SMALLER
EQUIPMENT SIZE BY FORMING LARGE DROPLETS
THAT CAN MORE EASILY GRAVITY SETTLE**



EDS-R00-3403

1. Vapor disengaging from liquid creates fine droplets.
2. Rising vapor carries liquid entrainment.
3. As the vapor passes through the mesh blanket, the droplets impinge on the wire surface and coalesce into large drops.
4. Large liquid drops fall free.
5. As the vapor leaves the mesh blanket it is almost entirely free of entrainment.

HOW DOES ENTRAINMENT OCCUR

**ENTRAINMENT OF LIQUID DROPLETS OF
VARYING SIZE AND QUANTITY IN A GAS
OCCURS**

- 1. WHENEVER GAS CONTACTS A
LIQUID**
- 2. WHEN LIQUID CONDENSES FROM
A GAS**
- 3. WHEN GAS IS GENERATED FROM
A LIQUID**

THEORY

- 1. DROPLETS CONTACT WIRE SURFACES**
- 2. DROPLETS GATHER AT WIRE INTERSECTION**
- 3. DROPLETS COALESCE AND GROW IN SIZE**
- 4. AS DROPLETS INCREASE IN SIZE THEY DROP LOWER IN THE MESH**
- 5. WHEN LARGE ENOUGH, THEY ARE PULLED DOWN BY GRAVITY AGAINST THE UPWARD GAS VELOCITY**
- 6. PARTICLE SIZE IS GOVERNED BY PHYSICAL PROPERTIES SUCH AS:**
 - A. DENSITY**
 - B. SURFACE TENSION**
 - C. VISCOSITY**

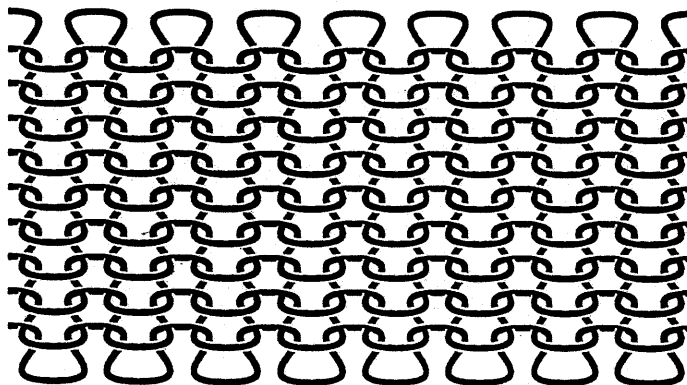
THE HIGHER THE VISCOSITY, THE LARGER THE DROPLET

THE HIGHER THE SURFACE TENSION, THE LARGER THE DROPLET

Since 1944, fine diameter wires interlocked by a knitting operation have been used to form a pad with a high free volume, usually between 95 and 99 percent, in order to minimize pressure drop (Figure 2).

Figure 2

Typical Layer of Wire Mesh



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The individual layers of wire are arranged to provide maximum impingement area, usually between 45 and 120 square feet per cubic foot.

Style	Wire Diameter (In)	Density (lbs/ft ³)	Surface Area (ft ² /ft ³)	Voids (%)
A	0.011	9	85	98.0
B	0.011	5	45	99.0
C	0.011	12	110	97.7

Style A - is a general purpose mesh used when there are no special requirements.

Style B - is used where fouling such (such as coking) or solids are probable.

Style C - is heavy duty, general purpose mesh used where excellent separation efficiency is required.

Styles A and C consist of individual crimped layers, each one of which is actually a nested double layer. Style B is a herringbone type of arrangement where the crimp directions are alternated. This style not only increases the percentage of voids for the same wire surface, but minimizes the sheltering of one wire behind another, as in the nested double layer construction.

MECHANISMS THAT CAUSE ENTRAINMENT

1. MECHANICAL

2. CONDENSATION

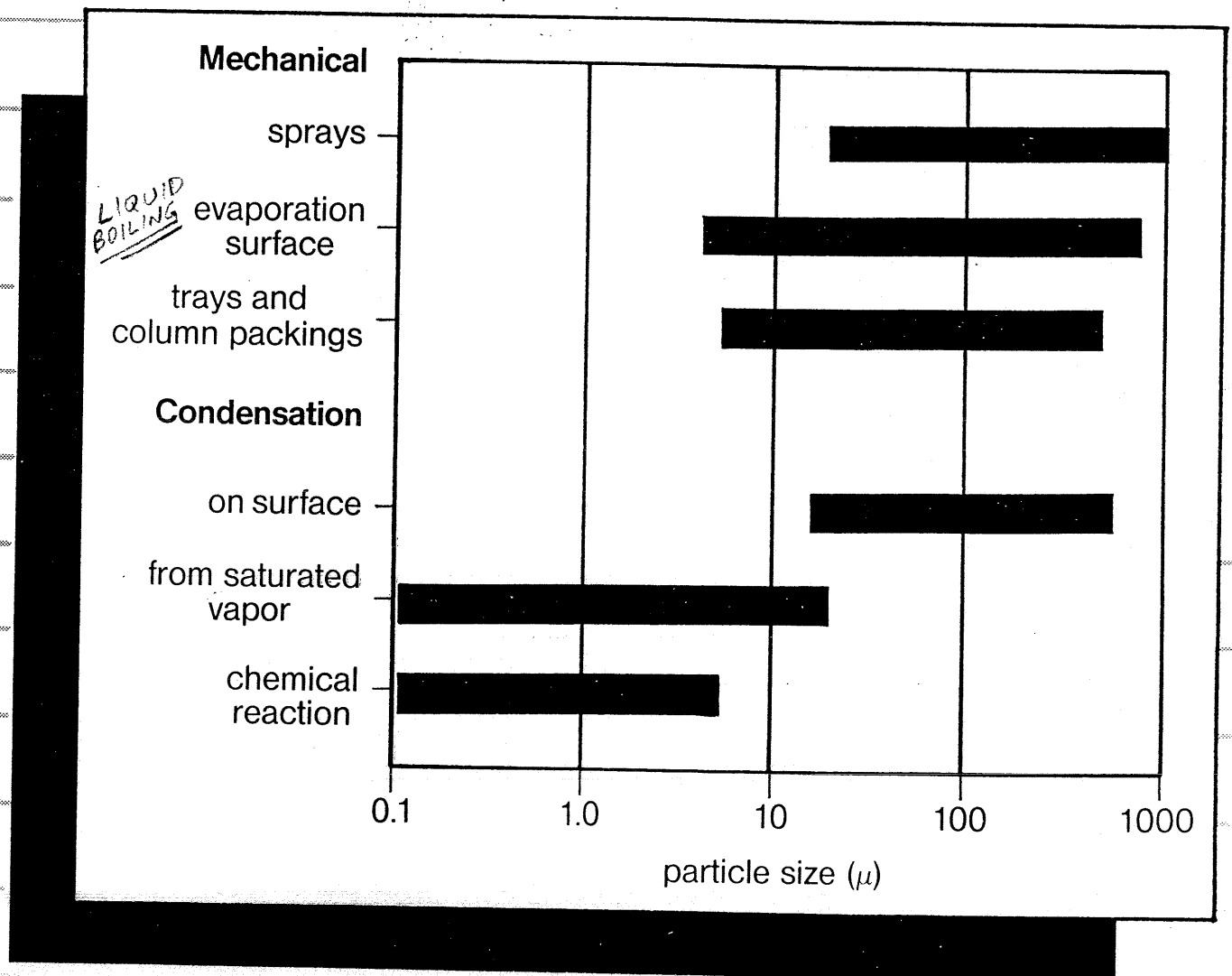


Figure 1. Typical particle size distribution ranges for entrainment caused by various mechanisms.

TYPES OF IMPINGEMENT SEPARATORS

1. STAGGERED BAFFLES OR CHANNELS
2. PERFORATED PLATES
3. FIBER BEDS
4. MESH BLANKETS

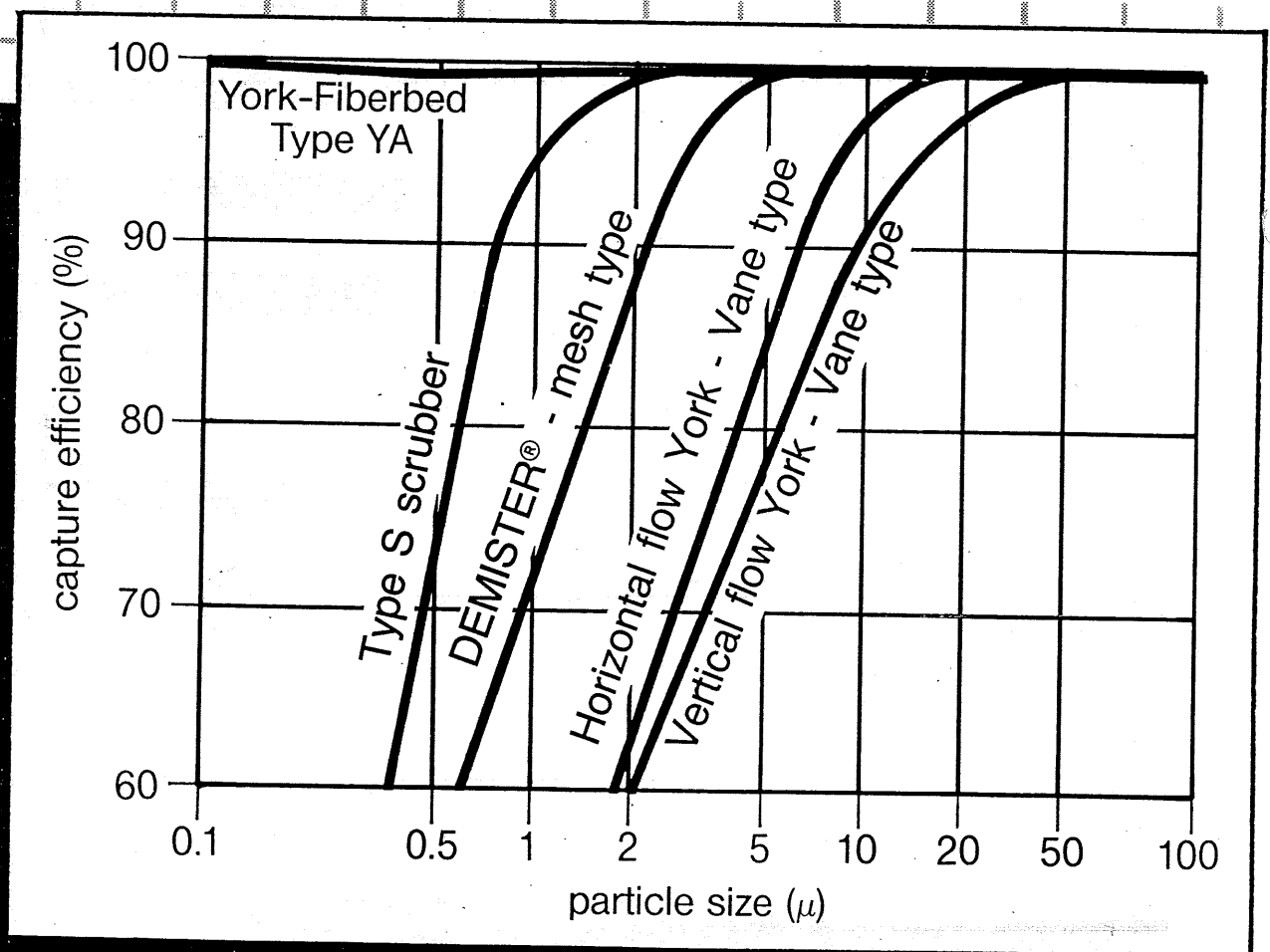
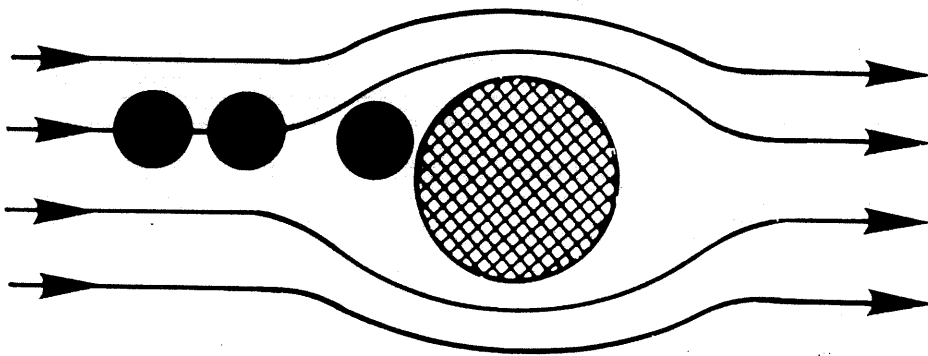


Figure 3. Efficiency of droplet capture vs particle diameter shown for four different types of mist eliminators.

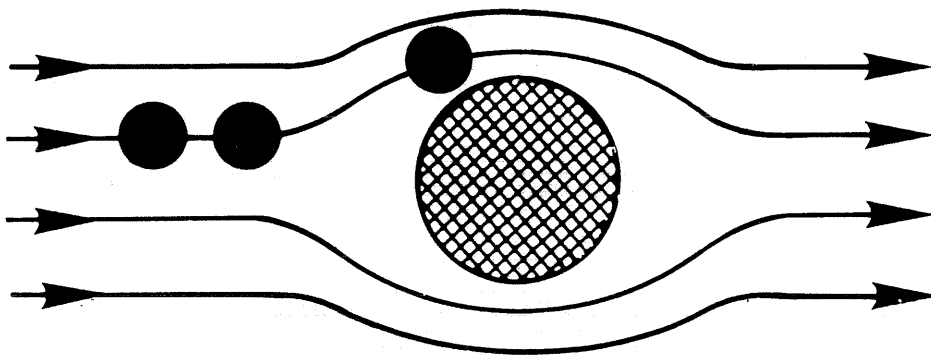
CAPTURE MECHANISMS

1. INERTIAL IMPACTION
2. DIRECT INTERCEPTION
(SURFACE ATTRACTION)
3. BROWNIAN CAPTURE

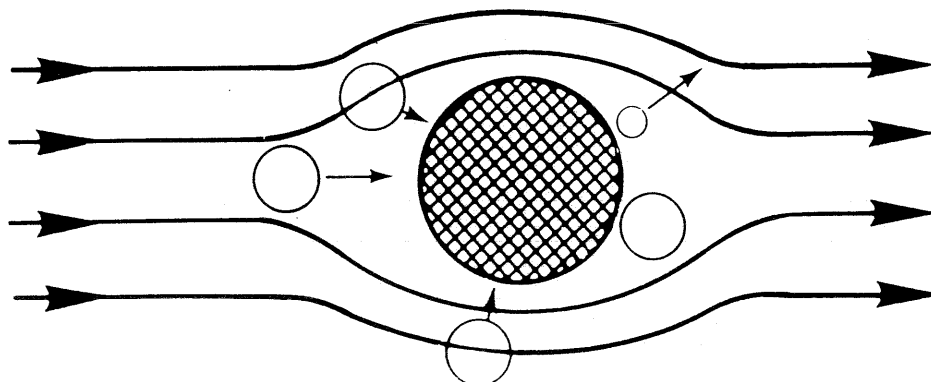
inertial impaction ($\geq 10\mu$)



direct interception ($1-10\mu$)



Brownian capture ($< 1\mu$)



WHY ARE MIST ELIMINATORS USED?

**1. REDUCE LOSS OF VALUABLE PRODUCT
(FOR EVAPORATORS, ABSORBERS, ETC)**

**2. INCREASE THROUGHPUT CAPACITY
(ANYWHERE GASES AND LIQUIDS COME
INTO CONTACT)**

3. IMPROVE PRODUCT PURITY

**4. ELIMINATE CONTAMINATION
(EVAPORATOR OVERHEADS)**

5. STOP DOWNSTREAM CORROSION

**6. PREVENT AIR POLLUTION
(REDUCE EMISSIONS FROM ACID PLANTS)**

SIZE OF MESH BLANKETS

Given a low enough velocity and sufficient time, most of the entrained liquid in a system would be removed by gravity, but the size of the equipment would be impractical. Like most equipment, moving or stationary, entrainment eliminators operate most efficiently within proper velocity limits. Velocity is an important factor in the sizing of a mesh blanket:

1. If the velocity is below the lower limit, the droplets follow the stream of gas without impinging.
2. If the velocity is at the lower limit, the droplets impinge on the wires due to the change in direction forced on the gas and the liquid runs off the wire.
3. If the velocity is increased above the minimum, a layer of liquid begins to form on the mesh and scrubbing helps to improve further entrainment separation.
4. If the velocity is further increased, the liquid layer gradually increases in depth nearing the exist side of the mesh.
5. If the maximum velocity is exceeded, re-entrainment will occur.

FACTORS GOVERNING ALLOWABLE GAS VELOCITY THRU A MESH BLANKET

- 1. GAS AND LIQUID DENSITY**
- 2. SURFACE TENSION OF LIQUID**
- 3. VISCOSITY OF LIQUID**
- 4. WIRE SURFACE AREA**
- 5. LIQUID ENTRAINMENT LOADING**
- 6. SUSPENDED SOLIDS CONTENT**

**LIQUID AND GAS DENSITY HAVE THE
MOST PRONOUNCED EFFECT ON DESIGN
VELOCITY**

SIZE CRITERIA

LIQUID AND GAS DENSITIES HAVE
THE MOST INFLUENCE

FROM STOKES LAW

$$V = K \left[\frac{d_l - d_g}{d_g} \right]^{0.5}$$

V=OPTIMUM VELOCITY FT/SEC

d_l =DENSITY OF LIQUID LBS/FT³

d_g =DENSITY OF VAPOR LBS/FT³

K=CONSTANT BASED ON SYSTEM PRESSURE

V DESIGN = 0.7 V OPTIMUM

K vs PRESSURE

Pressure (In of Hg Absolute)	K
Less than 1"	0.17
1"	0.17
5"	0.23
10"	0.28
20"	0.32
30"	0.35

Pressure (psia)	K
15	0.35
50	0.34
100	0.32
200	0.31
300	0.30
500	0.28
1000	0.27
Greater than 1000	0.27

VELOCITY vs REMOVAL EFFICIENCY

Style A, 6" Thick Mesh Blanket; Salt Water Evaporator

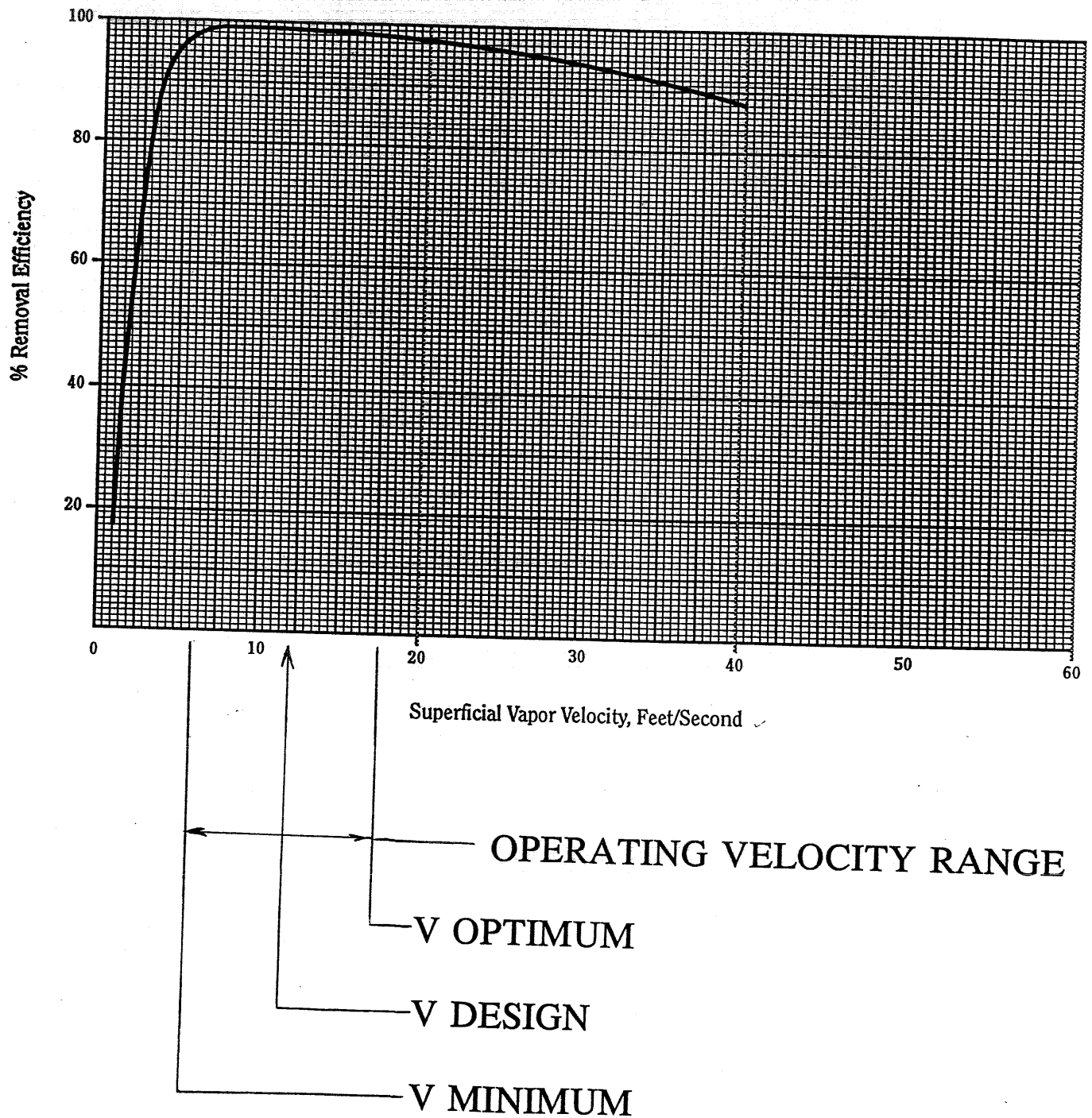
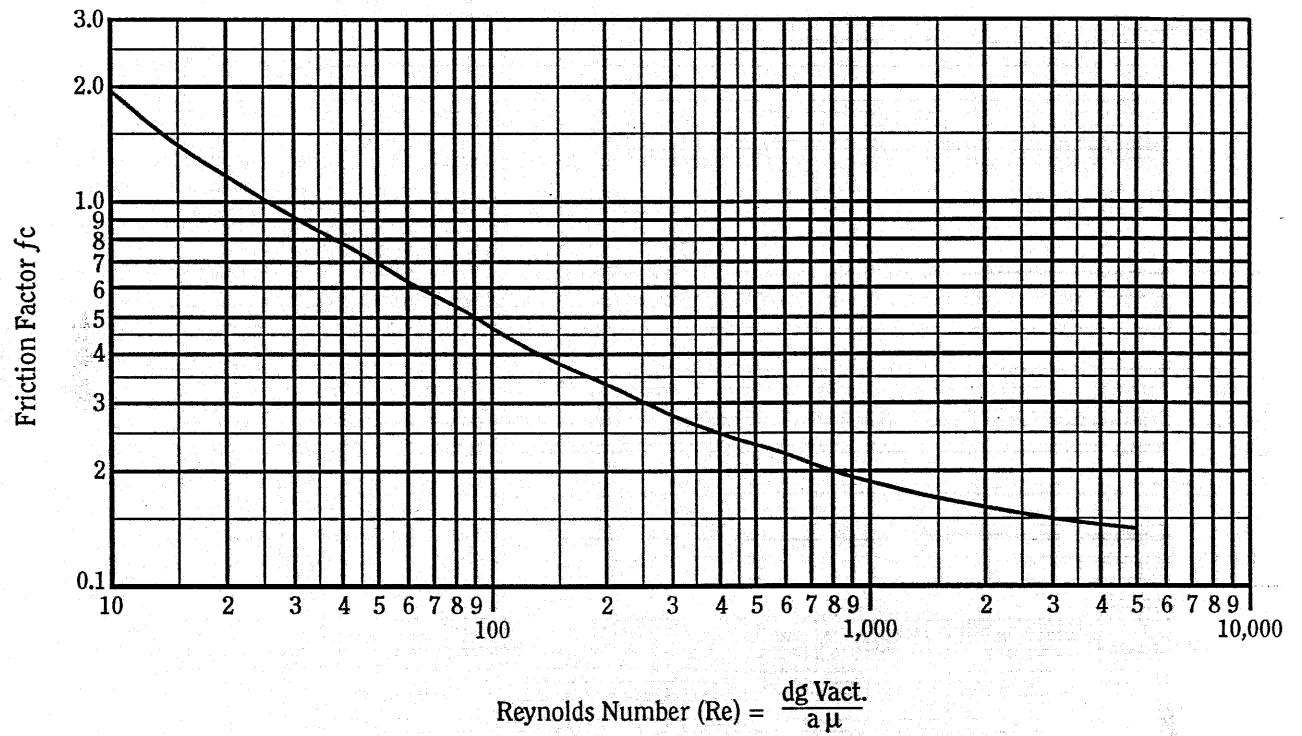


Figure 7

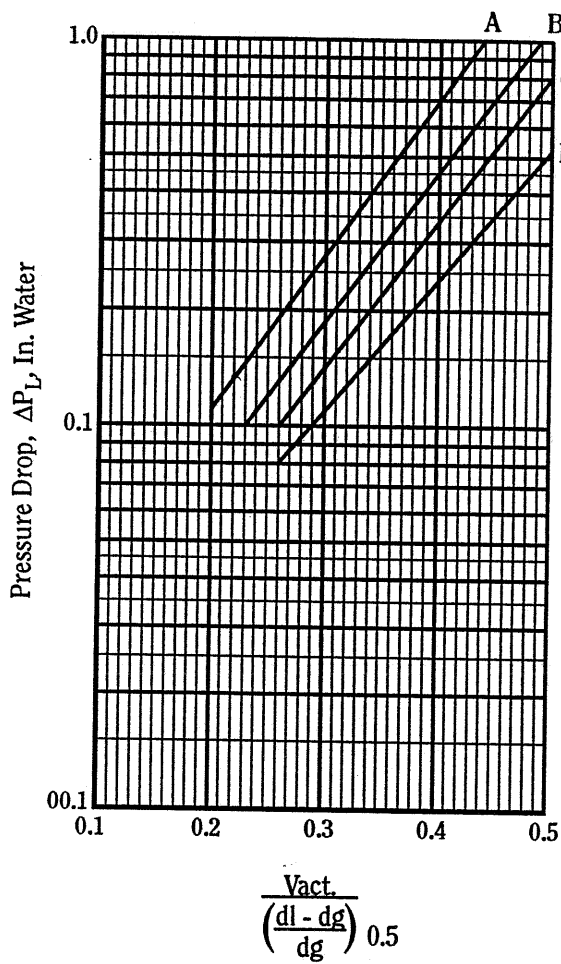
Friction Factor vs Reynolds Number for Mesh Blanket



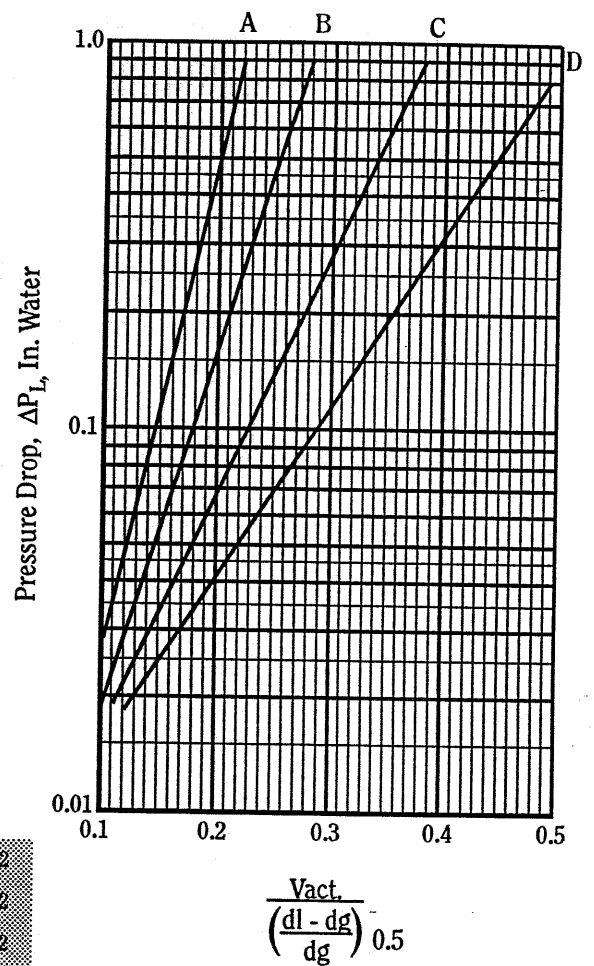
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Figure 8

Pressure Drop for Entrainment Load



Style B, 6 in thick mesh blanket



Style C, 6 in thick mesh blanket

Pressure Drop

The pressure drop in a mesh blanket varies considerably depending on the approach to re-entrainment conditions. At the lower velocity limit when the particles collect on the wires, coalesce, run down and drop off the mesh, the pressure drop is at its minimum. It is then essentially similar to that of a vapor passing through a dry packing. Because of the high percent of voids and short equivalent length of travel, the pressure drop is very low. Heavy entrainment loads at this low velocity still leave much free space and consequently still result in low pressure drop.

As the velocity increases, a condition is reached where the liquid run-off is inadequate and an equilibrium is reached at a given depth of liquid in the mesh. This depth increases with greater velocity and also greater loading until the point of re-entrainment is reached. This is the point of optimum allowable velocity and consequently the point of greatest pressure drop.

The pressure drop through a dry wire mesh blanket may be calculated by the equation:

$$DP_D = \frac{0.193 f_c t a d_g V_{act}^2}{g_c e^3}$$

Where:

ΔP_D = Pressure drop across the mesh blanket with no entrainment, inches of water

f_c = Friction factor, dimensionless (Figure 7)

t = Thickness of mesh blanket, ft

a = Surface area, ft²/ft³

d_g = Gas density, lb/ft³

g_c = Gravitational constant, 32.2 ft lb_m/lb_f s²

e = Void fraction of mesh blanket

V_{act} = Actual superficial gas velocity, ft/s

Since the total pressure drop across an operating mesh blanket is the sum of the dry pressure drop plus the additional pressure drop caused by the liquid loading within the mesh, the total pressure drop may be determined by the equation:

$$\begin{array}{lll} \Delta P_T = \Delta P_D + \Delta P_L \\ \text{(TOTAL)} & \text{(DRY)} & \text{(\Delta P DUE TO LIQUID LOAD)} \end{array}$$

MATERIALS OF CONSTRUCTION MESH MATERIAL

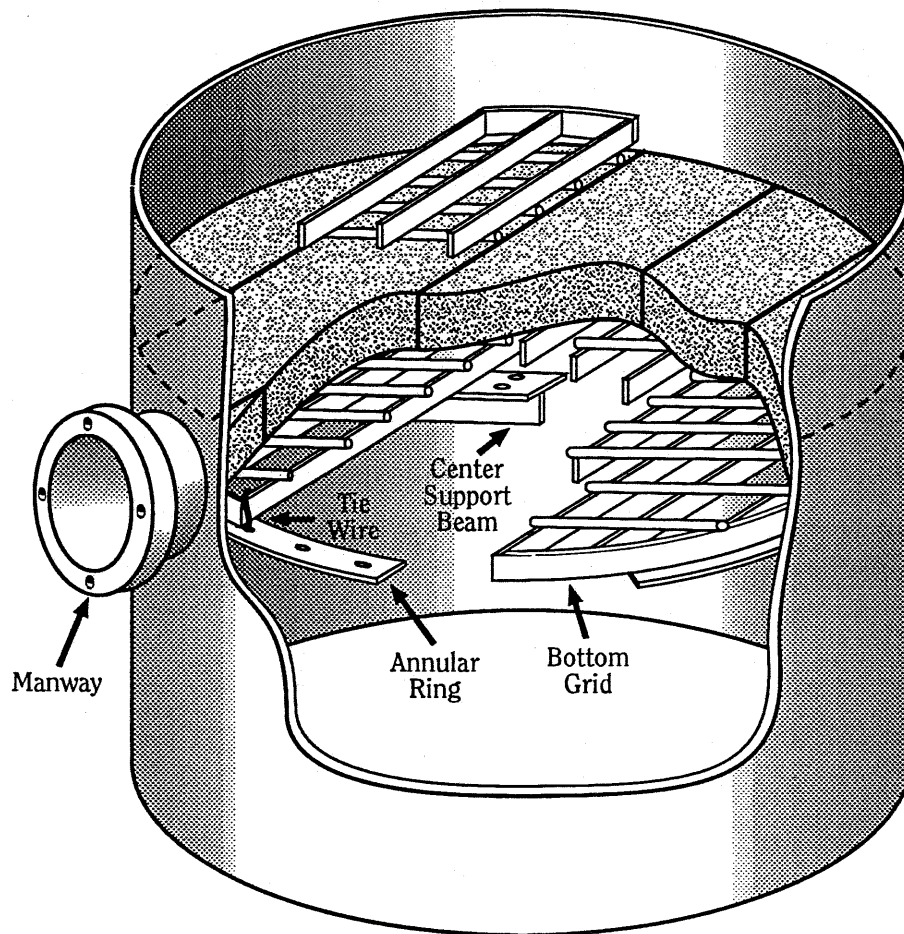
- 1. AUSTENITIC STAINLESS**
- 2. MONEL**
- 3. POLYETHYLENE**
- 4. POLYPROPYLENE**
- 5. TEFLON**

SUPPORT GRID MATERIAL

- 1. AUSTENITIC STAINLESS**
- 2. MONEL**
- 3. CARPENTER 20**
- 4. HASTELLOY**
- 5. TITANIUM**

Figure 9

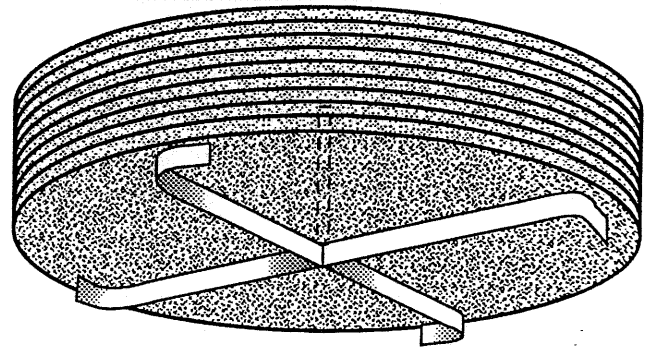
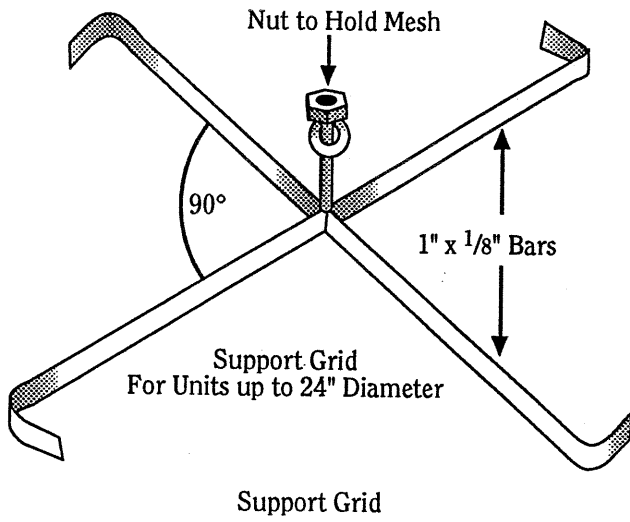
Typical Horizontal Installation of a Sectional Mesh Blanket



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Figure 13

Typical Horizontal One-Piece Mesh Blanket



Mesh on Support Grid

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Sample Problem

Design A Mesh Blanket for a Vertical Separator with the Following Data:

Pressure	110 Psig
Temperature	115°F
Vapor Flow Rate	257,760 lb/h
Vapor mol wt	7.3
Vapor Density	0.147 lb/ft ³
Vapor Viscosity	0.013 cp
Liquid °API	39.4
Liquid mol wt	97.3
Liquid Density	50.1 lb/ft ³

Calculate Optimum Allowable Velocity

$$V = K \left[\frac{d_l - d_g}{d_g} \right]^{0.5}$$

$$V = 0.32 \left[\frac{50.1 - 0.147}{0.147} \right]^{0.5}$$

$$V = 5.9 \text{ ft/s}$$

Calculate Design Velocity

The entrainment would fall into the spray category with a droplet size of 20 microns and larger. Efficient separation is accomplished over a range of 30% to 110% (70% average) of the optimum allowable velocity.

$$V_d = 0.7V$$

$$V_d = 0.7(5.9) = 4.13 \text{ ft/s}$$

Calculate Area Required

$$A_R = \frac{257,760}{0.147(3600)4.13}$$
$$A_R = 117.9 \text{ ft}^2$$

Calculate Diameter Required

$$D = 2 \left(\frac{A}{\pi} \right)^{0.5}$$
$$D = 2 \left(\frac{117.9}{3.14} \right)^{0.5} = 12.25 \text{ ft}$$

Because Support Ring is 2.5 Inches Wide, Add 5 Inches to Diameter

$$D_R = 12.25 + 0.42 = 12.67 \text{ ft (12'-8")}$$

Use Style A, 6 Inch Thick Mesh Blanket With Diameter Of 12'-8".

Estimate Pressure Drop

$$\Delta P_D = \frac{0.193 f_c t a d_g V_{act}^2}{g_c e^3}$$

$$a = 85 \text{ ft}^2/\text{ft}^3$$

$$V_{act} = 4.13 \text{ ft/s}$$

$$\mu = (0.013 \text{ cp}) (0.000672) = 0.0000087 \text{ lb/ft} \cdot \text{s}$$

$$\text{Reynolds No.} = \frac{d_g V_{act}}{a \mu} = \frac{0.147(4.13)}{85(0.0000087)} = 821$$

$$f_c = 0.20 (\text{Figure 7})$$

$$\Delta P_D = \frac{(0.193)(0.20)(0.5)(85)(0.147)(4.13)^2}{32.2(0.98)^3} = 0.136 \text{ in water}$$

$$\Delta P_L (\text{From Figure 8}) = \frac{257,760}{117.9} = 2186 \text{ lb/hr} \cdot \text{ft}^2$$

$$\frac{V_{act}}{\left(\frac{d_I - d_g}{d_g}\right)^{0.5}} = \frac{4.13}{\left(\frac{50.1 - 0.147}{0.147}\right)^{0.5}} = 0.224$$

ΔP_L for Style B ≈ 0.12 in H_2O

ΔP_L for Style C ≈ 1.0 in H_2O

Average $\Delta P_L \approx 0.56$ in H_2O

$$\Delta P_{T_1} = \Delta P_D + \Delta P_L = 0.136 + 0.56 = 0.696 \text{ in } H_2O$$

$$\Delta P_{T_2} = 1.5 \left(\frac{V_{act}}{V} \right)^2 = 1.5 \left(\frac{4.13}{5.9} \right)^2 = 0.74 \text{ in } H_2O$$

↑ SIMPLER CALCULATION AS A CHECK



APPENDIX 9 Continued

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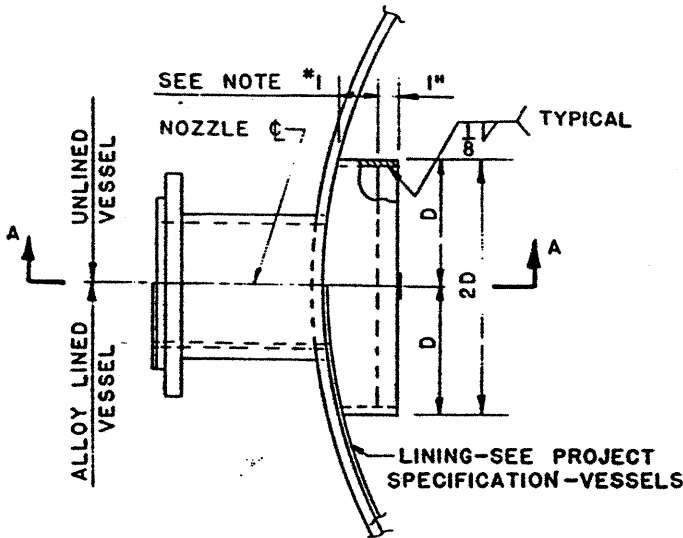
STANDARD DRAWING

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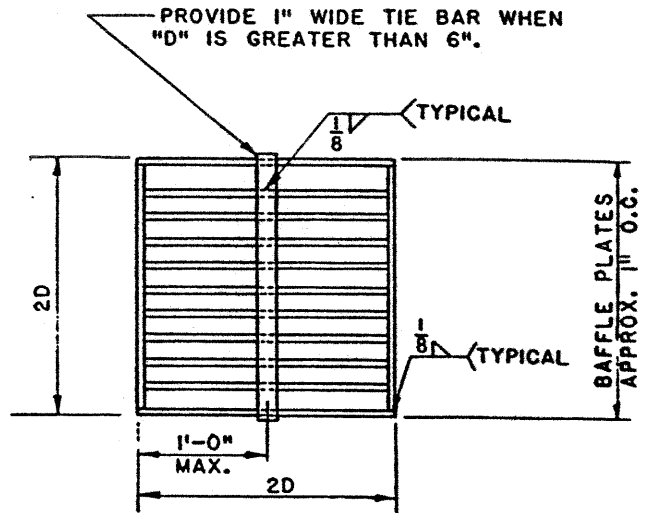
APPROVED: *HEM*

VORTEX BREAKERS

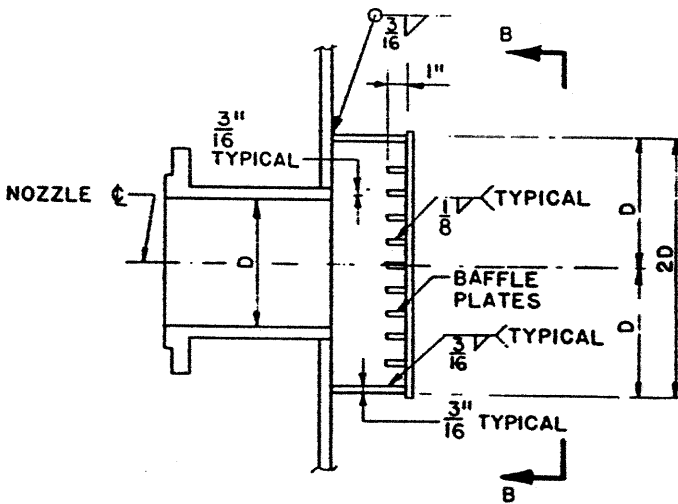
(SIDE OUTLET)



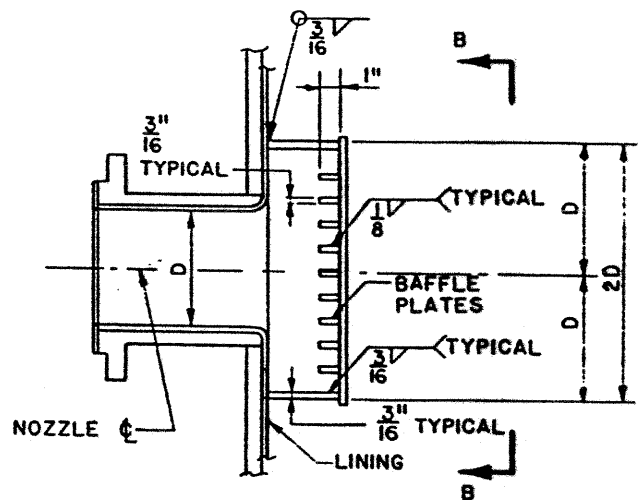
PLAN



VIEW B-B



SECTION A-A
UNLINED VESSEL

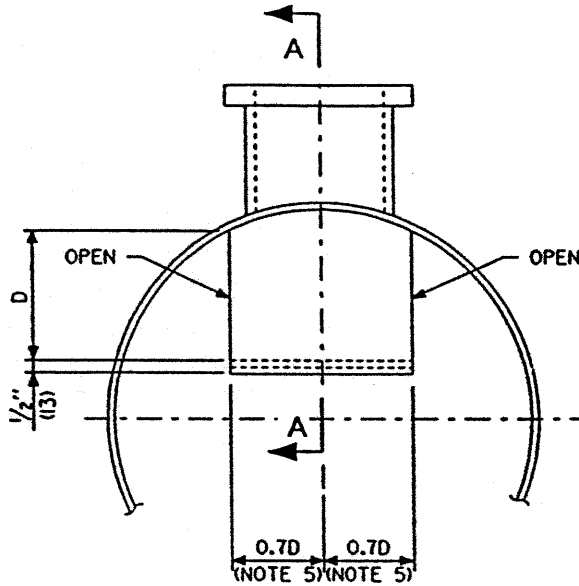


SECTION A-A
ALLOY LINED VESSEL

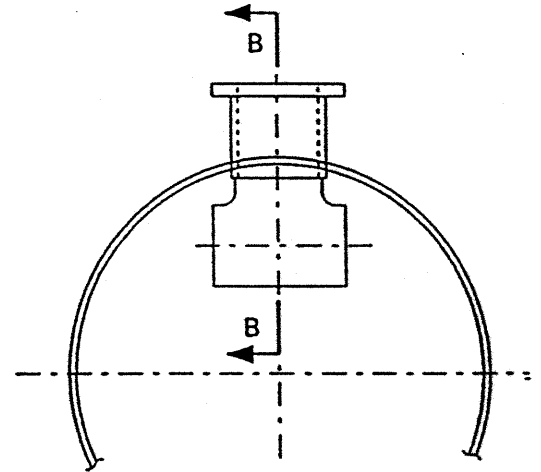
NOTES:

1. DISTANCE BETWEEN BAFFLE PLATES AND VESSEL SHELL TO BE 2" CLEAR AT ITS CLOSEST SECTION.
2. VORTEX BREAKER SHALL BE SAME MATERIAL AS VESSEL SHELL UNLESS LINED. FOR LINED VESSEL MATERIAL SHALL BE SAME AS LINING.
3. DETAILS, DIMENSIONS AND NOTES IN PROJECT SPECIFICATION-VESSELS TAKE PRECEDENCE OVER THOSE SHOWN HEREON.

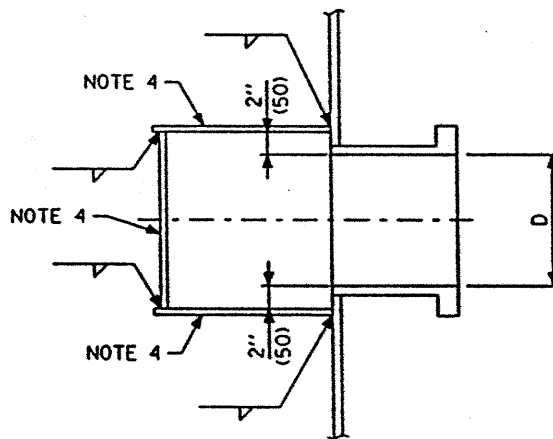
TEE DISTRIBUTOR FOR HORIZONTAL AND VERTICAL VESSELS



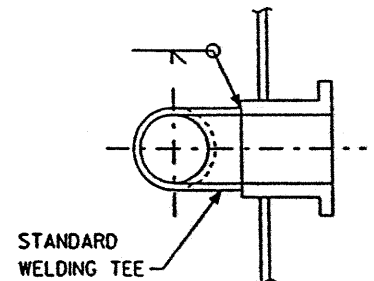
VESSEL SECTION



VESSEL SECTION



SECTION A-A
14" (356) AND OVER



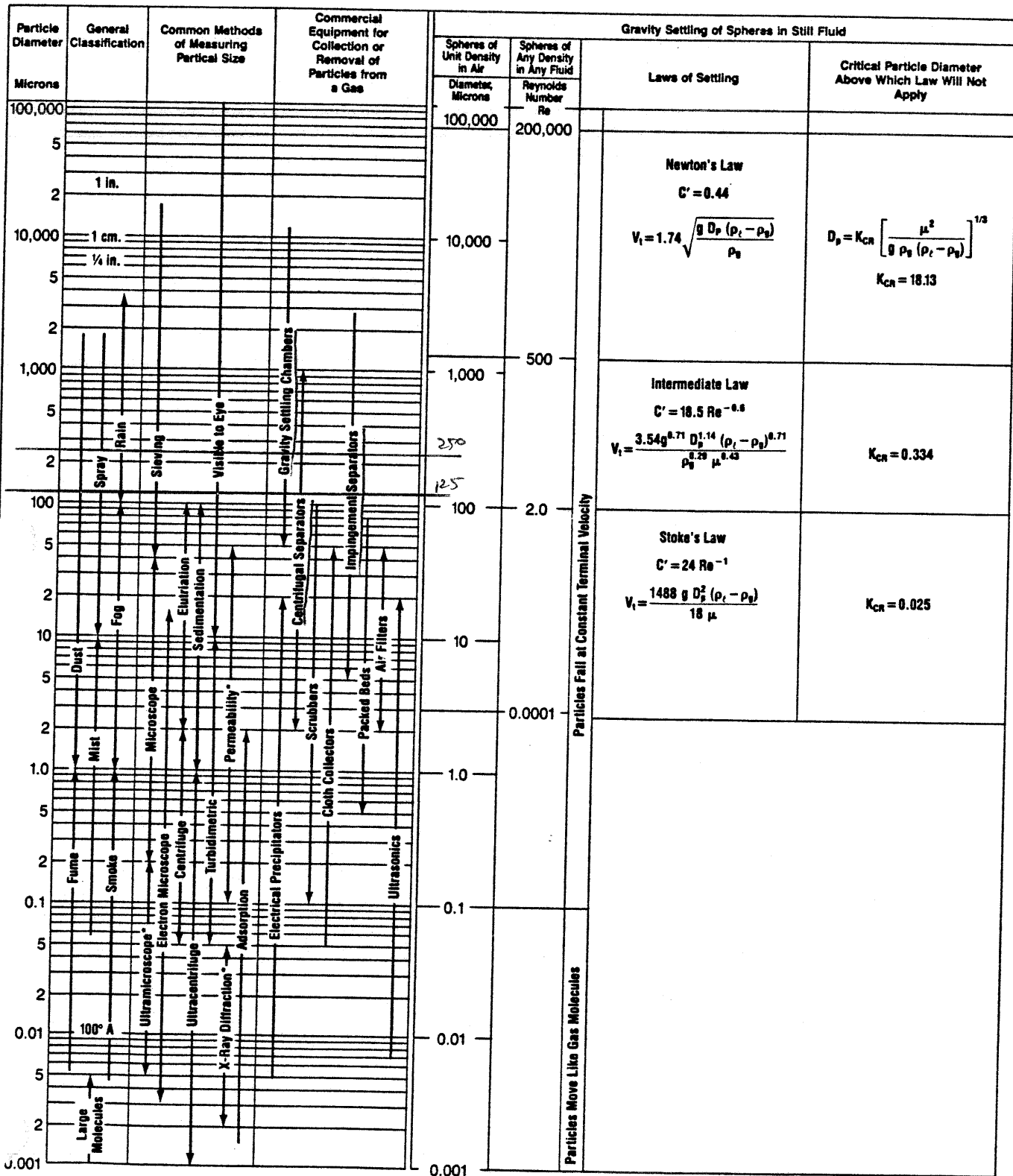
SECTION B-B
12" (305) AND UNDER

NOTES:

1. DETAILS, DIMENSIONS AND NOTES IN UOP PROJECT SPECIFICATION-VESSELS TAKE PRECEDENCE OVER THOSE SHOWN HEREON.
2. LETTER DIMENSIONS TO BE DETERMINED BY TRAY SUPPLIER IF NOT SPECIFIED IN UOP PROJECT SPECIFICATION-TRAYS AND PACKING.
3. DISTRIBUTOR PIPE FITTINGS TO BE STANDARD WALL.
4. 1/4" (6) PLATE MINIMUM. PROVIDE SUPPORT AND/OR STIFFENERS IF REQUIRED.
5. NOT TO EXCEED 0.3 OF VESSEL INSIDE DIAMETER.
6. DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.

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FIG. 7-4
Gravity Settling Laws and Particle Characteristics



Adapted From Ref. 7-12

SEPARATORS, DRUMS, AND RECEIVERS

All Pressure Vessels Except Reactors and Fractionators

Types of Vessels

Design Conditions

Sizing Criteria

Vessel Auxiliaries

PRESSURE VESSEL CODES

ASME Pressure Vessel Code

Design pressure > 15 psig

Diameter > 6 inches

Volume $\geq$ 120 gal

ASME Section VIII, Division 1

Governs most vessels

Wall thickness < 2 inches (50 mm)

ASME Section VIII, Division 2

Optional for high design pressure

Wall thickness > 4 inches (100 mm)

Higher allowable stresses

More nondestructive testing

ASME Section 1

Governs steam generation

Special rules

Foreign Codes

DESIGN TEMPERATURES – GUIDELINES FOR SELECTION

Normal

50°F (28°C) Above Operating Temperature

250°F (120°C) Minimum *Steam out cases*

Cryogenic

25°F (14°C) Below Operating Temperature

Minimum Design Metal Temperature

Lowest Temperature of:

25°F (14°C) Below Normal Operating

Lowest 24 Hour Mean Ambient

Autorefrigeration

Considerations/Exceptions:

Alternate Operations

Equipment Failure

Metallurgical Break Points

Specific Process Exceptions

Temperature for Vacuum Design

Flange Ratings

Cold Wall Designs

Steamout

Caustic Service 150°F (66°C)

150°F → 15 wt %
22½ Be
170°F → 7 wt %

DESIGN PRESSURES – GUIDELINES FOR SELECTION

Design Pressure

Below 1000 psig (70.4 kg/cm²), Greater of:

50 psig (3.5 kg/cm²)

25 psi (1.8 kg/cm²) + Maximum Operating Pressure

1.10 (Maximum Operating Pressure)

Above 1000 psig (70.4 kg/cm²), Greater of:

100 psi (7.0 kg/cm²) + Maximum Operating Pressure

1.05 (Maximum Operating Pressure)

Considerations/Exceptions:

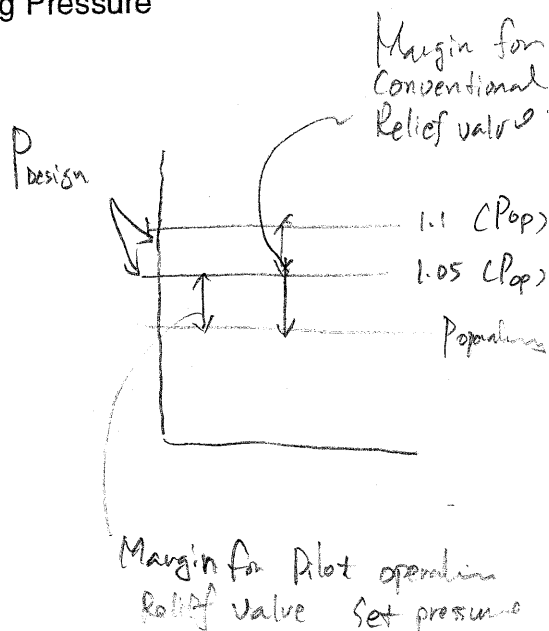
Alternate Operations

Relief Valve Type

Upflow Pressure Drop

Pump Shutoff Pressure
20 ~ 25 %

Specific Process Exceptions



DESIGN PRESSURES – GUIDELINES FOR SELECTION

Vacuum Design

Design for "Full Vacuum" if Vacuum Can Exist

Considerations/Exceptions

Normal Operation Under Vacuum

Evacuation for Start-up, Shutdown, Regeneration

Liquid Full/Hot Fluid/Blocked In

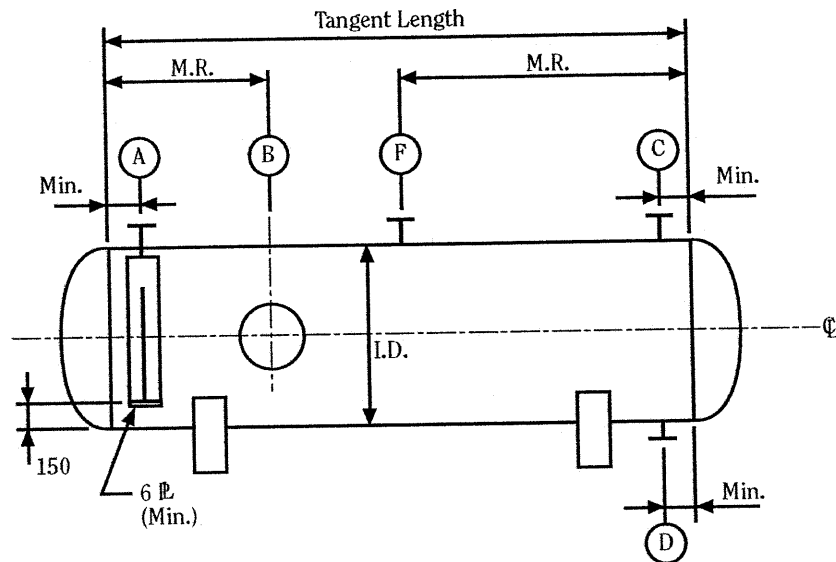
Fractionators – Loss of Heat Input

Client Requirements

Vacuum Design Not Specified for Steam Out

TYPES OF VESSELS

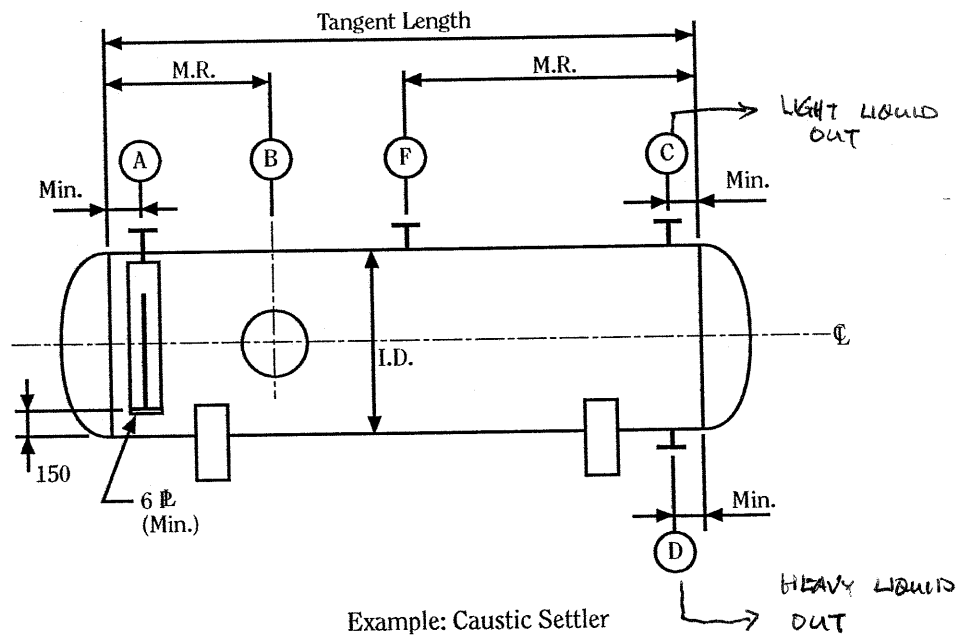
Vapor/Liquid Separator



Example: Overhead Receiver

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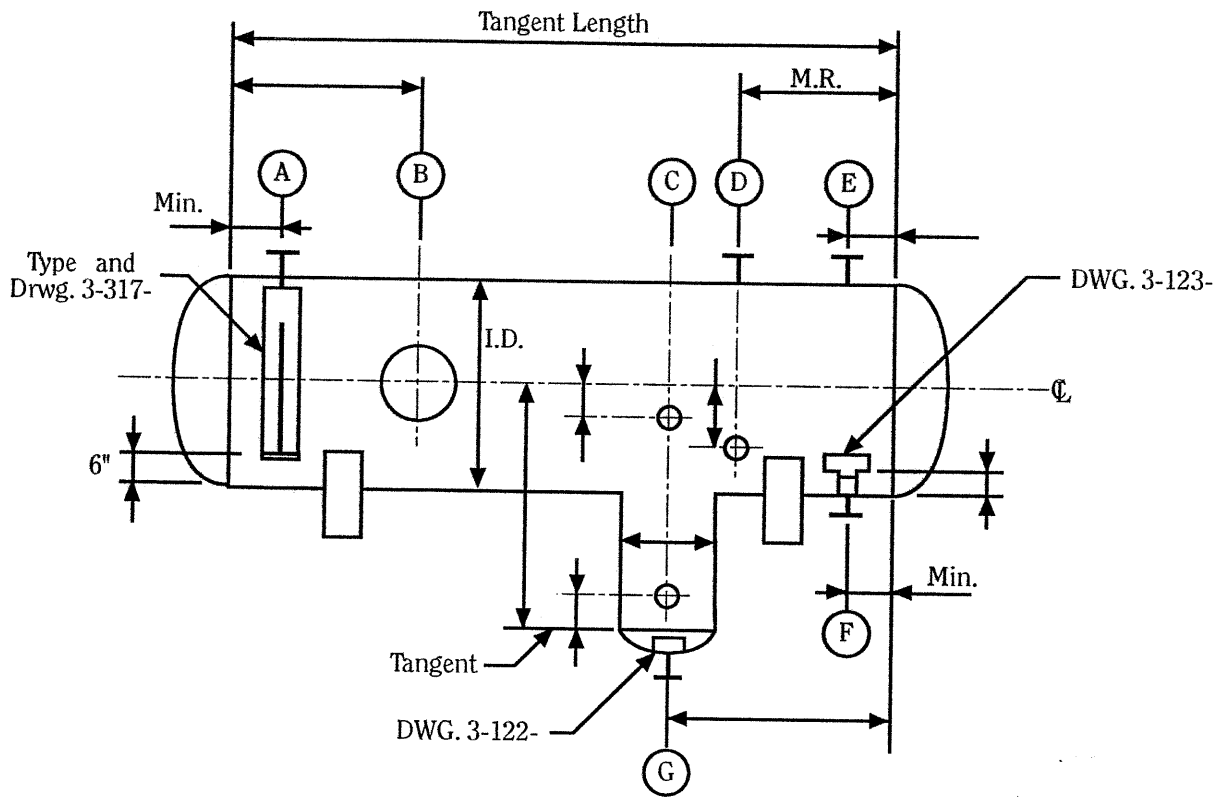
Liquid/Liquid Separator



Example: Caustic Settler

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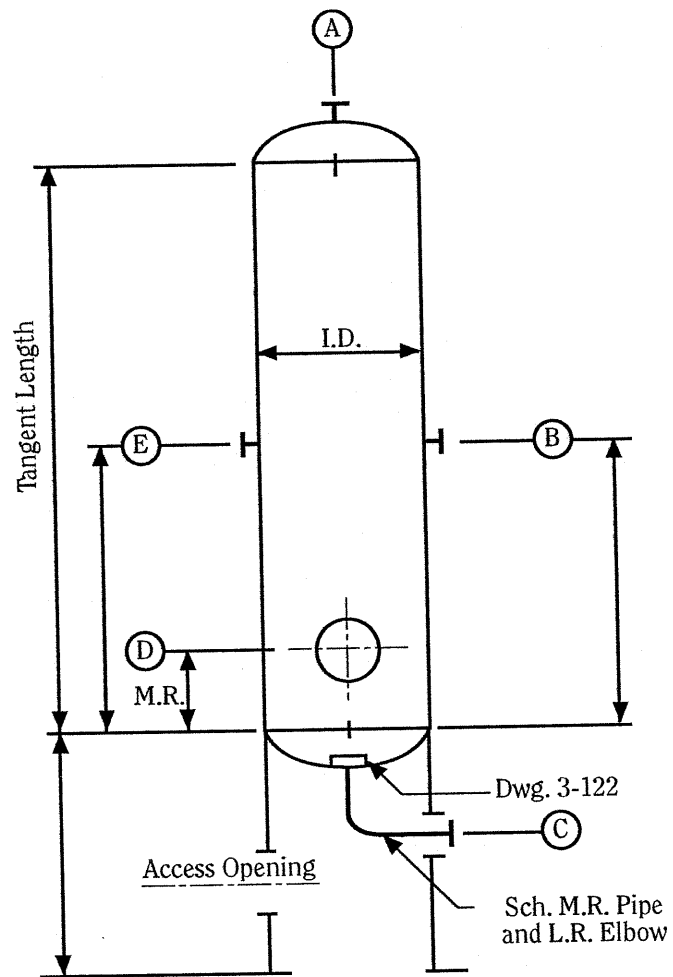
Vapor/Liquid/Liquid Separator



Example: HP Separator

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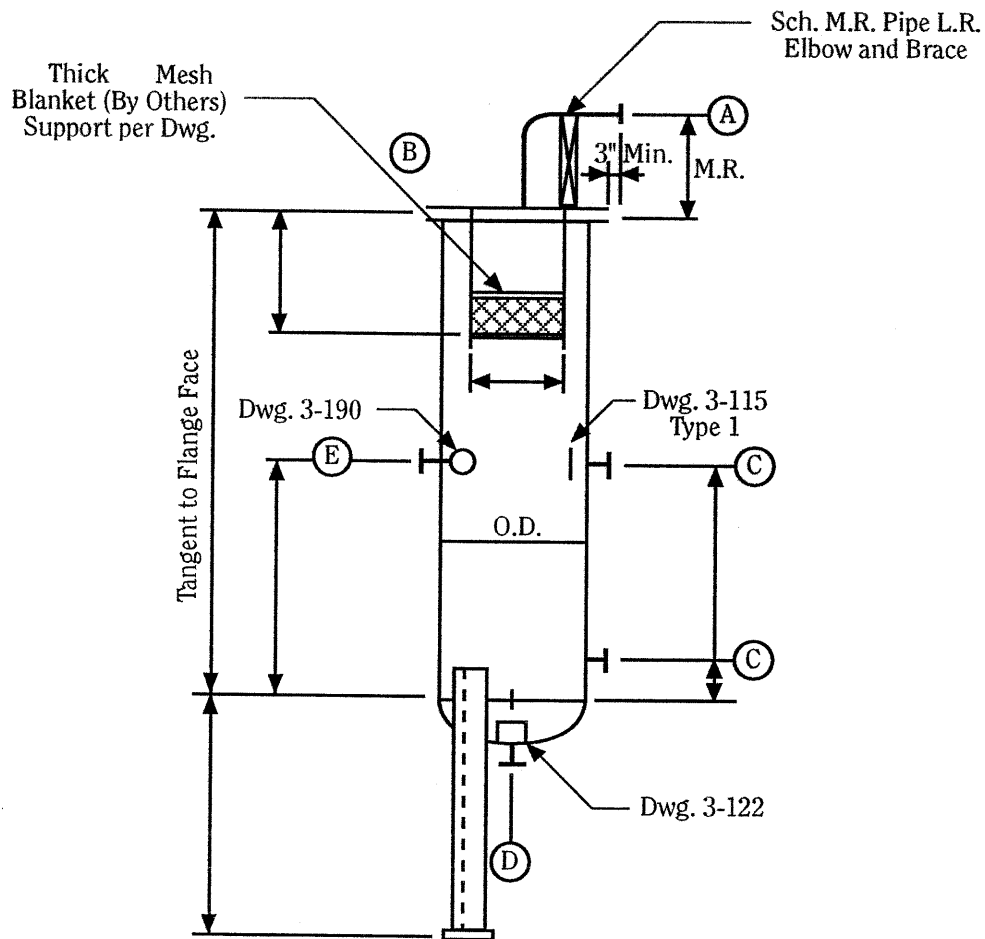
Vapor/Liquid Separator



Example: Separator, Flash Drum

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Small Vertical Separators



ID of 30 inch or less
Elevation of 5 feet or less
Example: Reciprocating Compressor Suction Drum

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RESIDENCE TIME CONSIDERATIONS

Experience

Similar Process Systems

Expert Recommendation

Effect of Lost Level

Upstream

Downstream

Effect of Overfill

Upstream

Downstream

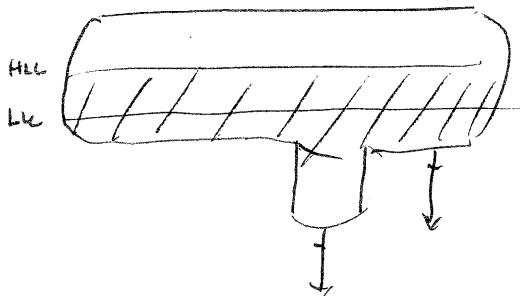
Difficulty of Separation

Fluid Properties

Fluid Velocities

RESIDENCE TIME GUIDELINES

Process Service	Residence Time
Vapor/Liquid Separation Horizontal Vessel NLL at Centerline	5 minutes on liquid
Vapor/Liquid/Liquid Separation Horizontal Vessel NLL at Centerline	10 minutes on liquid
Liquid Surge for Control High to Low Level	2-4 minutes HLL to LLL
Critical Separator Vertical Vessel	2 minutes above HLL to inlet nozzle
Drop Leg (Boot) Controlled Level	5-10 minutes
Drop Leg (Boot) Manually Drained	600 minutes
Feed Surge Drum	15-30 minutes



PHASE SEPARATION

Phases

Example

Vapor/Liquid

Separator
Flash Drum

Liquid/Liquid

Caustic Settler
Desalter

Vapor/Liquid/Liquid

Hydrotreater Separator
Wet Overhead Receivers

Vapor/Solid

FCC Regenerator

Liquid/Solid

Slurry Separator

VESSEL CONFIGURATION: SEPARATORS

Process Conditions

Vessel Configuration

High Vapor Rate
Low Liquid Rate
One Liquid Phase

Vertical Vessel

Low Vapor Rate
High Liquid Rate
One Liquid Phase

Horizontal Vessel

No Vapor Phase
Two Liquid Phases

Horizontal Vessel

Vapor Phase Present
Two Liquid Phases
Low Heavy Liquid Phase Rate

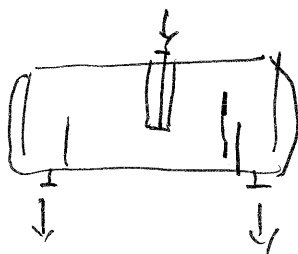
Horizontal with Boot

Vapor Phase Present
Two Liquid Phases
Low Light Liquid Phase Rate

Horizontal with Baffled Outlet

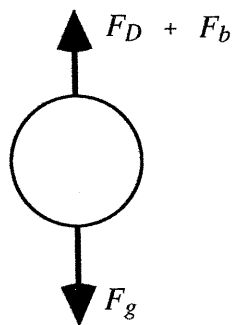
Vapor Phase Present
Two Liquid Phases
Liquid Phases Equal Rates

Horizontal with 2 Baffled Outlets



GRAVITY SETTLING LAWS

Particle Moving in a Fluid



F_d = Drag
 F_b = Bouyant Force
 F_g = Gravitional Force
 F = Resultant Force
 a = Particle Acceration
 u = Particle Velocity

$$F = F_g - F_d - F_b = ma = m \frac{du}{dt}$$

- FOR VESSEL DESIGN -

- ① CALCULATE DROPLET TERMINAL VELOCITY
- ② SIZE VESSEL TO KEEP VELOCITY OF CONTINUOUS PHASE LESS THAN PARTICLE TERMINAL VELOCITY TO ALLOW SETTLING

At steady state:

$$\frac{du}{dt} = 0$$

and $u = u_t$ = terminal velocity

$$\text{So } F_g = F_d + F_b$$

Where:

$$F_g = \frac{mg}{g_c}$$

$$F_b = \frac{mpg}{\rho_P g_C}$$

$$F_d = \frac{C_D u_t^2 \rho A_P}{2 g_C}$$

$$A_P = \frac{\pi D_P^2}{4}$$

$$m = \frac{1}{6} \pi \rho_P D_P^3$$

m = Mass of Particle

g = Gravitational Acceleration

g_C = Gravitational Constant

ρ = Density of Fluid

ρ_P = Density of Particle

A_P = Projected Area of Particle

D_P = Diameter of Particle

C_D = Drag Coefficient

Substitute and solve for u_t :

$$u_t = \left[\frac{4 D_P g (\rho_P - \rho)}{3 C_D \rho} \right]^{0.5}$$

FOR HEAVY DROPLET -
LIGHT CONTINUOUS PHASE

(e- ρ_P) FOR LIGHT DROPLET -
HEAVY CONTINUOUS PHASE

Limitations:

Spherical particle SIZE $\rightarrow$ Fig 9-4

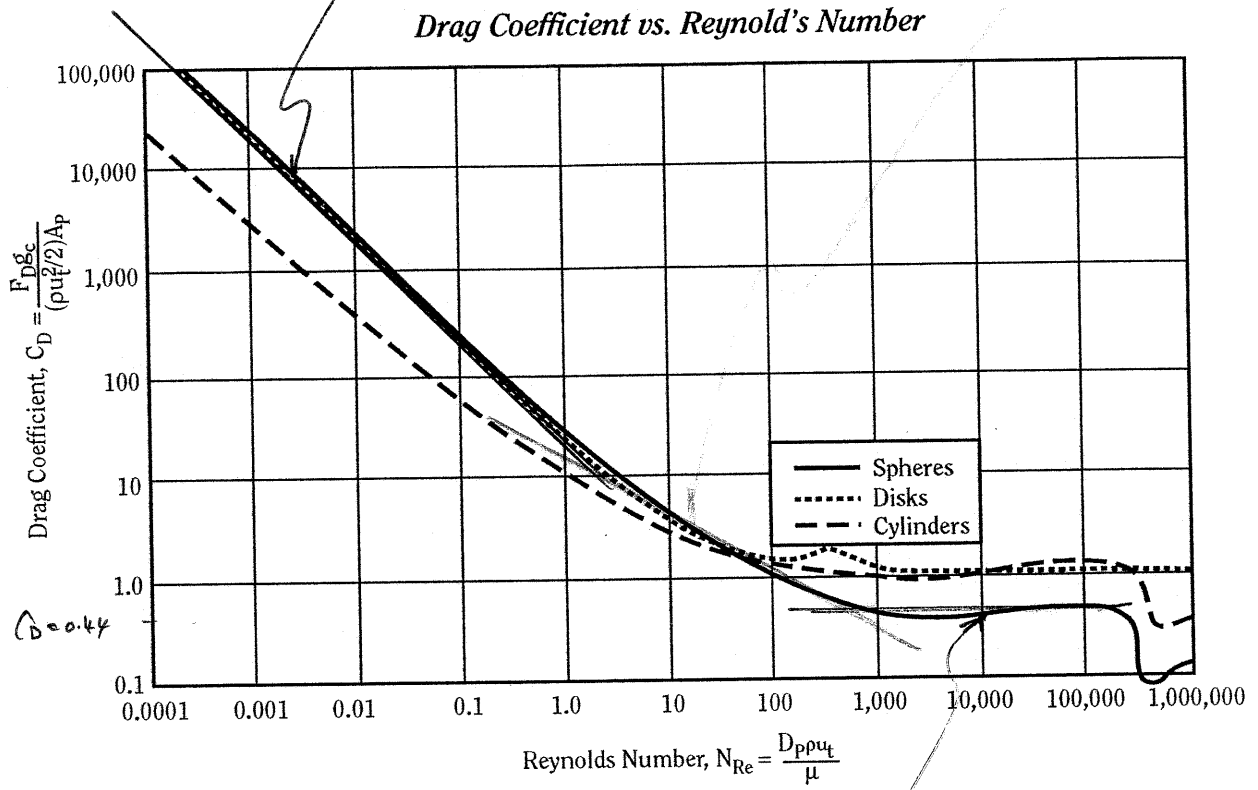
Stagnant fluid

No interaction with other particles

No wall effects

The terminal velocity for a particle can now be calculated if C_D can be quantified.

STOKES $N_{RE} < 2$



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$$C_D = \frac{24}{N_{RE}}$$

$$C_D = \frac{18.5}{N_{RE}^{0.6}}$$

Newton's Equation

For:

$$500 < N_{Re} < 200,000$$

Where:

$$N_{Re} = \frac{D_P \rho u_t}{\mu}$$

Then:

$$C_D = 0.44$$

And:

$$u_t = 1.75 \left[\frac{g D_P (\rho_P - \rho)}{\rho} \right]^{0.5}$$

Stokes' Equation

For:

$$N_{Re} < 2$$

Where:

$$N_{Re} = \frac{D_P \rho u_t}{\mu}$$

Then:

$$C_D = \frac{24}{N_{Re}}$$

And:

$$u_t = \frac{(\rho_P - \rho)g D_P^2}{18\mu}$$

This equation usually applies in liquid phase.

Intermediate Equation

For:

$$2 < N_{Re} < 500$$

Where:

$$N_{Re} = \frac{D_P \rho u_t}{\mu}$$

Then:

$$C_D = \frac{18.5}{N_{Re}^{0.6}}$$

And:

$$u_t = \frac{0.153 g^{0.71} D_P^{1.14} (\rho_P - \rho)^{0.71}}{\rho^{0.29} \mu^{0.43}}$$

In range of Newton's equation, $N_{Re} > 500$, liquid droplets falling in vapor will deform.

Then:

$$C_D \neq 0.44$$

Let:

$$\rho_P = \rho_L$$

$$\rho = \rho_V$$

For:

$$D_P = 175 \text{ micron}$$

And:

$$C_D = 1$$

$$u_t = 0.157 \left[\frac{\rho_L - \rho_V}{\rho_V} \right]^{0.5}$$

HORIZONTAL VESSEL SIZING EXAMPLE

Sizing Steps

Select L/D

Determine Liquid Residence Time

Determine Normal Liquid Level

Calculate Diameter to Satisfy Residence Time

Calculate Diameter for Each Phase Separation

Liquid from Vapor

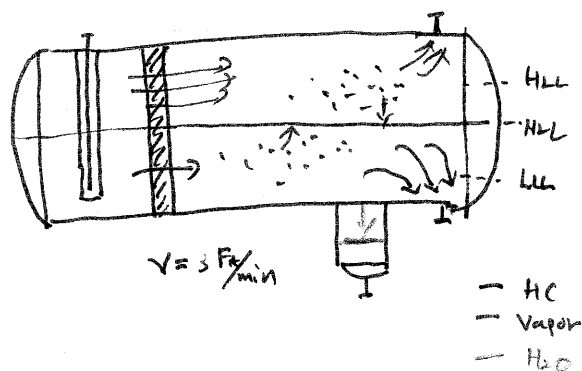
Vapor from Liquid

Liquid from Liquid

If Coalescing Blanket, Calculate Diameter for 3 ft/s

Select Governing (Largest) Diameter

Round Off



HORIZONTAL VESSEL SIZING EXAMPLE

Dropleg Sizing Steps

Determine Residence Time

Calculate Diameter Based on Phase Separation

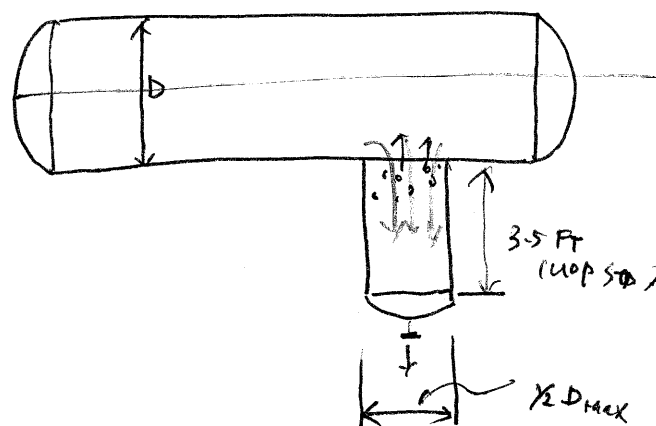
Calculate Diameter Based on Velocity Limits (If Any)

Calculate Diameter Based on Residence Time (Set Length = 3.5 feet)

Select Governing (Largest) Diameter

If D_{DL} Greater Than Half Vessel Diameter, Then Set $D_{DL} = 1/2$ Vessel Diameter and Recalculate L_{DL}

Round Off



VESSEL NOZZLES

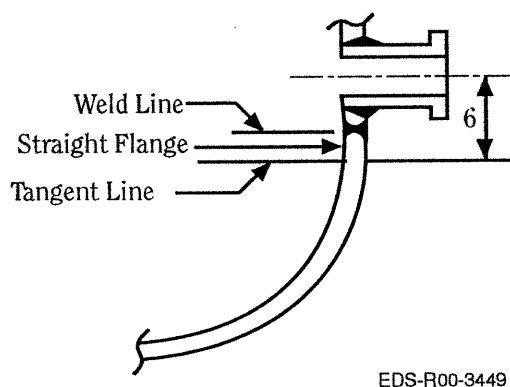
Nozzle Location Limitations

Minimum 6 Inches from Tangent (2" if under)

Half Nozzle Diameter Plus 5 Inches from Tangent

Tangential Nozzles

Vessel Nozzles



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Minimum Nozzle Size

UOP Default is 1 Inch

Client Request in BEDQ

Maximum Nozzle Size

Normally Half Vessel Diameter

Oversized Nozzles

Stab-in Internals

Internal Lining/Insulation

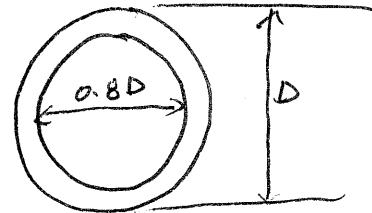
Instrument Requirements

PSV Nozzles (NOZZLE ID = PSV INLET B)

Reduce Velocity (2 PHASE ENTRY TO RELIEVERS)

Nozzles on Heads

Must Fit in 0.8D Circle



Manways

18 Inch Inside Diameter

Larger to Fit Internals

Larger for Client Request

At Centerline of Horizontal (UNLINED VESSEL)

On Top of Lined Horizontal

Steam Out

Separate Connection on Vessel (Required by UOP when vessel is normally steamed out at startup).

Inspection Openings

Required by Code

Two $1\frac{1}{2}$ Inch Openings 16" & UNDER

Flanged Head 18" to 24" ✓

Manway

Drop Leg (Boot)

Unlined Vessel

Unlined Boot

Welded Boot

Lined Vessel, = or > 30 Inch Inside Diameter Boot

Lined Boot

Welded Boot

Lined Vessel, < 30 Inch Boot

Unlined Boot

Flanged Boot

Consider Corrosion Allowance

Vents and Drains

On Vessel or Piping

Vent at High Point

Drain at Low Point

Need for Closed Systems

Vents & Drains same size

Recommended Sizes

(
15' & UNDER - 2"
15' to 20' - 3"
20' + - 4"

Unloading

Catalyst Withdrawal Nozzles

Manways

Pressure Relief Valves

Specify Inside Diameter

ANSI Class 300 Minimum

On Vessel or Piping

Avoid Excess Pressure Drop - 3 % Allowed.

VESSEL SUPPORTS

Skirt

Most Common Support

Ventilate

No Flanges – Leaks

Pipe Legs

Small Vessels

Less Than 30 Inches Diameter

Less Than 5 Feet Elevation

Lugs

Support from Structure

Provides Good Ventilation

Table Top

Most Expensive

For Unloading Catalyst

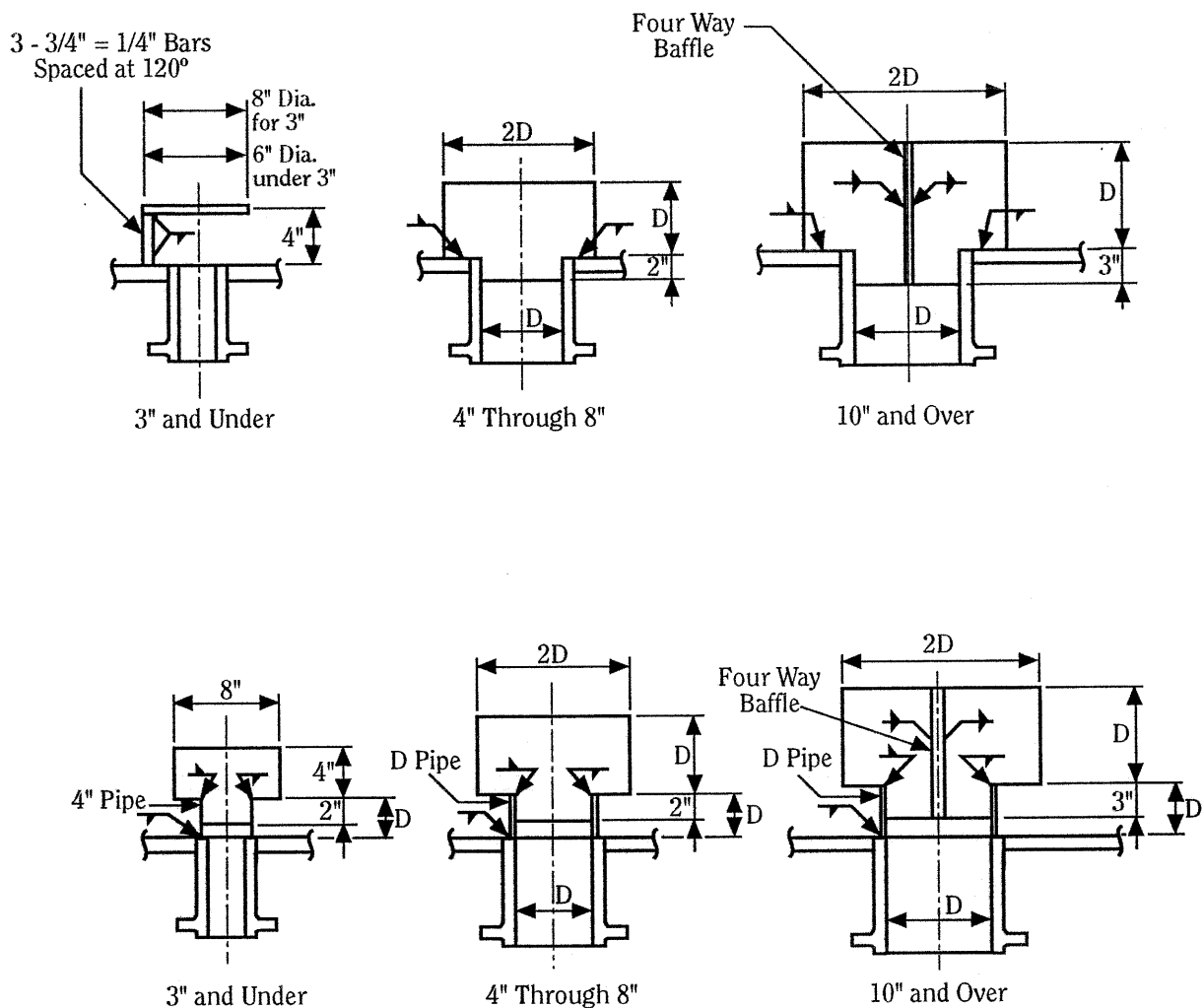
Saddles

Horizontal Vessels

On Piers

In Structure

Vortex Breaker



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RAISED VORTEX BREAKER
REQUIRED FOR 2 LIQUID PHASES

VESSEL ANCILLARIES

Vessel Supports

Stiffener Rings

Vacuum Service

Insulation Rings

Support for Insulation

Fireproofing

Vessel Supports

Up to 35 Feet Above Grade

Insulation

Retard Heat Loss/Gain

Weather Shielding

Davits

For Handling Internals

Platforms

Access to Equipment, Manways 8 Feet Above Grade or More