Vertical Vessels

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Lesson Objectives:

1. Know the basic mechanical function of vertical vessels.
2. Know how to calculate and fill out the Fluor standard nozzle table.
3. Know how to show nozzles and related callouts on the piping isometric and plan drawings.
What is a Vertical Vessel??

A vertical vessel contains bubble trays and bubble caps which are used to extract from a process system a certain required fraction such as butane or propane.

These fractions are obtained by draw-offs at certain temperature points. No chemical changes occurs. The separation results from the different boiling points of different products.

The lighter the product, the lower the boiling point.

The desired product separation is drawn off generally as a vapor from the top of the fractionating tower.
The basic stock for typical refinery operations is crude oil. Crude oil consists of thousands of different combinations of carbon and hydrogen atoms and arranged into molecules. These molecules have its own boiling point temperature. A group of several molecules with a narrow range of boiling point is called a fraction.

The crude oil is first heated to approximately 700°F and is pumped into the “flash zone” of the fractionation column. The crude oil separates into a liquid and vapor in this zone. Petroleum with a low boiling point temperature vaporizes and rises towards the top within the fractionation column. As the vapors rise the higher boiling point vapors condense and become a liquid. This liquid runs over bubble trays which slows down the rising vapors and helps to capture liquids as the vapors condense. The vapors are at a higher temperature than the liquid, thus keeping the boiling point constant.

A desired fraction is side-streamed from the fractionation column through nozzles or piping set at specific levels. This fraction is then pumped to a different section of the refinery for further processing.
Lighter fractions are normally used for gasoline. These fractions are normally in a vaporized state and is sent to an overhead condenser which cools the vapor and turns the vapor into a liquid. This liquid is then sent to a horizontal vessel for temporary storage until further refining is required. Some of the condensed liquid in the horizontal vessel is pumped back up to the top of the distillation column as reflux. Reflux is used to keep the trays from drying out. The vapors within the horizontal vessel is side-streamed to manufacture methane, propane, and butane.
Trayed Tower Nozzle Names

- Overhead
- Re却x
- Tray
- Drawoff
- Chimney
- Feed
- Maintenance Access
- Reducer Drawoff
- Reducer Return
- Maintenance Access
- Level Instruments
- Bottoms
Tower Skirt

- **Bottom Outlet Opening**
- **Stiffening Ring**
- **Base Ring**
- **Vent Hole**
- **Skirt Access Opening**

Dimensions:
- 12" x 18" / 300 x 450 minimum
- 2-1/2" / 75 bolts

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Typical Arrangement

a. Process Flow Diagram

b. Plan Arrangement
The elevation, or height above grade to the vertical vessel tangent line is dependent on

NPSH REQUIREMENTS
MAINTENANCE REQUIREMENTS
MINIMUM CLEARANCE
COMMON ACCESS
REBOILER MAINTANENCE
Access And Clearance

OPERATOR ACCESS

MINIMUM CLEARANCE

VERTICAL REBOILER

MAINTENANCE ACCESS

COMMON ACCESS

vertical reboiler
Elevation And Orientation Requirements For Maintenance Access

**Trayed Tower**
- Nozzle diameter: 45° / 125 min.
- MAINTENANCE ACCESS TO BE LEVEL WITH TOP OF PACKING SUPPORT
- T.L.

**Packed Tower**
- MIN 1” / 0.125

a. Maintenance Access Elevations
Elevation And Orientation Requirements For Maintenance Access

b. Maintenance Access Orientations
Examples Of Downcomer Trays

[Diagram of Downcomer Trays]

TRAY SUPPORTS

LIQUID

VAPOR

LIQUID

DOWNCOMER SPACE

BUBBLE CAP

LIQUID

VAPOR

DOWNCOMER SPACE

FLUOR.

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Arrangement Reboiler
Top Head Arrangement

- Alternative Vessel Vent Location
- Vapor Outlet
- Vessel Vent
- Alternative Vapor Outlet Location
- Relief Valve
- Knuckle Radius
- Tangent Point
- Alternative Relief Valve Location
- 0.42X Internal Diameter
- I-Nozzle Diameter Minimum
- Large Diameter Lines Do Not Require Flanged
- Nozzle
Typical Platform Arrangement

- PIPING
- PREFERRED LOCATION ACCESS
- NOT REQUIRED PAST STANDPIPE & INSTRUMENTS
- LEVEL INSTRUMENTS
- LADDER TO UPPER LEVELS
- PLATFORM SUPPORT BRACKETS
- PLATFORM SUPPORT BRACKETS
- MAINTENANCE ACCESS
- SIDE EXIT PREFERRED
- LADDER FROM GRADE
- PLATFORM EL. 109'-0"
  109.740
Platform Width Requirements
Platform Orientation
Pipe supports for vertical vessels should be located as close to the line’s nozzle as possible. By locating the pipe support close to the nozzle the loads exerted onto the nozzle will become decreased.

Pipe guides should be spaced so as not to restrict the flexibility of the pipe. See 000 250 2650.

The “L” dimension of a pipe is the distance between the back of the pipe to the outside diameter of the vessel shell or outside diameter of vessel insulation.
Relief Valve Systems
Tower Piping Arrangement
Arrangements For Level Instruments

Plan

Level Controller (Right Hand)
Cover Swing Area
Platform

Elevation

1/2" Or 2" Ø
10 To 2050

DRAIN 3/4" a. Single-Mounted Level Controller
When orienting temperature nozzles, check for adequate clearance of probe with downcomer wall.
Common Bridle-Level Instrument Arrangement

FLUOR®
Utility Station Requirements

1 1/2" RISERS

SUPPORT

STEAM

AIR
Nozzle Block Chart shows centerline coordinate drop of vertical pipe.
<table>
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<tr>
<th>EQUIP. NO.</th>
<th>SIZE AND RATNING</th>
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<th>ORIENTATION PROJECTION</th>
<th>CENTERLINE COORDINATE DROP</th>
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REFERENCE: Shell Goal Venture - Geismar Plant
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References:
Practices #

000.250.2650 - Vessel Layout and Orientation - Piping
000.250.2651 - Vessel Layout and Orientation - Trays
000.250.2660 - Vessel Layout - Classification of Vessel versus Piping
Questions??
Exercise PI-E11D
Test PI-T11