

Specification for Vertical and Horizontal Emulsion Treaters

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Upstream Segment

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Specification for Vertical and Horizontal Emulsion Treaters

1 Scope

1.1 General

This specification covers minimum requirements for material, design, fabrication, and testing of vertical and horizontal emulsion treaters. The jurisdiction of this specification terminates with each pressure vessel as applicable: the emulsion treater with firetube(s) and, if used, the heat exchanger(s) and water siphon. Pressure vessels covered by this specification are classified as natural resource vessels by API 510, *Pressure Vessel Inspection Code*. An emulsion treater is a pressure vessel used in the oil producing industry for separating oil-water emulsions and gas, and for breaking or resolving emulsified well streams into water and saleable clean oil components. Emulsion treaters are usually equipped with one or more removable firetubes or heat exchange elements through which heat is applied to the water and/or emulsion to aid the emulsion breaking process.

1.2 Background

Emulsion treating is normally conducted on crude oil immediately after it is separated from its associated gas in a vessel referred to as a treater or sometimes as a heater treater. High gas-oil ratio wells or those produced by gas lift may require the installation of an oil and gas separator upstream of the treater to remove most of the associated gas before the emulsion enters the treater. Where the water to oil ratio is high, Freewater knockouts may be required upstream of the treater. The function of the treater is to dehydrate (or dewater) the produced crude oil to a specified level of basic sediment and water (BS&W). Oil-water separation may be enhanced by heating, emulsion breaking chemicals, coalescing media, and/or electrostatic fields in vessels sized for substantial liquid residence time. Process considerations are covered in Annex A. Refer to Figure 1, Figure 2 and Figure 3, which show general arrangements of components, piping and instrumentation. (Some of the illustrated features are considered optional.)

2 References

API Specification 5L, *Specification for Line Pipe*

API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks: Nonrefrigerated and Refrigerated*

ASME B1.1¹, *Unified Inch Screw Threads, (UN and UNR Thread Form)*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

ASME B16.11, *Forged Steel Fittings, Socket-Welding and Threaded*

ASME B18.2.1, *Square and Hex Bolts and Screws, Inch Series*

ASME B18.2.2, *Square and Hex Nuts*

ASME B31.1, *Process Piping*

ASME Boiler and Pressure Vessel Code, Section IX—*Welding and Brazing Qualifications*

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1—*Rules for Construction of Pressure Vessels*

¹ ASME International, 3 Park Avenue, New York, New York 10016, www.asme.org.

ASTM A36 ², *Standard Specification for Carbon Structural Steel*

ASTM A36P, *Standard Specification for Carbon Structural Steel: Plates*

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A105, *Standard Specification for Carbon Steel Forgings for Piping Applications*

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A123, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

ASTM A153, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A181, *Standard Specification for Carbon Steel Forgings, for General-Purpose Piping*

ASTM A216, *Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service*

ASTM A283, *Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality*

ASTM A285, *Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength*

ASTM A307, *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength*

ASTM A1011, *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*

ASTM B454, *Specification for Mechanically Deposited Coatings/Cadmium/Zinc on Ferrous Metal*

AWS A 5.1 ³, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*

NACE RP 0372 ⁴, *Method for Lining Lease Production Tanks with Coal Tar Epoxy*

NFPA No. 30 ⁵, *Flammable and Combustible Liquids Code*

3 Definitions

3.1

basic sediment and water

BS&W

Commonly used as a measure of treating performance.

NOTE Treating performance is highly variable, but most crude oils are treated to a range of 0.2% to 3.0% BS&W. ASTM Standard Test No. D96-82 is an accepted standard for this test.

² ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

³ American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126, www.aws.org.

⁴ NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.

⁵ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-7471, www.nfpa.org.

3.2

burner system

A system of firing accessories, including treater firetubes designed for the specific fuel and may be either natural or forced draft design.

NOTE Intake flame arrestors and other optional burner accessories as listed in Annex G may also be included.

3.3

coalescing

Process of causing small dispersed water-in-oil or oil-in-water droplets to combine into larger droplets which are easier to separate by gravity.

NOTE Coalescing sections provide large surface areas per unit of volume and usually consist of fibrous beds such as excelsior (referred to as hay sections), or compartments of specially designed components. Electrostatic fields are another means of inducing coalescence, commonly referred to as electrostatic treating.

3.4

collector pipe

Perforated or slotted pipe near the top of the coalescing section in a treater to remove the treated oil as uniformly as possible through this portion of the treater.

3.5

desalting

A form of emulsion treating which may be identical to conventional treaters with the addition of supplemental injection and mixing of low salinity water into the feed emulsion to dilute the brine phase and thereby lower the salt content of the treated crude.

NOTE Desalting is used both in oil producing areas and refineries. It may consist of one or more stages to achieve maximum desalting efficiency.

3.6

design pressure

Pressure used in the design of a vessel for the purpose of determining the minimum permissible thickness or physical characteristics of the different parts of the vessel.

NOTE When applicable, static head shall be added to the design pressure to determine the thickness of any specific part of the vessel.

3.7

electrostatic treater

Emulsion treating vessel that utilizes an electrical grid and usually a fire tube to coalesce the fluid. This type of treater usually operates at lower temperatures than ones without grids.

3.8

emulsion

Relatively stable dispersion of water and oil which normally exists in the production stream from flowing or pumped oil wells.

3.9

firebox

Complete assembly consisting of the firetube(s), mounting flange(s), intake(s) and stack adapters.

3.10**firetube**

Portion of the firebox in contact with the liquids consisting of one or more U-tubes fired at one end and exhausting through a vertical stack for each U-tube.

NOTE Natural gas or hydrocarbon liquids are normally used to fire the treater through a submerged furnace chamber called the firetube. In larger treaters the firetube may consist of a large diameter first pass firetube and multiple return tubes manifolded into a common stack.

3.11**grid**

Electric field in electrostatic treater that is distributed by a steel assembly of plates, rods, screens or combinations of these, which enhances coalescing of the water droplets.

NOTE The grid does not provide heat. The projected grid area is significant to the performance and capacity of the treater.

3.12**heat density**

Term commonly applied to the heat release through the cross section of the firetube, expressed as BTU/hr/in.² of cross sectional area.

3.13**heat duty**

Heat absorbed by the process, expressed as BTU/hr.

3.14**heat exchanger**

Shell-and-tube, plate type or other heat exchanger optionally employed to recover heat from the heated crude oil by preheating the incoming emulsion.

3.15**heat flux**

Term commonly applied to the average heat transfer rate through the firetube, expressed as BTU/hr/ft² of exposed area.

3.16**heating shroud or hood**

Baffle surrounding firetubes in treaters designed to increase emulsion heating efficiency by minimizing the heating of free water which separates from the emulsion before heating.

3.17**intake flame arrestor**

Device placed on the air intake of the firetube to prevent propagation of flame from inside the firetube to the outside atmosphere, normally consisting of a corrugated aluminum cell mounted in a metal housing which attaches to the firebox.

3.18**interface drain**

Pipe connection extending to the normal interface level with a vortex breaker which is used periodically to drain off any accumulated sludge.

3.19**liquid (fluid) packed**

Condition in horizontal treaters where the coalescing section or entire treater operates completely full of liquid.

3.20**maximum allowable working pressure****MAWP**

Maximum gage pressure permissible at the top of a completed vessel in its operating position for a designated temperature, based on calculations for every element of the vessel using nominal thicknesses exclusive of allowances for corrosion and thickness required for loadings other than pressure.

NOTE This is the basis for the pressure setting of the pressure relieving devices protecting the vessel.

3.21**mid-baffle**

Bulkhead in horizontal emulsion treaters, located between the heating section and the coalescing section.

3.22**operating pressure**

Pressure at the top of a pressure vessel at which it normally operates, not exceeding the MAWP and usually kept at a suitable level below the setting of the pressure relieving devices to prevent their frequent opening.

3.23**pounds per thousand barrels****PTB**

Pounds of salt per thousand barrels of crude oil, used in conjunction with BS&W to express the quality of untreated and treated crude oils in relation to desalting applications of emulsion treaters.

3.24**removable**

Total component that is field replaceable without welder assistance.

3.25**sand jets**

System of one or more perforated pipes, or nozzles, located near the bottom of emulsion treaters which is used periodically to clean out sediments by flushing with water.

3.26**sand pans**

Inverted angle baffles or troughs located above the sand (sediment) outlet connections to facilitate uniform sand or sediment removal, with notches in the troughs or pans to increase the velocity of the water leaving the vessel to prevent bridging.

3.27**spark arrestor**

Device placed on the exhaust of the stack to prevent sparks from being emitted to the outside atmosphere, normally consisting of a metallic wire screen attached across the top diameter of the stack.

3.28**spreader(s)**

Device or system designed to distribute the incoming emulsion as uniformly as practical through the cross section of the vertical or horizontal shell.

3.29**stack downdraft diverter**

Device attached to the top of the stack designed to reduce the effects of wind currents on the burner system.

3.30**stack flame arrestor**

Device placed on the exhaust of the stack to prevent propagation of flame from inside the firetube to the outside atmosphere, normally consisting of a corrugated aluminum or stainless steel cell mounted in a metal housing which attaches to the top of the stack.

3.31**stack rain shield**

Device attached to the top of the stack to prevent rain from falling directly into the stack. It may also serve as a stack downdraft diverter.

3.32**treating**

Separation of gas, oil and water from emulsified well streams by gravity and enhanced means of breaking emulsions such as heating, chemical and/or coalescing sections.

3.33**turbolators**

Core of baffles designed to induce turbulence in the return leg of firetubes which enhances heat transfer efficiency.

3.34**vortex breaker**

Device located on outlet nozzles to prevent vortex formation.

3.35**water siphon (water leg, grasshopper)**

Piping system for the controlled flow of water from the treater which sets the water/oil interface level within the treater, where the water flows through a vertical loop of piping set at an adjustable level below the treater oil level with the top of the loop equalized in pressure with the gas zone of the treater.

4 Material**4.1 ASME Code**

All material used in the fabrication of emulsion treaters, including firetubes, siphons and heat exchangers included in the scope of this specification shall comply with the material requirements of the latest edition of Section VIII, Division 1 of the ASME *Boiler and Pressure Vessel Code*, hereinafter referred to as the ASME Code.

4.2 Non-pressure Parts

Steel parts such as stacks, ladders and platforms not welded directly to the ASME Code vessel shall be weldable carbon steels, selected from ASTM, API or AISI specifications. Corrosion resistant materials such as reinforced plastic may be used inside the vessel or inside the water siphons for non-pressure service.

4.3 Material Selection

Materials for corrosive fluids should be selected based on a review of NACE publications for materials that conform to 4.1. Consideration should be given to material selection as it relates to weight loss corrosion, sulfide stress cracking (SSC), chloride stress cracking, or other forms of corrosion. It is the responsibility of the user to determine what consideration for corrosion should be made to the vessel during its intended life (reference ASME Code, Section VIII, as applicable to corrosion.) Corrosion control guidelines are given in Annex B.

4.4 Corrosion

Corrosion control consideration for treaters furnished to this specification shall be for the pressure containing parts and as can be identified as falling within the requirements of the applicable sections of the ASME Code. Corrosion control considerations for vessel internals (non-pressure parts and fire-tube) is by mutual agreement between the purchaser and the manufacturer and not a part of this specification.

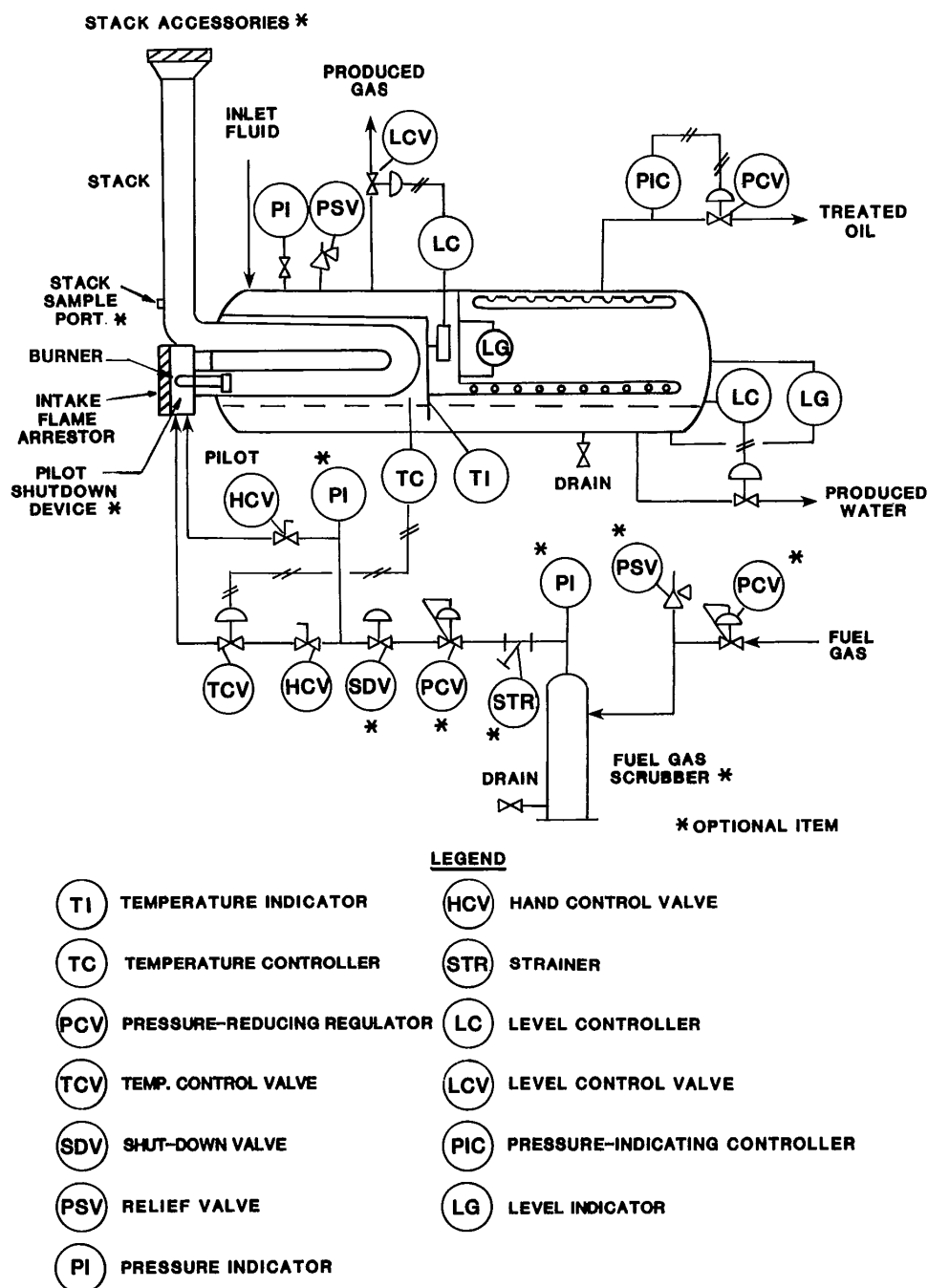
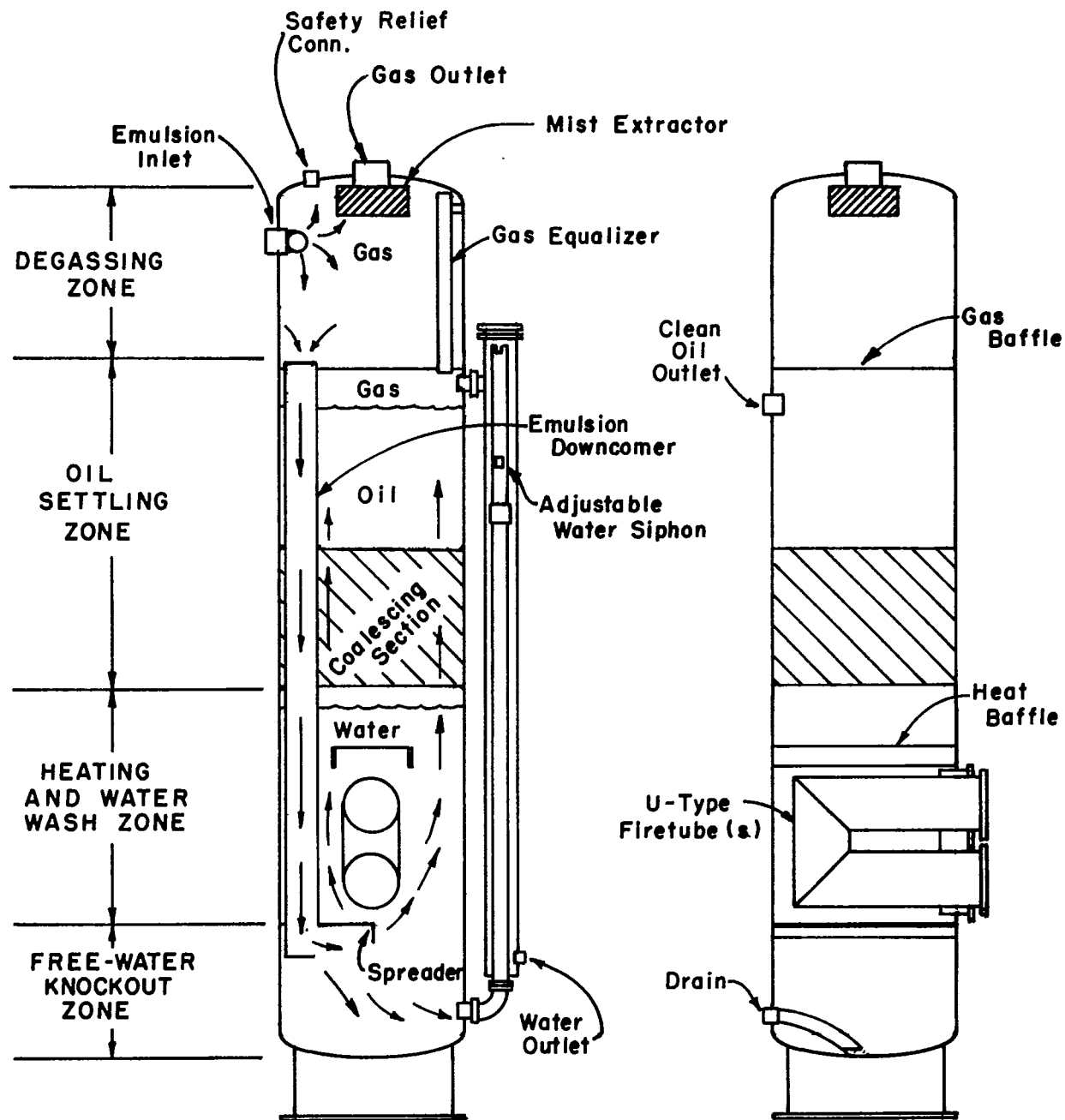


Figure 1—Typical Treater Assembly



NOTE Many variations of design are available from different manufacturers.

Figure 2—Typical Vertical Treater