MODEL – CUSTOM DEAERATOR

DEAERATOR SPECIFICATION

1.0 Description

The deaerator shall be a direct contact, tray type with integral vent condensing equipment and separate water storage section. The heater shall be designed for two-stage operation. Incoming undeaerated water enters the deaerator through spring-loaded, stainless steel spray valves. These variable orifice valves produce a fine spray in a uniform pattern from 5% to 200% of design capacity. The fine droplets of water maximize the surface area in contact with steam, raising the temperature to within a few degrees of saturation temperature and instantly releasing the majority of the corrosive, non-condensable gases. The preheated and partially deaerated water flows through the tray stack where the hottest, purest steam vigorously scrubs the water to heat it to saturation and strip the last traces of dissolved gases. Counterflow movement of water and steam ensures that the water leaving the bottom layer of trays is “stripped” by pure steam entering the deaerator.

2.0 Scope

The equipment and services to be furnished include, but are not limited to, the following:

- Deaerating feedwater heater with storage vessel
- Inlet distribution header with spray valves
- Deaerating tray assemblies
- Integral supports for the storage tank and deaerating heater, including bolting between vessels
- Connections for Buyer supplied and installed instrumentation and piping
- Insulation clips
- Special tools and/or devices required for maintenance

Items not included (unless noted) are the following:

- Ladders and platforms
- Insulation

3.0 Codes and Standards

3.1 Code Requirements

The deaerator shall be designed, manufactured, tested and stamped in accordance with ASME, Section VIII, Division 1 and latest addenda. The deaerator and water storage sections shall also be registered with the National Board of Boiler and Pressure Vessel Inspectors and shall be so stamped. The deaerator and storage section shall be hydro-tested as required by ASME. The vessel MAWP shall be equal to, or greater than, the design pressure.

3.2 Additional Standards

The deaerator shall be designed in accordance with the latest edition of the Heat Exchange Institute (HEI) Standards and Typical Specifications for Deaerators and shall include the following:

- Postweld heat treatment
- Radiography per RT-2 minimum
- Magnetic particle testing of interior nozzle to shell welds

4.0 Technical Requirements

4.1 Design

The vessels shall be designed for the pressure and temperature as specified on the Deaerator Data Sheet. Internal design pressure shall be a minimum of 30 psig. Design temperature shall be a minimum of 400 ºF. The vessels shall be designed for full vacuum.

The materials used for pressure parts and for external supports shall be in accordance with the ASME Code, as necessitated by the design pressure and temperature. The vessel heads and shell shall be fabricated with a 1/8" corrosion allowance. Nozzles, nozzle necks, and manway covers shall include a minimum of 1/16" corrosion allowance. A corrosion allowance is not required for stainless steel components.

4.2 Fabrication

All pressure welds are to be full penetration, with a finished surface that is smooth and sufficiently free of abrupt changes in profile. For vessel longitudinal and circumferential seams, the SAW welding process is preferred due to its inherent smoothness. For nozzles and other welds, a process may be selected in which the manufacturer is experienced. Grinding is to be performed as required to attain a smooth surface.

Where possible, vessel shell and head seams are to be located such that they are accessible for future internal inspection.

4.3 Internal materials

All materials in contact with noncondensable gases, undeaerated water or steam which has previously been in contact with undeaerated or partially deaerated water shall be stainless steel, stainless steel lined or stainless steel clad. Liners and shields shall be not less than 1/8 inch (3.2 mm) thick. To avoid possible liner collapse during transient load conditions, liners and shields shall be securely attached by means which avoid welding stainless steel to the carbon steel shell. Any stainless steel components that are heat treated with the vessel shall be made of "L" grade stainless steel.

4.3.1 Spray System

A spray system shall be provided to distribute condensate evenly into the spray chamber. The spray system shall consist of a stainless steel header containing spring-loaded spray valves. Spray valves shall be type 316 stainless steel and shall produce a hollow cone, thin-filmed spray pattern over the range of 5% to 200% of design capacity. Valves shall be provided with nonbinding guides as required to ensure proper spray distribution. Valve springs shall be heat treated if heat treatment is required to retain their elastic properties at the temperatures to be encountered. Spray valves shall be readily accessible for inspection, maintenance, and removal without disturbing any internal piping.

4.3.2 Tray System

Trays shall be riveted or stamped of type 430 stainless steel, not less than 16 gauge. Welding shall not be utilized for tray construction. Trays shall be interchangeable and of a convenient size and weight for easy handling. Trays shall be housed in a stainless steel enclosure, closed on five sides to eliminate oxygen coming in contact with the carbon steel head/shell. Tray hold downs shall be designed to secure the trays so that they will not become dislodged while in service, during sudden load rejection, or during shipping and erection.

4.3.3 Vent Condenser

The vent condenser shall be stainless steel and of the internal, direct contact, spray type.

4.4 Storage Tank

The storage vessel shall be sized for 10 minutes retention at overflow based upon the design capacity shown on the Deaerator Data Sheet. The overflow level shall not be closer to the top of the vessel than 85% of the diameter.

4.5 Connections

4.5.1 General

Nozzle sizes shall be as required to meet the velocity criteria and recommendations of HEI. Unless noted on the Deaerator Data Sheet, connections 2" and smaller shall be socket weld and connections larger than 2" shall be butt weld.

Nozzles shall be joined to the vessel shells using complete penetration welds through the shell and any reinforcing pads. Longitudinal joints in nozzle necks shall be fully radiographed.

4.5.2 Makeup and Vent

The makeup and vent connections shall be "L" grade stainless steel or carbon steel with stainless steel liners.

4.5.3 Downcomer/Equalizer

Deaerating section and storage section shells shall be connected by downcomer pipes and pressure equalizing pipes. Each pipe shall be shop fitted so that only one field weld per pipe will be required. A trial fit-up in the shop shall be performed to verify satisfactory fit of the deaerator to the water storage section after postweld heat treatment. The fit-up may be witnessed by the Buyer. The downcomers shall be ground flush with the internal surface of the deaerating section. The equalizing piping shall protrude into the deaerating section as far as possible without restricting flow area. Baffles shall be provided to prevent direct impingement of flashing steam on any internal surface of the deaerating section. Equalizing pipes shall be of sufficient size and in sufficient quantity to limit pressure differential between deaerating and storage sections to 0.5 psi (3.5 kPa) or

less and prevent pressure buildup in the storage section during transient conditions, unit trip, or load reduction.

4.5.4 Manways

The deaerating section shell shall be provided with a hinged and bolted manway for tray access. Manways shall be of adequate size for tray removal and be a minimum of 18" diameter. The storage section shell shall be provided with a hinged and bolted manway at each end. Each manway shall be provided with 3/4 inch (19 mm) diameter grab rungs attached to the inside surface of the shell. Manway shall be furnished complete with bolting and two (2) spare, spiral wound gaskets.

4.5.5 Returns

The following returns shall be introduced by means of baffles or other suitable distribution system:

- High-Pressure Heater Drains Inlet: These returns shall be introduced into the deaerating section below the trays or into the storage section above the water level.
- Combustion Air Preheater Return, Combustion Gas Reheat, Building Heating, and Process Condensate Returns: These returns shall be introduced over the trays.
- Boiler Feed Pump Recirculation: These returns shall be introduced into the water storage section above the water level.

4.5.6 Pump Suction

Pump suction connections shall extend into the storage vessel a minimum of 3" to prevent sludge and debris from entering the pumps. The connections shall be complete with a vortex breaker.

4.5.7 Nozzle tolerances

Fabrication tolerances for location of nozzles shall not exceed the following limitations. The tolerance values indicated shall not be cumulative:

- Nozzles shall be located within 1/4 inch of the locations indicated on the drawings.
- Nozzle tilt and misalignment shall be limited to ±1/2 degree.

- Angular misalignment of flange faces and nozzle butt-weld ends shall be limited so that the distance from any point on the weld end or flange circumference to the true plane does not exceed 1/8 inch (3.2 mm).
- Flanged connections shall have a 1 degree maximum rotational misalignment between mating bolt holes.

4.5.8 Nozzle Loads

Connections shall be suitably reinforced to withstand forces and moments imposed by connecting piping. Allowable forces and moments shall be provided at major equipment attachment locations which interface with materials, such as piping, supplied by others. Allowable forces and moments shall be provided for normal operating conditions.

4.5.9 Impingement Protection

All steam, drain return and condensate return inlets shall be provided with stainless steel baffles or shell liners to prevent impingement of steam, water, or noncondensable gases on any part of the carbon steel shells or tray enclosure. Baffles and liners shall be constructed of stainless steel plate not less than 1/4 inch (6.4 mm) thick.

4.6 Supports

The storage section shall be provided with not less than two cradle type supports. The number of supports shall be as determined by the manufacturer. Where two supports are provided, one end shall be anchored and the other support free to allow thermal expansion by means of slotted bolt holes, and, if the calculated thermal expansion is greater than 0.4 inch, sliding plates. The size of the plates shall be determined by the manufacturer and shall be adequate to accommodate the range of thermal expansion experienced between the specified minimum dry-bulb temperature and the maximum operating temperature of the deaerator. Supports shall be of fabricated steel and shall be designed to withstand lateral thermal expansion loads. Supports shall be welded to the shell. All supports required for supporting the deaerating section directly on the water storage section shall be provided, including all bolts and nuts or studs.

4.7 Insulation clips

Insulation clips shall be provided on 18” centers.

4.8 Lugs

Platforms and ladders, and their supports if required, will be furnished under separate specifications. Lug dimensions and locations will be determined after contract award. Both deaerating section and storage section shells shall be provided with lifting lugs. Lifting lugs shall be designed as guides for lifting the assembled vessels.

4.9 Inspection and Testing

4.9.1 General

All nondestructive examination shall be performed by ASNT certified personnel, and is to be performed prior to postweld heat treatment.

4.9.2 Specific Requirements

- Visual examination – all pressure welds and welds to pressure components shall be visually inspected, and are to be sufficiently free of undercut, arc strikes, porosity and spatter. Any indication that could be interpreted as a crack is to be removed.
- Magnetic particle examination – all carbon steel internal nozzle-to-shell welds shall be wet fluorescent magnetic particle examined.
- Dye penetrant examination – all stainless steel internal nozzle-to-shell welds shall be dye penetrant examined.
- Radiographic examination – vessel weld seams shall be radiographed to a minimum of RT-2 as per ASME Section VIII, Div. 1.

4.9.3 Hydrotesting

Vessels shall be hydrotested in accordance with ASME code. Hydrotest water is to contain less than 50ppm chloride.

4.10 Postweld Heat Treatment

Vessels shall be postweld heat treated in accordance with ASME code. Although heat treatment may not be required per ASME code, it is still a process requirement.

5.0 Shop Cleaning and Preparation for Shipment

5.1 Interior

Prior to the installation of stainless steel internals, the interior carbon steel surfaces of the deaerating and water storage sections shall be blast cleaned. Blasting shall be with silica free steel grit of 16 to 30 mesh size. Grit shall be completely free of all silica and silica compounds. After hydrostatic testing and drying with clean heated air, interiors shall be thoroughly cleaned and coated with a rust-preventive compound. The rust-preventive compound shall be completely water soluble. After coating, bags of activated alumina desiccant shall be distributed in both the deaerating and storage sections. The bags shall be secured to prevent movement during shipment. A warning notice to remove desiccant before placing the unit in operation shall be affixed on each manhole cover. Each section shall be provided with not less than 3 pounds of dry desiccant per 100 cubic feet of volume (1 kg of desiccant per 2.1 cubic meters of volume). Desiccant shall be purchased in airtight containers and not opened until the desiccant is ready for placement inside the vessels. Before or immediately after placement of desiccant, all shell connections and openings shall be covered with tight fitting closures. All closure edges shall then be sealed with an adhesive-backed, waterproof, cloth tape. Sealing shall be airtight and of adequate strength to remain so during shipment and storage.

5.2 Exterior

Exterior surfaces of the deaerating and water storage sections shall be blast cleaned per SSPC-SP6 and prime painted with inorganic zinc. An area 2 inches (50 mm) wide shall be left unpainted adjacent to field welded seams. Machined weld-end preparations shall be coated with consumable rust-preventive coating.

5.3 Preparation for shipment

Prior to shipment, flanged connections are to be sealed with bolted plywood covers and weld ends are to be sealed with plastic shipping caps.

The Deaerator and storage vessels shall be shipped as complete units as follows:

- Deaerating Section: Fully assembled with all spray nozzles, internal piping, baffles, and trays.
- Storage Section: Fully assembled with all internal piping and baffles

5.4 Nameplate

Nameplate stamping required by the ASME shall appear on unpainted stainless steel nameplates which shall be permanently attached to the deaerator on 4 inch (100 mm)

extended brackets designed to clear the insulation. Nameplates with code stamps shall be affixed to both deaerator and water storage sections. Bracket details, location, and nameplate data shall be indicated on the drawings. Nameplates shall indicate that the vessels are designed for full vacuum.

6.0 Performance

6.1 Performance Guarantee

The deaerator shall be designed for safe and reliable operation under the conditions shown on the Deaerator Data Sheet over the full load range from 10% to 100% of the specified design capacity. The deaerator shall be guaranteed to deliver the following:

- Water effluent within 2ºF of the saturation temperature corresponding to the steam pressure within the deaerator.
- Reduction of O2 in effluent to 0.005 cc/liter (7ppb) or less when tested at the outlet of the Deaerator in accordance with ASME PTC 12.3
- Reduction of the free CO2 in effluent to 0 ppm when tested by the APHA method.

6.2 Performance Tests

Testing shall be in accordance with the HEI standard using a suitable colorimetric test. Testing shall be performed as close to the deaerator storage section as possible and below the water level. Dissolved oxygen in deaerated and/or partially deaerated water shall be determined by either the titration method as defined in ASME PTC 12.3, or the Rhodazine D™ method by CHEMetrics, Inc., using 0 to 20 ppb range oxygen self-filling ampules. Carbon dioxide test shall be run per the APHA method.

7.0 Submittals

- Product data: Submit manufacturer's standard technical data including rated capacity and operating conditions of selected model and installation instructions.
- Drawings: Submit drawings indicating dimensions, weights, required clearances, foundation loads, etc. Drawings to be submitted on paper and in electronic format.

- Operating and Maintenance data: The manuals shall contain drawings or pictures of equipment showing part names and numbers to facilitate the ordering of spare parts.
- Manufacturing Data books: At the conclusion of manufacturing, pertinent manufacturing documentation shall be compiled and submitted. Documentation is to include manufacturer's data reports, material test certificates, nondestructive examination records, heat treatment and hydrotest charts, and nameplate rubbings.
- Six (6) sets of each of the above shall be provided.

8.0 Accessories

The following accessories are to be provided if noted on the Deaerator Data Sheet.

8.1 Water inlet valve

Furnish one water inlet valve sized for the maximum amount of makeup flow and pressure drop shown on the Deaerator Data Sheet. The valve shall be an equal percentage globe style, cage guided, with 416 hardened stainless steel trim. Provide a fail open pneumatic actuator with sufficient force to provide the required shutoff and stable control at service conditions. For pneumatic control, a caged displacer level controller shall be provided. Controller shall be direct acting with a range equal to the displacer length. If electronic control is specified, provide an I/P positioner accepting a 4-20 ma input and a level transmitter.

8.2 Steam pressure reducing valve

Furnish one steam pressure regulating valve sized for the maximum steam flow as shown on the Deaerator Data Sheet. The valve shall be a globe style with flange ratings and body material commensurate with the service conditions. The valve shall have equal percentage control characteristics and be cage guided. A fail closed pneumatic actuator shall be provided. If pneumatic control is specified on the Deaerator Data Sheet, furnish a proportional reverse acting pressure controller, complete with air filter regulator, mounted directly to the valve actuator. For electronic control, provide an I/P positioner accepting a 4-20 ma input and a pressure transmitter.

8.3 Relief valve

Provide safety relief valves set to relieve at the deaerator design pressure. Each safety relief valve shall have a carbon steel angle type body with stainless steel seat and disk. Valves shall be designed with lifting lever and enclosed bolted bonnets. Safety relief valves shall be code stamped. Relief valves should be shipped separately for field installation under separate specifications.

8.4 Thermometer

Provide two 5" dial (minimum) bimetal thermometer gauges with stainless steel thermowells. Gauges should be constructed with adjustable viewing angle, hermetically sealed and with a stem length consistent with the location of the gauge in the deaerator. In addition to consideration of the operating temperature of the deaerator, the gauge resolution (graduations) should be considered when selecting the temperature range of the thermometer.

8.5 Pressure gauge

Provide one 4 1/2" dial (minimum) type pressure gauge with stainless steel bourdon tube construction. Either dry or liquid filled gauges may be specified. Supply a siphon tube and shutoff cock for mounting the pressure gauge. In addition to consideration of the operating pressure of the deaerator, the gauge resolution (graduations) should be considered when selecting the pressure range of the pressure gauge.

8.6 Vent valve/orifice

The Supplier shall determine the quantity and size of vent connections. Properly sized vent valves with orifices shall be furnished by the Supplier for installation in vent piping provided under separate specifications.

8.7 Vacuum breaker

Vacuum breaker (not applicable with full vacuum design).

8.8 Overflow

Overflow trap or valve with control to relieve full capacity of deaerator.

8.9 Level Switch

Provide level switches for overflow, high, low, and low-cutoff level alarms. At minimum these switches will have the following characteristics:
Housings will be general purpose NEMA-1; Switch ratings shall be 10 amps 120 VAC/DC; Switch action shall be SPST. Other housings, ratings, and actions may be specified. Mercury or non-mercury switches may be specified.

8.10 Gauge Glass

Gauge glass column with shutoff valves to cover 10%-90% of the storage tank diameter. At minimum, the gauge glass should be 5/8" O.D. and rated for the operating temperature and pressure of the deaerator.