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TITLE: **Specification For Plate and Frame Heat Exchangers**

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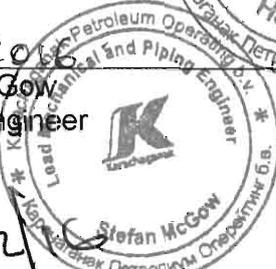
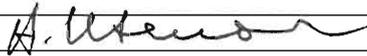
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Executive Summary

This specification covers the requirements for the design, materials, fabrication, testing, and painting of gasketed or semi-welded Plate Heat Exchangers. This specification does not cover spiral plate or plate fin heat exchangers

Definitions/Abbreviations

MT- Magnetic Particle Testing

MAWP – maximum allowable working pressure

WPQR – Welding procedure qualification records

PT - Penetrant Testing

WPS – Welding procedure specification

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1.0 SCOPE

1.1 General

1.1.1 The purpose of this specification is to cover requirements for the design, materials, fabrication, testing, and painting of gasketed or semi-welded Plate Heat Exchangers. This specification does not cover spiral plate or plate fin heat exchangers.

1.1.2 Exchanger data sheet, which will include material specifications, fluid characteristics and design conditions, shall be supplied by the PURCHASER for each unit.

1.1.3 In case of a conflict between the documents included in a Material Requisition, the order of precedence should be:

- a) Notes in the Material Requisition.
- b) Equipment data sheets.
- c) This Specification.
- d) API 662 Plate Heat Exchangers for General Refinery Services
- e) ASME Codes
- g) Other Specifications listed in the Material Requisition.

In any case, all conflicts must be submitted to PURCHASE for individual resolution.

1.2 Quotation

1.2.1 The Supplier shall supply a complete thermal, hydraulic, and mechanical guarantee. If the exchanger does not perform at the design conditions specified on the data sheet, the Supplier shall make the necessary adjustments to rectify the exchanger on-site in such a way that it shall permanently perform within the guaranteed level.

1.2.2. The Supplier's proposal must include the following:

- a) Completed data sheets with exchanger weights empty and full.
- b) Preliminary drawing showing exchanger dimensions and connection sizes/locations.
- c) Maximum design pressure with identification of limiting component.

- d) Maximum gasket design temperature at the design pressure specified on the exchanger data sheet.
- e) Maximum particle size which will pass through the exchanger.
- f) Fluid velocities and shear stresses for each different flow channel.
- g) Fluid velocities through connections and plate ports. If the size of the plate port is different from the frame connection, the Supplier must state both sizes.
- h) Plate thickness before pressing.
- i) Percent plate pack expansion available.
- j) Percent over surface and equivalent fouling factor.
- k) Method of gasket attachment to plates.
- L) Special tool requirements.
- m) Plate WPS and supported WPQR , if applicable.

1.2.3 The Supplier's shall include the cost for ASME Code inspection and stamping.

1.3 Supplier Drawing And Data Requirements

- 1.3.1 General arrangement drawings or outline drawings must show exchanger dimensions, connection locations and size, supports, compressed plate pack length (during operation), materials, design conditions, weights empty and full, and access requirements.
- 1.3.2 Detail drawings of the plate pack shall show the design of each plate type, plate material, and location of each plate type within the plate pack.
- 1.3.3 Detail drawings of the gaskets shall identify each gasket type, gasket material, and location of each gasket type within the plate pack.
- 1.3.4 Detail drawings of the frame shall show location and material of each component. Location of any welds must be identified along with the WPS and supported WPQR used.
- 1.3.5 Other data as required by API 662.
- 1.3.6 Instruction manuals are required to show proper methods of:
 - a) Opening and closing the exchanger for servicing.
 - b) Compressing the plate pack for operation.
 - c) plate removal.

- d) gasket replacement.
- e) plate cleaning.
- f) shutdown and startup procedure.

2.0 CODES AND STANDARDS

2.1 The plate heat exchanger shall be designed, fabricated and tested in accordance with the applicable sections of API 662 and Section VIII, Division 1 of the ASME Code for Pressure Vessels latest edition (with latest Addenda). Code stamping is required unless it is for water or lube oil services.

2.2 Additional Codes And Standards

API Standard 662	Plate Heat Exchangers for General Refinery Services
ASME Section II	Materials (Parts A, B, and D)
ASME Section V	Nondestructive Examination
ASME Section IX	Welding, Brazing and Fusing Qualifications
ASME B1.1	Unified Screw Threads
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory Made Wrought Steel Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket Welding and Threaded

2.3 Related Specifications

The following related specifications and standards also apply:

- a) Specifications, Addenda, and Appendices listed in the Material Requisition
- b) All federal, state, and local laws and regulations where applicable.

3.0 DESIGN

3.1 Process

- 3.1.1 The exchanger shall be of a single pass, counter-current flow design to facilitate access to the plate pack for maintenance and to enable cleaning by back-flushing. A multi-pass design may be quoted as an alternate design.
- 3.1.2 The frame and tightening bolts of the exchanger shall be designed to permit the future installation of a minimum of 20% additional plates.
- 3.1.3 Percent oversurface or fouling resistances shall be as specified on the data sheet, but in no case shall the percent oversurface be less than 20%.
- 3.1.4 Supplier shall keep to a minimum the number of different types of plates offered unless an appreciable capital savings is realised.
- 3.1.5 Flow area of the ports shall be such that the entrance and exit pressure drops combined are not more than 30% of the total calculated pressure drop.
- 3.1.6 Design shall maximise fluid velocity between plates within the pressure drop restrictions to reduce the fouling rate and to produce high heat transfer coefficients.
- 3.1.7 The maximum velocity through the exchanger inlet and outlet nozzles shall be:
- | | |
|----------------------|---------|
| Carbon Steel | 3.6 m/s |
| Stainless Steel | 6.1 m/s |
| Titanium | 6.1 m/s |
| Aggressive solutions | 3.0 m/s |
- 3.1.8 For gas stripping fluid applications (amines, selexols, etc.) where alternative multi-pass designs are offered, the exchanger shall have a maximum of two passes with the fluid rising in the last pass to prevent gas pocketing.
- 3.1.9 Port diameters shall not be less than nozzle inside diameter.

3.2 Mechanical

- 3.2.1 The design temperature shall be used for the design metal temperature of the ports, end plates, connector plate, and the fixed and movable covers.
- 3.2.2 Design pressure for the gasketed plate and frame heat exchangers shall not exceed 25 barg.
- 3.2.3 Design temperature for the gasketed plate and frame heat exchangers shall not exceed 180°C.
- 3.2.4 The exchanger shall carry a stamped marking for the maximum allowable working pressure (MAWP) at hot and corroded conditions and based on the actual metal thicknesses. Supplier shall identify the limiting component.

3.2.5 Carbon steel ports shall have a minimum corrosion allowance 3 mm. All alloy and alloy lined material will have no corrosion allowance unless otherwise specified. Alloy linings or weld overlay shall not be included in strength calculations.

3.3 Plates

3.3.1 Plates shall be designed for full differential pressure, with one side at the design pressure and the other side at atmospheric pressure.

3.3.2 The minimum thickness of plates after pressing shall be 0.5 mm.

3.3.3 Port holes not feeding passes between plates shall be fully gasketed and vented to the atmosphere.

3.3.4 Design of plates shall be such that metal-to-metal contact exists between adjacent plates.

3.3.5 Plates shall be fully supported from the top carrying bar and guided only by the bottom bar. The plates shall have integrally reinforced slots.

3.3.6 End plates shall be furnished at the fixed and movable cover to provide sealing of the first and last flow channel and provide support to the adjacent plate.

3.3.7 Plate alignment shall be accomplished mechanically with the aid of the carry and guide bars. Designs which require the use of gaskets to achieve satisfactory plate alignment are not acceptable. The use of hanging clips on plates for alignment (round or square carrying bars) is limited to plates of a maximum length of 915 mm.

3.3.8 A removable metal shroud shall be provided by the Supplier to completely cover the top and sides of the plate pack. A drip tray shall be provided below the plate pack for the length of the frame.

3.3.9 Each plate shall be permanently marked to identify the type and orientation.

3.3.10 Plates shall be replaceable individually without requiring removal of any other plate(s).

3.3.11 On alternative designs with multi-pass configuration, the Supplier must identify in their quote the turning plate construction. The unblanked ports must be designed to withstand full differential pressure without permanent deformation or failure. Above 6 inch ports, the turning plate shall be minimum 6 mm thick carbon steel material with port linings appropriate for the intended fluid service.

3.3.12 Plates shall be pressed on a homogeneous sheet in one step. Designs incorporating plates with incremental pressing along its length must be approved but can be offered as an alternate design.

3.4 Fixed And Movable Covers

3.4.1 Single pass counter-current design shall have all nozzle connections located in the fixed cover.

- 3.4.2 Holes for tightening bolts shall be uniformly distributed around the periphery of the covers. Exchangers with port sizes 3" and larger, or with tightening bolts 25 mm diameter and larger shall have slotted holes and provide a mechanical method for retention of the tightening bolts.
- 3.4.3 The movable cover shall be supported from the upper carrying bar by means of roller bearings and guided by the bottom bar.
- 3.4.4 Cover design shall not include stiffeners.
- 3.4.5 Carbon steel cover plates must satisfy the requirements of paragraph UCS-66 of the ASME Code, Section VIII, Division 1, in regard to impact testing. Unless otherwise stated, minimum ambient temperature shall be considered to be -45 deg. C.
- 3.4.6 All welded attachments to covers, including nameplate brackets, nozzle reinforcement, etc. shall be continuously welded to the covers. These welds shall be examined by MT or PT to ensure that there are no unacceptable defects that may cause leaks. The only exception is the non-pressure retaining nozzle to cover welds can have a telltale gap at the lowest point to meet ASME requirements.

3.5 Tightening Nuts and Bolts

- 3.5.1 The tightening bolt length shall accommodate the provision for future plate pack expansion.
- 3.5.2 The minimum diameter of the tightening bolt shall be 16 mm.
- 3.5.3 The stationary end of the tightening bolt shall have a mechanically or Loctite attached captive nut. Welding of the nut to the tightening bolt is not permitted. A locking device shall be used on one end to prevent bolt rotation during bolt tightening and loosening. Washers shall be provided on each end of the tightening bolt.
- 3.5.4 The Supplier shall specify in their quotation any special devices required for bolt tightening. Supplier shall also provide information on tightening devices that expedite maintenance on their exchangers.

3.6 Carrying And Guide Bars

- 3.6.1 A smooth surface shall be provided for the movable cover roller for the whole length of the carrying bar. Aluminium components are not allowed.
- 3.6.2 The carrying bar shall be designed to support 1.5 times the weight of a flooded exchanger including movable cover, tightening bolts, nuts, and nozzles.
- 3.6.3 The design of the carrying and guide bars shall provide for individual plate removal. If dropout slots in the carrying bar are intended, the number of slots provided shall be stated in the quotation.

3.6.4 Carrying bars and guide bars shall be fabricated from a single length of material. Bolted splices are not allowed.

3.7 Supports and Frame

3.7.1 Supports shall be furnished at both ends of the frame.

3.7.2 Two M10 electrical earth bosses shall be installed diagonally opposite each other at the supports.

3.8 Connections

3.8.1 All inlet and outlet connections shall be extended flange construction or studded ports. Unless otherwise noted, the flange facing shall be raised face.

3.8.2 Nozzle projections shall be of sufficient length to insure installation and removal of nozzle flange bolts.

3.8.3 All nozzles in one pass by one pass designs shall be located in the fixed cover.

3.8.4 Nozzle neck attachment to the cover shall be of welded construction. Screwed back-up flanges shall not be used.

3.8.5 Nozzle sizes of 1-1/4", 2-1/2", 3-1/2", 4-1/2" or 5" shall not be used.

3.9 Plate Gaskets

3.9.1 Gaskets must be compatible with the fluids, design pressure, and design temperature specified on the data sheet. Reduced gasket life due to gasket temperature/pressure limitations below the specified design temperature/pressure is NOT PERMITTED.

3.9.2 Gaskets shall be positioned in a groove around the heat transfer surface and around the port holes of the plate. The grooves shall be designed to prevent over/under compression of the gaskets when the plate pack is compressed to its design value.

3.9.3 All gaskets, except between end plates and heads, shall be identical. Gaskets must be one piece moulded.

3.9.4 Gasket design shall allow a metal-to-metal contact between plates when plate pack is compressed.

3.9.5 In general, gasket attachment may be glued or non-glued. Non-glued gaskets are preferred in clean services, and glued gaskets are preferred in fouling services.

3.9.6 The gasket plate surface shall be thoroughly cleaned by means of solvent cleaning or mechanical means and dried before the application of the gasket. Emery cloth or abrasive powders shall not be used to clean out the gasket grooves.

- 3.9.7 For glued-in gaskets, the cleaned groove shall have a heat cured adhesive material applied and the gasket installed. The adhesive material must be compatible with the gasket and operating fluids. All plates with gaskets shall be stacked in a fixture to align the gaskets, placed under slight compression to remove air pockets, and heat cured at a temperature recommended by the adhesive manufacturer. The curing time shall be at least one hour, but not less than the adhesive manufacturer's recommendation. Deformed gaskets must be replaced.
- 3.9.8 Relieving grooves shall be provided where internal seals are used to prevent cross contamination of fluids. The grooves must allow all seal leaks to be visually evident at the outside surface of the plate pack.
- 3.9.9 Representative gaskets from each gasket production batch used in the exchanger must be subjected to a hardness test, compression set test, and dimensional check prior to installation. Gasket hardness must be within 10% of the manufacturer's recommended hardness value.

3.10 Handling Devices

- 3.10.1 Provision for lifting the exchanger must be provided by permanent lifting lugs or frame holes, and shall be designed to support twice the maximum exchanger dry weight. Holes shall be no less than 25 mm in diameter. Lifting lugs shall be a welded-on type with a machined hole.

4.0 MATERIALS

4.1 Materials of construction

4.1.1 Unless otherwise noted on the data sheets, materials of construction shall be:

- Fixed and movable cover: Carbon Steel SA-516 Grade 70 or 60 (with supplementary requirements –S5)
- Plates: As shown on Data Sheet.
- Tie bars: SA-320-L7M.
- Nuts: SA-194-7M.
- Carry Bar and Guide Bar: Stainless steel at points of contact with plate.

4.1.2 All materials shall be suitable for specified design temperature.

4.1.3 Material certificates shall be in accordance with EN10204 Type 3.1

4.2 Nameplates: Austenitic stainless steel

4.2.1 All surfaces in contact with the fluids (including liners if applicable) shall be made of the same material specified for the plate on the data sheet. The only exception is when carbon steel nozzles are specified on the data sheet.

4.2.2 All pressure retaining materials shall be ASME Code qualified materials.

4.2.3 Supplier shall provide service experience for the gasket material proposed. As a minimum, the gasket material shall be suitable for 3 to 4

years of leak-proof service. Gasket material shall be subject to approval by PURCHASER.

- 4.3.4 On welded plates, welding methods must be detailed in the Supplier's proposal.

5.0 TESTING

- 5.1 After complete assembly and before shipment, the exchanger shall be hydrostatic tested in accordance with the requirements of ASME Section VIII Division 1. Each side shall be tested independently of the other. The test pressure shall be held for a minimum of one hour on each side. The test shall be conducted in the presence of the PURCHASER's inspector.
- 5.2 The chloride content of water used for hydrostatic testing shall not exceed 50 ppm when the exchanger contains austenitic stainless steel materials.

6.0 PAINTING

- 6.1 The external portions of each heat exchanger, except the stainless steel portions of the carry and guide bars in contact with the plates, the machined surfaces of flanges, and other gasket surfaces, shall be painted in accordance with the project paint specification, referenced in the Material Requisition.

7.0 PREPARATION FOR SHIPMENT

- 7.1 The exchanger shall be thoroughly drained after hydrotest and blown dry with air or inert gas. Flanged connections shall be protected against corrosion by the application of an easily removable rust preventative coating, and be provided with rubber gasketed metal or wooden cover plates.
- 7.2 Machined carbon steel surfaces exposed to the atmosphere shall be suitably protected during shipment by means of an easily removable rust preventive coating of satisfactory consistency.
- 7.3 Bolts, studs and stud bolts shall be lubricated with a molybdenum disulfide composition, and provided with protective sleeves.
- 7.4 Each exchanger shall be marked in accordance with requirements for identification as specified in the Purchase Order.
- 7.5 Additional preparation requirements, if any, will be referenced in the Request For Bid and the Purchase Order.
- 7.6 Supplier shall provide 12 month preservation.
- 7.7 Shipping notices shall be forwarded to the PURCHASER as directed in the Purchase Order.