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| | CLIENT: PETROBRAS | | FOLHA: 1 de 9 | |
| | PROGRAM: PLATES FOR PLATE HEAT EXCHANGERS (PHE) | | | |
| | AREA: | | | |
| | | TITLE: PLATES FOR GASKETED PLATE HEAT EXCHANGERS | | |

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| REV. | MODIFICATION DESCRIPTION | | | |
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| 0 | ORIGINAL | | | |
| A | GENERAL REVISION | | | |
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TITLE:

PLATES FOR GASKETED PLATE HEAT EXCHANGERS

Summary

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1 INTRODUCTION

This technical specification establishes the minimum requirements for supplying heat exchanger plates (without installed gaskets) to be applied in plate heat exchangers (PHE).

In case of supplying heat exchanger plates with installed gaskets, the requirements of gasket for plate heat exchangers (I-ET-3010.00-1200-456-PPC-1) shall also be fulfilled.

This technical specification was elaborated to be applied mainly in large Plate Heat Exchangers.

Plate Heat Exchangers (PHE) are classified as large when nozzle diameter exceeds 200 mm (including).

Smaller sized Plate Heat Exchangers (PHE) may have different technical requirements for gaskets evaluation. For these cases, Petrobras must be consulted to verify the need to meet the requirements of this technical specification.

The requirements for plates of PHE of this technical specification aim application in equipment to be installed and used inside Petrobras facilities. Petrobras is not responsible about the use of equipment qualified as meeting this document requirements, outside Petrobras facilities.

2 REFERENCE DOCUMENTS

- API 662 Part 1** Plate Heat Exchangers for General Refinery Services.
Part 1 - Plate-and-Frame Heat Exchangers
- ET-3010.00-1200-456-PPC-001** Gaskets for Plate Heat Exchangers – EPDM, NBR and
HNBR types

3 ABBREVIATIONS

- PHE Plate Heat Exchanger
- ISO International Organization for Standardization
- ET Technical Specification (Especificação Técnica in Portuguese)
- API American Petroleum Institute

4 TECHNICAL REQUIREMENTS

The technical requirements described in this document refer to documentary tests or tests.

Heat exchanger plates for PHE are classified according with the following characteristics:

- Plate material (e.g., Grade 1 Titanium - ASTM B-265 Gr.1 – Stainless steel 316L, etc.)
- PHE model (e.g., TL35-BFD, GLP-230, etc.)
- Plate thickness (in general, ranging from 0.5 to 0.8 mm)
- Plate configuration (e.g., “H”, “L”, etc.)

The technical requirements stated in this technical specification apply for any PHE plates, regardless of plate model, material, thickness, and configuration.

PHE plates shall comply with the general requirements (4.1) and specific requirements (4.2). In addition, the manufacturer shall submit the plate inspection data report, in conformity with the requirements addressed in the plate inspection section (4.3).

The report to prove compliance with the requirements indicated in 4.1 and 4.2 must be submitted together with the Technical Proposal. The report indicated in 4.3 must be submitted together with the plates provided.

Petrobras informs that at any time after the conclusion of the process of purchase of plates (when they are already under the responsibility of Petrobras), it may carry out inspections and/or evaluations on the product delivered by the Manufacturer. If there is any defect or deviation from the requirements set forth in this technical specification, the Manufacturer will be subject to the sanctions provided in the contract.

Petrobras informs that it will perform thermal and hydraulic performance evaluations of the purchased plates when the plates arrive at Petrobras facilities, after the purchase process conclusion. If the evaluations evidence incompatible performance with the supplied plate model, the manufacturer is subject to the sanctions disposed in the contractual documentation.

4.1 GENERAL REQUIREMENTS

- 4.1.1 All the plates shall be identified with a permanent mark in the plate surface containing the serial number and the necessary information to allow material certificates traceability.
- 4.1.2 The furnishment of reconditioned, repaired or used plates is prohibited. All supplied plates shall have suffered only the loads inherent of the plate forming manufacturing process.
- 4.1.3 The furnishment of plates containing local weld repairs is prohibited.
- 4.1.4 All the furnished plates shall be absent of superficial defects or through thickness defects (such as cracks, pits, scratches, etc.).
- 4.1.5 The manufacturer shall include in the furnishment the plate quality material certificates, containing results of chemical composition tests and mechanical proprieties tests according to the specified material ASTM specification.
- 4.1.6 The manufacturer shall comply with the API 662 Part 1 requirements and recommended practices to assure the adequate performance and service life, during PHE operation.
- 4.1.7 The manufacturer shall assure that all supplied plates have the plate geometry in accordance with the plate model specified in the acquisition process.
- 4.1.8 The manufacturer shall assure that all supplied plates have the thermal performance and pressure drop performance in accordance with the plate model specified in the acquisition process.
- 4.1.9 The plates shall be supplied inside a packing box assuring plates protection during transportation and storage. The plates shall be mechanically fixed inside the packing box, preventing plate movement inside the packing box during transportation. The maximum number of plates inside each packing box is 125 (one hundred twenty-five) units.
- 4.1.10 The method used to lock and tie the plates inside the box (packaging) must allow, after removing some plates, the remaining boards in the package to be locked and tied properly with guarantee of protection during transport and storage.
- 4.1.11 Storage and handling instructions must be provided.

4.2 SPECIFIC REQUIREMENTS

Figure 1 indicates the main dimensions of a heat exchanger plate.

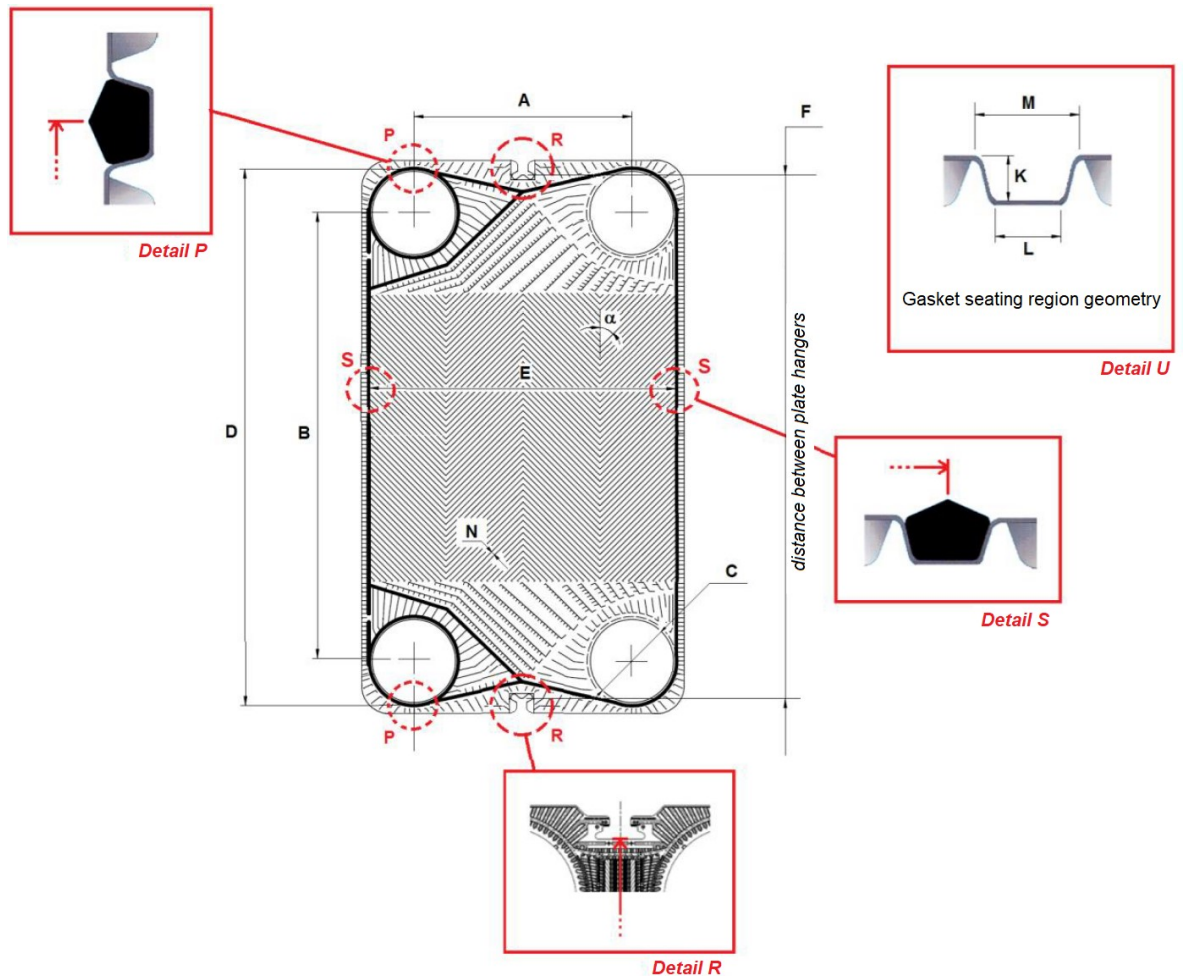


Figure 1 - Main dimensions of a PHE plate.

The Table 1 indicates the dimensions present in Figure 1. In addition, it includes the heat exchange plate area (S_p) and the plate thickness (e).

For compliance with the specific requirements, the plate manufacturer shall include Table 1 data in the furnishing process Databook, including the manufacturing tolerances, regarding the plate model to be furnished to Petrobras. If the plate manufacturer is also the original manufacturer of that PHE model, the nominal values and manufacturing tolerances are not mandatory.

The plate dimension values shall be in accordance with the values for the PHE model for which the supply process is specified.

Table 1 - Nominal plate dimensions and dimensional tolerances to be informed by the plate manufacturer in the supply process.

| Dimensions | | | Description |
|----------------|-----------|-----------------|--|
| A | nominal | mm | Horizontal distance between port centers. |
| | tolerance | ± mm | |
| B | nominal | mm | Vertical distance between port centers. |
| | tolerance | ± mm | |
| C | nominal | mm | Ports diameter. |
| | tolerance | ± mm | |
| D | nominal | mm | Plate height measured between gasket centers (Figure 1, detail P). |
| | tolerance | ± mm | |
| E | nominal | mm | Plate width measured between gasket centers (Figure 1, detail S). |
| | tolerance | ± mm | |
| F | nominal | mm | Distance between plate hangers (Figure 1, detail R). |
| | tolerance | ± mm | |
| K | nominal | mm | Plate corrugation depth (Figure 1, detail U). |
| | tolerance | ± mm | |
| L | nominal | mm | Width of the basis of the gasket seating surface (Figure 1, detail U). |
| | tolerance | ± mm | |
| M | nominal | mm | Larger width of the gasket seating region (Figure 1, detail U). |
| | tolerance | ± mm | |
| N | nominal | mm | Corrugation's pitch. |
| | tolerance | ± mm | |
| α | Nominal | ° | Chevron angle (referenced to the vertical line, according to Figure 10). |
| S _P | Nominal | mm ² | Heat exchanger area per plate. |
| e | nominal | mm | Plate thickness |
| | tolerance | ± mm | |

The Manufacturer must state in the report the nominal values and manufacturing tolerance of the dimensional values shown in Table 1.

NOTE: If the cross-sectional gasket seating geometry (Figure 1, detail U) varies in some regions of the plate, the manufacturer shall inform the dimensions for each zone. For instance, some plate models have a pre deformed region at the non-supported diagonal of the gasket seating zone, near the ports.

IMPORTANTE: to comply with the requirements of this technical specification, the manufacturer may not provide the Table 1 dimensions only if it is also the original manufacturer of the PHE that the furnished plates will be used.

4.3 PLATES INSPECTION

The manufacturer shall sample 5% of the furnished plates or 10 plates, whichever is greater and conduce a dimensional inspection to verify the dimensions presented in Table 2.

The manufacturer shall submit a report of the dimensional inspection, indicating the measured dimensions for each of the dimensions presented in Table 2, for all verified plates.

In addition to the dimensional inspection, the manufacturer shall execute dye penetrant tests at the sampled plates. The dye penetrant test shall be executed to verify absence of through thickness defects at the plates. The manufacturer shall include in the inspection reports a copy of the dye penetrant test procedure adopted, as well as the tests results.

After dye penetrant testing, the plates shall be completely cleaned.

The inspection report shall be provided by the manufacturer to Petrobras with the Databook for the furnished plates.

Table 2 - Dimensions to be verified by the manufacturer during the sampled plates inspection.

| Dimension | Value (mm) | Dimension description |
|-----------|------------|--|
| A | | Horizontal distance between port centers. |
| B | | Vertical distance between port centers. |
| C | | Ports diameter. |
| D | | Plate height measured between gasket centers (Figure 1, detail P). |
| E | | Plate width measured between gasket centers (Figure 1, detail S). |
| F | | Distance between plate hangers (Figure 1, detail R). |