

ANSI/AHRI Standard 401 (SI)

**2015 Standard for
Performance Rating of
Liquid to Liquid Heat
Exchangers**



Approved by ANSI on November 6, 2015



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IMPORTANT

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Note:

This standard supersedes AHRI Standard 400–2001 with Addenda 1 and 2.
For the I-P ratings, see ANSI/AHRI Standard 400 (I-P)–2015.

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PERFORMANCE RATING OF LIQUID TO LIQUID HEAT EXCHANGERS

Section 1. Purpose

1.1 Purpose. The purpose of this standard is to establish for Liquid to Liquid Heat Exchangers: definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; marking and nameplate data; and conformance conditions.

1.1.1 Intent. This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to Liquid to Liquid Heat Exchangers as defined in Section 3, which includes the following types of heat exchangers:

- 2.1.1** Plate heat exchangers
- 2.1.2** Shell-and-tube heat exchangers
- 2.1.3** Shell-and-coil heat exchangers
- 2.1.4** Shell-and-U-Tube heat exchangers

2.2 Exclusions. This standard does not apply to heat exchangers used for change of phase or non-liquid heat transfer applications.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (<https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology>) unless otherwise defined in this section.

3.1 Cold Stream. The liquid stream with the lower inlet temperature.

3.2 Field Fouling Allowance. Provision for anticipated fouling during use.

3.2.1 Fouling Factor. The thermal resistance due to fouling accumulated on the heat transfer surface.

3.3 Hot Stream. The liquid stream with the higher inlet temperature.

3.4 Liquid to Liquid Heat Exchanger. A heat transfer device used to exchange heat between two liquid streams that are single phase fluids.

3.5 Number of Transfer Units (NTU). A dimensionless coefficient representing the magnitude of thermal performance. The equation for NTU is given in Appendix C.

3.6 Plate Heat Exchanger. Heat transfer device that typically utilizes corrugated metal plates in a bolted frame. An alternate technique is for the plates to have elastomeric gaskets that seal the unit and direct the heat transfer stream in countercurrent flow. The corrugated plates can also be brazed together using a sacrificial alloy thus avoiding the need for a bolted frame.

3.7 *Published Ratings.* A statement of the assigned values of those performance characteristics by which a unit may be chosen to fit its application. As used herein, the term Published Ratings includes all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated conditions.

3.8 *"Shall" or "Should".* "Shall" or "should" shall be interpreted as follows:

3.8.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.8.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.9 *Shell Type Heat Exchanger.* A heat transfer device utilizing an arrangement of multiple hollow cylindrical flow channels (tubes) contained within another larger hollow cylindrical flow channel (shell). The fluid flowing within the tubes exchange thermal energy through the tube wall with another fluid flowing within the shell. This includes Shell-and-Tube, Shell-and-U-Tube, and Shell-and-Coil Heat Exchangers.

3.9.1 *Shell-and-tube Heat Exchanger.* A bundle of tubes contained in a shell or container. The tube(s) carry a fluid through them, while the shell is also provided with an inlet and outlet for flow of another fluid.

3.9.2 *Shell-and-U-tube Heat Exchanger.* A heat-exchanger system consisting of a bundle of U tubes surrounded by a shell; one fluid flows through the tubes, and the other fluid flows through the shell, around the tubes.

3.9.3 *Shell-and-coil Heat Exchanger.* A heat-exchanger system consisting of helically corrugated tubes surrounded by a shell; one fluid flows through the tubes, and the other fluid flows through the shell, around the tubes.

Section 4. Test Requirements

4.1 *Test Requirements.* All Published Ratings shall be verified by tests conducted in accordance with Appendix C.

Section 5. Rating Requirements

5.1 *Ratings.* Published Ratings of Liquid to Liquid Heat Exchangers shall consist of ratings at conditions as elected by the manufacturer to facilitate the selection of equipment. Ratings shall contain all information shown in Section 6.2.1. When ratings include a Field Fouling Allowance, they shall be calculated by the method specified in Appendix D.

5.1.1 *Clean Surface Condition.* Ratings shall be based on tests with initially clean heat transfer surface(s) and conducted in accordance with Section 4.1.

The results of these tests are accepted as reflecting a Fouling Factor of zero. The Fouling Factor or heat transfer margin (if used) shall be agreed upon by the end user and the manufacturer.

5.2 The manufacturer shall provide published information as to the maximum and minimum recommended flow rates for clean liquid.

5.3 *Rating Tolerances (Applies to all Products Covered by this Standard).* To comply with this standard, measured test results shall not be less than 95% of the Published Rating for heat transfer rates and measured values of pressure drop shall not exceed Published Ratings by more than 15%, or 3 kPa, whichever is greater.

Section 6. Minimum Data Requirements for Published Ratings

6.1 *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall include all information shown in Section 6.2.1. All claims to ratings within the scope of this standard shall be accompanied by the statement “Rated in accordance with ANSI/AHRI Standard 401 (SI)”. All claims to ratings outside the scope of this standard shall be accompanied by the statement “Outside the scope of ANSI/AHRI Standard 401 (SI).” Wherever Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

6.2 *Published Ratings.* Published Ratings (in catalogs or as computer output) shall include, or be capable of generating, unit designation(s), and the information below.

6.2.1 Published Ratings shall state all the pertinent operating conditions and shall include the following data:

- 6.2.1.1** Hot stream inlet and outlet temperatures, °C
- 6.2.1.2** Cold stream inlet and outlet temperatures, °C
- 6.2.1.3** Total heat transfer rate, W
- 6.2.1.4** Identification of hot stream and cold stream liquids
- 6.2.1.5** Hot stream flow rate, L/s
- 6.2.1.6** Cold stream flow rate, L/s
- 6.2.1.7** Hot stream pressure drop, kPa
- 6.2.1.8** Cold stream pressure drop, kPa
- 6.2.1.9** Fouling Factor, $\text{m}^2 \cdot ^\circ\text{C}/\text{W}$
- 6.2.1.10** Hot stream NTU
- 6.2.1.11** Cold stream NTU

6.2.2 Published Ratings shall be accompanied by the following information:

- 6.2.2.1** Hot stream and cold stream design pressures, kPa
- 6.2.2.2** Unit dimensions (length, width, height), mm
- 6.2.2.3** All standard connection types and sizes, mm
- 6.2.2.4** Dry weight, kg
- 6.2.2.5** Flooded weight (water), kg

If only clean heat transfer surface ratings are published, a statement shall be included to contact the manufacturer if fouled heat transfer surface ratings are required.

Section 7. Marking and Nameplate Data

7.1 *Marking and Nameplate Data.* As a minimum, each heat exchanger shall be marked with the following information, along with any other information required by governing codes and regulations:

- 7.1.1** Name of manufacturer
- 7.1.2** Manufacturer’s model or serial number
- 7.1.3** Hot stream side design pressure, kPa
- 7.1.4** Cold stream side design pressure, kPa