*भारतीय मानक*

***Indian Standard***

**IS 6088 : 2024**

# ट्रांसफार्मर के लिए तेल-से-पानी हीट एक्सचेंजर्स — विशिष्टि

*( दूसरा पुनरीक्षण )*

# Oil-To-Water Heat Exchangers for Transformers — Specification

*( Second Revision )*

ICS 27.060.30



भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
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**May 2024** **Price Group 8**

Chemical Engineering Plants and Related Equipment Sectional Committee, MED 17

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Chemical Engineering Plants and Related Equipment Sectional Committee, had been approved by the Mechanical Engineering Divisional Council.

This standard was first published in 1971 and subsequently revised in 1988. The present revision has been taken up with a view incorporating the modification found necessary as a result of experience gained in the use of this standard. Also, in this revision, the standard has been brought into latest style and format of Indian Standards, and references to Indian Standards, wherever applicable have been updated. BIS certification marking clause has been modified to align with the revised *Bureau of Indian Standard Act*, 2016.

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# OIL-TO-WATER HEAT EXCHANGERS FOR TRANSFORMERS — SPECIFICATION

*( Second Revision )*

## 1 SCOPE

This standard covers material, construction and testing requirements of oil-to-water heat exchangers for transformers.

## 2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

## 3 TYPES AND RATING

### 3.1 Types

The heat exchangers shall be of Types A, B, C and D depending upon the position of oil and water connections. These may be either suspended mounted (SM) or base mounted (BM) heat exchangers as shown in Fig. 1 and Fig. 2, respectively.

### 3.2 Rating

The heat exchangers shall be rated according to their guaranteed heat dissipation capacity. It shall be one of the following:

50 kW, 100 kW, 160 kW, 250 kW, 350 kW, 400 kW, 500 kW, 630 kW, 800 kW, 1 000 kW, 1 600 kW

## 4 MATERIAL

The material used for various components of heat exchangers shall not be of a quality inferior to those specified below. Any other material equal or superior in performance to those specified may be used, subject to agreement between the manufacturer and the user.

### 4.1 Shell

The steel used for the construction of shell shall be at least equivalent to Grade A of IS 2062.

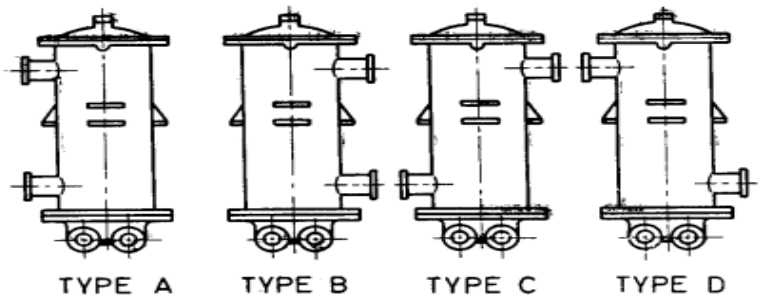



FIG.1 SUSPENDED MOUNTED (SM) TYPE HEAT EXCHANGERS

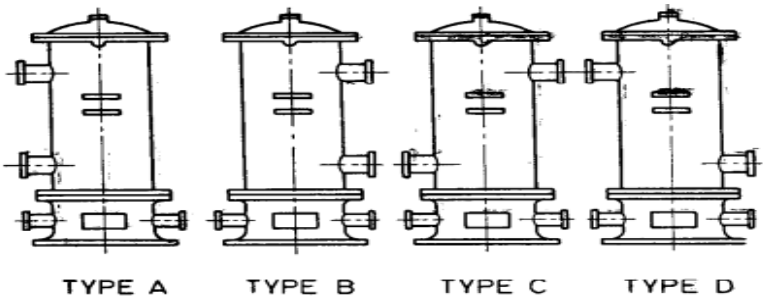



FIG. 2 BASE MOUNTED (BM) TYPE HEAT EXCHANGERS

### 4.2 Tube Plates

The material used for the tube plates shall be leaded brass to naval Grade 6 of IS 8362 or mild steel to Grade A of IS 2062, as may be agreed to between the manufacturer and the user.

### 4.3 Tubes

The material used for the tubes shall be solid drawn admiralty brass to IS 1545. Only those tubes on which the pressure tests in accordance with the requirements for the relevant standards have been carried out shall be used.

### 4.4 Baffles

The steel used for the baffle shall conform to IS 2062.

### 4.5 Water Chamber

The steel used for the construction of the water chamber shall conform to Grade A of IS 2062. Alternatively, the water chamber may be constructed of Grade 15 of cast iron conforming to IS 210.

### 4.6 Cover

The material for the cover shall conform to Grade A of IS 2062.

### 4.7 Components

The material of the component parts (*see* Fig. 3 and Fig. 4) are given in Table 1.

## 5 DESIGN, DIMENSIONS AND FINISH

### 5.1 Design

The heat exchanger shall be designed in accordance with the requirements of IS 4503. General requirements for transformer heat exchangers are given in Table 2. It shall be so designed that it may be mounted and protected in the open, without rain water or condensate collecting on it with the consequent risk of damage to joints. The tubes shall be of the seamless drawn type expanded in the tube plate. The tube bundle shall be of the floating type and capable of withdrawal when necessary. The water chambers shall be removed and capable of being emptied. In the case of the suspended mounting type, the design shall be such that the removal of the water chambers does not affect the oil circuit.

**5.1.1** Account shall be taken of the fouling factor in designing the heat exchangers. The minimum fouling resistance shall be as follows:

a) Transformer oil $0.000\ 2\ \frac{\mathrm{hm}^2\ ^\circ\mathrm{C}}{\mathrm{kCal}}$

b) Sea water $0.000\ 1\ \frac{\mathrm{hm}^2\ ^\circ\mathrm{C}}{\mathrm{kCal}}$

c) Brackish water or river water $0.000\ 2\ \frac{\mathrm{hm}^2\ ^\circ\mathrm{C}}{\mathrm{kCal}}$

A free exit of water without any scope to build up pressure shall be ensured. The oil pressure shall be higher than the water pressure.

**Table 1 Parts of the Material Component**

(*Clauses* 4.7, 9.2.1 *and* 9.2.2)

| Sl No. (1) | Description (2) | Remarks (3) |
|---|---|---|
| i) | Welding neck flange, 15 mm nominal size | Conforming to IS 6392 |
| ii) | Cover | — |
| iii) | Screw plug P3/4 | Conforming to IS 554 |
| iv) | Plate mounting | — |
| v) | Access cover for cleaning water space | — |
| vi) | Thermometer pocket P3/4 | *See* **5** |
| vii) | Thermometer pocket P3/4 | *See* **5** |
| viii) | Welding neck flange, Class 10 | Conforming to IS 6392, nominal bore according to $d_3$ |
| ix) | Welding neck flange, Class 10 | Conforming to IS 6392, nominal bore according to $d_4$ at the manufacturer's option |

**Table 2 General Requirements for Transformer Heat Exchanger**

(*Clauses* 5.1, 5.2, 5.2.1, 9.2.1 *and* 9.2.2)

| Sl No. | Heat Dissipation Rating | Volume of Oil Circulated | Volume of Water | Pressure Drop *Max* | | Oil Temperature | | Water Temperature | | Oil Filling Capacity[1)] | Weight of Heat Exchanger *Max* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Oil | Water | Inlet | Outlet | Inlet | Outlet | | |
| | kW | $m^3/h$ | $m^3/h$ | MPa | MPa | °C | °C | °C | °C | | *kg* |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| i) | 50 | 17 | 4.5 | | | | | | | 45 | 150 |
| ii) | 100 | 33 | 9.0 | 0.04 | 0.01 | | | | | 60 | 240 |
| iii) | 160 | 53 | 13.5 | | | | | | | 90 | 300 |
| iv) | 250 | 82 | 22.5 | | | | | | | 120 | 420 |
| v) | 350 | 116 | 31.5 | 0.05 | 0.015 | 70 | 63.5 | 35 | 45 | 170 | 530 |
| vi) | 400 | 135 | 36 | | | | | | | 240 | 580 |
| vii) | 500 | 170 | 45 | | | | | | | 300 | 600 |
| viii) | 630 | 210 | 57 | | | | | | | 375 | 720 |
| ix) | 800 | 270 | 72 | 0.06 | 0.02 | | | | | 480 | 760 |
| x) | 1 000 | 340 | 90 | | | | | | | 600 | 1 000 |
| xi) | 1 600 | 540 | 144 | | | | | | | 800 | 1 400 |

[1)] Capacity of the oil in the tube side of heat exchangers when filled initially with oil.

**5.1.2** The velocity of water in the heat exchanger shall not be less than 1 m/s.

**5.1.3** Minimum outside diameter of tube shall be 12.7 mm.

**5.1.4** Minimum tube thickness shall be 0.89 mm.

**5.1.5** Tube pitch shall be 1.20 times tube outer diameter (OD) for tube OD less than 16 mm and 1.25 times tube OD for tube OD greater than 16 mm.

**5.1.6** Tube pattern shall be 60° triangular pitch.

**5.1.7** Maximum tube hole size in baffle plate shall be the tube OD plus 0.4 mm.

**5.1.8** Clearance between shell inner diameter (ID) and baffle OD.

**5.1.8.1** *Disc and doughnut baffle arrangement*

a) Maximum radial clearance at any point between shell ID and doughnut baffle OD shall not exceed 30 mm including the ovality of the shell; and
b) The ovality of the shell shall be limited to a maximum of 3.0 mm on diameter.

**5.1.8.2** *Segmental baffle arrangement*

Maximum of design shell ID minus baffle OD shall not exceed the following values:

| *Sl No.* | *Shell ID* | *Clearance* |
|---|---|---|
| (1) | (2) | (3) |
| i) | ≤ 400 mm | 3.0 mm |
| ii) | 401 to 1 000 mm | 5.0 mm |
| iii) | 1 001 to 1 400 mm | 6.0 mm |
| iv) | 1 401 and above | 8.0 mm |

**5.2 Dimensions**

The dimensions of the suspended mounted heat exchangers shall conform to the requirements given in Table 2 read with Fig. 3 and those of the base mounted heat exchangers shall conform to the dimensions given in Table 3 read with Fig. 4.

**5.2.1** *Tolerances*

Permissible deviations from dimensions specified in Table 2 and Table 3 without tolerance indication shall be the coarse class specified in IS 2102 (Part 1) except

in the case of dimensions $e_4$ and $e_6$ which shall be of the medium class.

**5.2.2** The dimensions of the cover shall conform to those given in Fig. 5. Alternatively, the cover may be bolted to the water box using studs or bolts with suitable jointing material to give a leak-proof joint.

### 5.3 Finish

The external surface of the heat exchanger shall be spray galvanized to a total thickness of not less than 0.12 mm which is equal to applying not less than 600 g/m$^2$ by the spraying method. Subject to agreement between the manufacturer and the user, the external surface may be painted instead of spray galvanizing. The interior surface of the water chambers shall be painted with rust protection paint. All bolts and nuts shall be protected against corrosion or made of corrosion resistant material.

## 6 MONITORING EQUIPMENT

The heat exchangers may be provided with the following equipment subject to agreement between the manufacturer and the user:

a) Thermometer on the oil side [depth of immersion 100 mm, thread P3/4 × 20 mm (*see* IS 554), flange diameter 38 mm];
b) Thermometer on the water side [depth of immersion 65 mm, thread P3/4 × 20 mm (*see* IS 554), flange diameter 38 mm];
c) Pressure gauge on oil outlet and water inlet to IS 3624, thread P1/2 (*see* IS 554);
d) Flow monitor on oil outlet and water inlet;
e) Water overflow pipe communicating, at option, with vent plug on upper water chamber;
f) Differential pressure monitor. This is connected to the oil outlet and water inlet. The oil side connection is made to one of the two flanges under Sl No. (i) in Table 1 and
g) Device fitted at the water outlet to indicate any leakage of oil-to-water.

## 7 TESTING

The leakage test is carried out with the transformer oil at room temperature and at a pressure of 1 MPa or one-and-a-half times the design pressure, whichever is greater, and with the pressure of 0.5 MPa or one-and-a-half times the design pressure, whichever is greater, maintained on the water side. Reckoning from the time the last leak occurs, the test pressure may be maintained for two hours, both on the oil side and on the water side. At the end of this time, there shall be no evidence of further leakage.

## 8 DESIGNATION

The designation of the heat exchangers to this specification shall include the following information:

a) Common name;
b) Type;
c) Cooling rating; and
d) Designation of this standard.

*Example*:

An oil-to-water heat exchanger for base mounting (BM) Type A with a heat dissipation rating of 100 kW is designated as:

Heat Exchanger BM A 100, IS 6088

## 9 SAMPLING

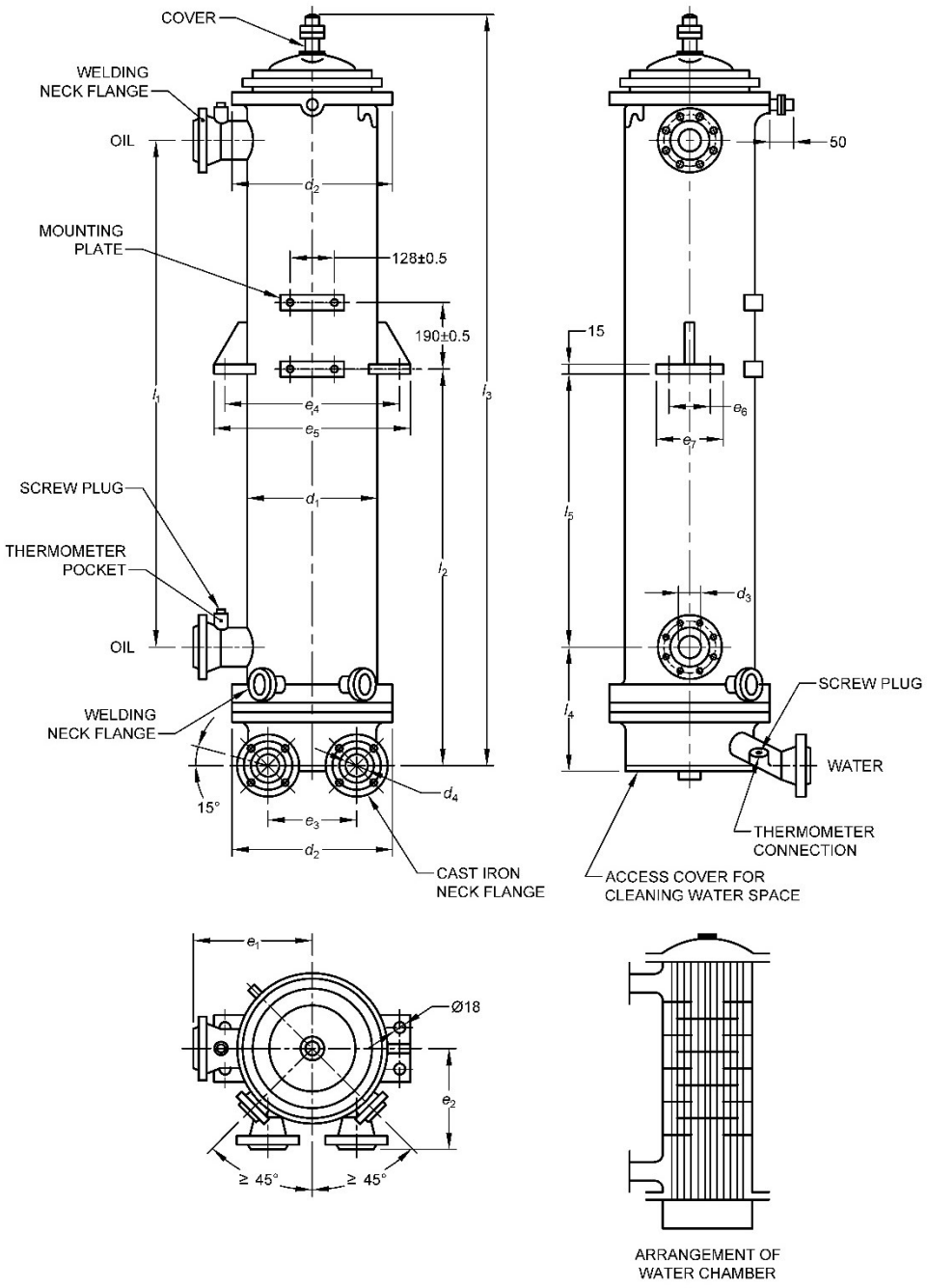
### 9.1 Lot

In consignment, all the oil-to-water heat exchangers of the same designation manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

**9.2** For ascertaining the conformity of the lot, the procedure for sampling and inspection as given in IS 2500 (Part 1) shall be followed. The type of sampling plan, inspection level and acceptable quality level (AQL) to be followed for various characteristics shall be as given in **9.2.1** and **9.2.2**.

**9.2.1** For ascertaining the conformity of the lot with respect to dimensions, design and designation, a single sampling plan with inspection Level IV and AQL of 1.5 percent as given in Table 1 and Table 2 of IS 2500 (Part 1) shall be followed.

**9.2.2** For ascertaining the conformity of the lot with respect to finish and leakage test, a single sampling plan with inspection Level III and AQL of 1.5 percent as given in Table 1 and Table 2 of IS 2500 (Part 1) shall be followed.




All dimensions in millimetres.

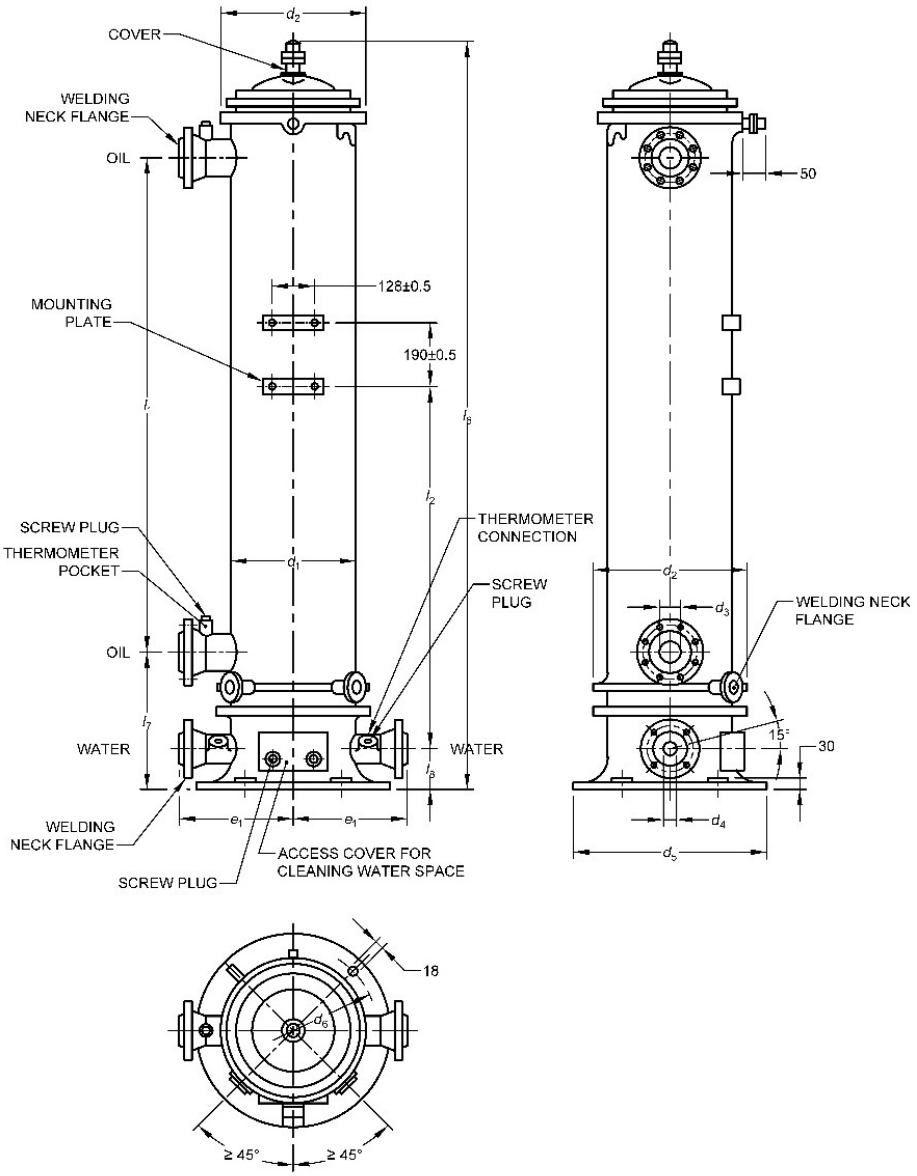
FIG. 3 DIMENSIONS FOR SUSPENDED MOUNTED (SM) HEAT EXCHANGER

**Table 3 Dimensions of Suspended Mounted Heat**

**Exchangers** (*Clause* 5.2 *and* 5.2.1)

All dimensions in millimetres.

| Sl No. | Heat Dissipation Rating kW | $d_1$ | $d_2$ | $d_3$ | $d_4$ | $e_1$ | $e_2$ | $e_3$ | $e_4$ | $e_5$ | $e_6$ | $e_7$ | $l_1$ | $l_2$ | $l_3$ *Max* | $l_4$ *Max* | $l_5 \pm 2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
| i) | 50 | 200 to 220 | 270 to 290 | 65 | 40 | 225 | 160 | 155 | 320 | 360 | 60 | 100 | 1 000 | 750 | 1 415 | 235 | 550 |
| ii) | 100 | 250 to 280 | 330 to 360 | 65 | 40 | 260 | 190 | 160 | 380 | 420 | 100 | 150 | 1 085 | 820 | 1 545 | 260 | 595 |
| iii) | 100 | 290 to 320 | 370 to 400 | 100 | 50 | 275 | 220 | 180 | 450 | 500 | 100 | 150 | 1 160 | 820 | 1 655 | 285 | 575 |
| iv) | 250 | 340 to 370 | 430 to 460 | 125 | 50 | 300 | 235 | 200 | 450 | 510 | 150 | 200 | 1 320 | 1 100 | 1 870 | 300 | 835 |
| v) | 350 | 380 to 420 | 470 to 510 | 125 | 65 | 325 | 255 | 250 | 520 | 570 | 150 | 200 | 1 500 | 1 100 | 2 050 | 340 | 810 |
| vi) | 400 | 380 to 420 | 470 to 510 | 125 | 65 | 325 | 255 | 250 | 520 | 570 | 150 | 200 | 1 500 | 1 100 | 2 050 | 340 | 810 |
| vii) | 500 | 380 to 420 | 470 to 510 | 125 | 65 | 325 | 255 | 250 | 520 | 570 | 150 | 200 | 1 500 | 1 100 | 2 050 | 340 | 810 |
| viii) | 630 | 450 to 500 | 540 to 600 | 150 | 80 | 380 | 315 | 350 | 600 | 650 | 190 | 250 | 1 860 | 1 320 | 2 450 | 375 | 1 000 |
| ix) | 800 | 450 to 500 | 540 to 600 | 150 | 80 | 380 | 315 | 350 | 600 | 650 | 190 | 250 | 1 860 | 1 320 | 2 450 | 375 | 1 000 |
| x) | 1 000 | 510 to 550 | 620 to 670 | 200 | 100 | 420 | 350 | 400 | 650 | 700 | 200 | 280 | 2 140 | 1 510 | 2 830 | 410 | 1 150 |
| xi) | 1 600 | 580 to 630 | 700 to 750 | 200 | 100 | 460 | 390 | 400 | 730 | 780 | 200 | 280 | 2 140 | 1 510 | 2 830 | 410 | 1 150 |




All dimensions in millimetres.

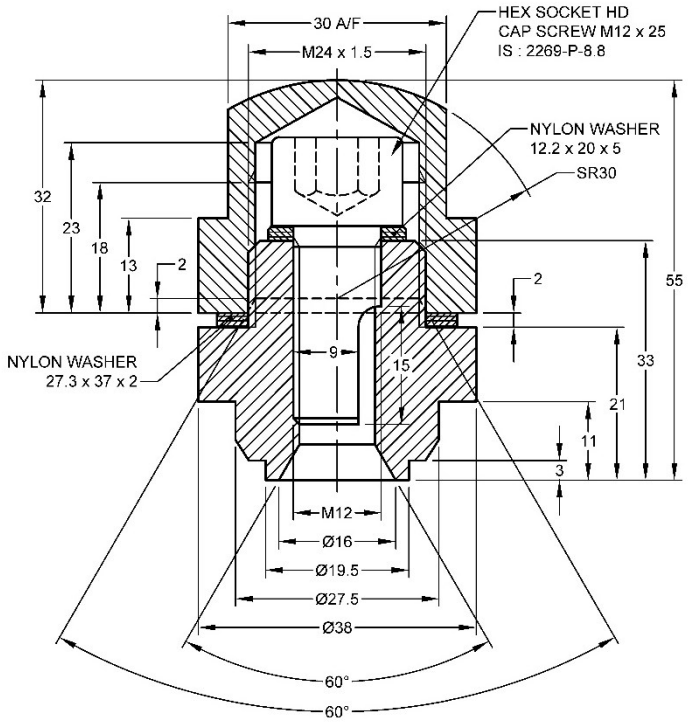
FIG. 4 DIMENSIONS FOR BASE MOUNTED (BM) HEAT EXCHANGER

**Table 4 Dimensions of Base Mounted Heat Exchangers**

(*Clauses* 5.2 *and* 5.2.1)

All dimensions in millimetres.

| **Sl No.** | **Heat Dissipation Rating** kW | $d_1$ | $d_2$ | $d_3$ | $d_4$ | $d_5$ | $d_6$ | $e_1$ | $l_1$ | $l_2$ | $l_6$ *Max* | $l_7 \pm 2$ | $l_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| i) | 50 | 200 to 290 | 270 to 290 | 65 | 40 | 360 | 310 | 225 | 1 000 | 750 | 1 515 | 300 | 100 |
| ii) | 100 | 250 to 280 | 330 to 360 | 66 | 40 | 430 | 380 | 260 | 1 085 | 820 | 1 645 | 325 | 100 |
| iii) | 160 | 290 to 320 | 370 to 400 | 100 | 50 | 480 | 430 | 275 | 1 160 | 820 | 1 765 | 355 | 110 |
| iv) | 250 | 340 to 370 | 430 to 460 | 125 | 50 | 530 | 480 | 300 | 1 320 | 1 100 | 1 995 | 390 | 125 |
| v) | 350 | 380 to 420 | 470 to 510 | 125 | 65 | 570 | 520 | 325 | 1 500 | 1 100 | 2 175 | 415 | 125 |
| vi) | 400 | 380 to 420 | 470 to 510 | 125 | 65 | 570 | 520 | 325 | 1 500 | 1 100 | 2 175 | 415 | 125 |
| vii) | 500 | 380 to 420 | 470 to 510 | 125 | 65 | 570 | 520 | 325 | 1 500 | 1 100 | 2 175 | 415 | 125 |
| viii) | 630 | 450 to 500 | 540 to 600 | 150 | 80 | 630 | 580 | 380 | 1 860 | 1 200 | 2 580 | 450 | 130 |
| ix) | 800 | 450 to 500 | 540 to 600 | 150 | 80 | 630 | 580 | 380 | 1 860 | 1 200 | 2 580 | 450 | 130 |
| x) | 1 000 | 510 to 550 | 620 to 670 | 200 | 100 | 700 | 650 | 420 | 2 140 | 1 300 | 2 990 | 500 | 140 |
| xi) | 1 600 | 580 to 630 | 700 to 750 | 200 | 100 | 780 | 730 | 420 | 2 500 | 1 400 | 3 350 | 500 | 140 |




All dimensions in millimetres.
FIG. 5 DIMENSIONS FOR COVER

## 10 MARKING

A rating plate carrying the following information shall be mounted on the position shown in Fig. 3 and Fig. 4:

a) Manufacturer's name oil trade-mark;
b) Type of heat exchanger;
c) Heat, in kW, dissipation rating;
d) Volume, in $m^3/h$, of oil circulated;
e) Volume, in $m^3/h$, of water circulated;
f) Weight, in kg, of heat exchanger, when empty;
g) Oil filling in litres; and
h) Year of manufacture.

Sufficient space shall also be provided on the rating plate for inscribing information concerning commissioning, cleaning, removal of tube test and assembling of the heat exchanger.

### 10.1 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

## 11 DISPATCH

Before dispatch, the heat exchangers shall be thoroughly cleaned internally so that they are ready for use without requiring any further work to be done on them. The oil and water connections shall be blanked.

## 12 INSTALLATION AND OPERATION

Correct installation and preventive maintenance programme are the user's responsibilities.

### 12.1 Clearance for Dismantling

For straight tube exchangers fitted with removable bundles, sufficient clearance shall be provided at the stationary head and to permit removal of the bundle from the shell, adequate space shall be provided beyond the rear head to permit removal of the shell cover and/or floating head cover.

### 12.2 Foundation Bolts

The foundation bolts to the base mounted heat exchangers shall be loosened at one end of the unit to allow free expansion of shells. Slotted holes in supports are provided. The equipment like HP heaters where the tubes are of mild steel, nitrogen purging inside is done for protection against rusting during long storage. In case the tube material is

non-ferrous nitrogen purging is not required. The procedure for nitrogen purging is given in Annex B.

### 12.3 Levelling

Exchangers must be set level and square so that the pipe connections may be made without forcing.

### 12.4 Operation

Heat exchangers which are not in operation must be either empty on the water side or also must carry a continuous flow.

## ANNEX A

(*Clause* 2)

## LIST OF REFERRED STANDARDS

| *IS No.* | *Title* |
|---|---|
| IS 210 : 2009 | Grey iron castings — Specification (*fifth revision*) |
| IS 554 : 1999/ ISO 7-1 : 1994 | Pipe threads where pressure — Tight joints are made on the threads — Dimensions, tolerances and designation (*fourth revision*) |
| IS 1545 : 1994 | Solid drawn copper and copper alloy tubes for condensers and heat exchangers — Specification (*third revision*) |
| IS 2062 : 2011 | Hot rolled medium and high tensile structural steel — Specification (*seventh revision*) |
| IS 2102 ( Part 1) : 1993/ISO 2768-l : 1989 | General tolerances: Part 1 Tolerances for linear and angular dimensions without individual tolerance indications (*third revision*) |
| IS 2500 (Part 1) : 2000/ISO 2859-1 : 1999 | Sampling procedures for inspection by attributes: Part 1 Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection (*third revision*) |
| IS 3624 : 1987 | Specification for pressure and vacuum gauges (*second revision*) |
| IS 4503 : 1967 | Specification for shell and tube-type heat exchangers |
| IS 6392 : 2020 | Steel pipes flanges — Specification (*first revision*) |
| IS 8362 : 1977 | Specification for copper and copper alloy rolled plates for condensers and heat exchangers |

## ANNEX B

(*Clause* 12.2)

## NITROGEN PURGING PROCEDURE

### B-1 GENERAL

The equipment, such as HP Heaters, live steam tube nest and bled steam tube nest after hydraulic test are dried and nitrogen purged inside for protection against the rusting of the tube nest. The tube nest for the above equipment is of mild steel tube without any protective coating. Hence, maintaining the inert atmosphere with nitrogen inside the equipment is a must. The nitrogen pressure should be 0.35 bar to 0.70 bar.

### B-2 CHECK

**B-2.1** Immediately after receiving the equipment at site, the following checks should be carried out:

a) Pressure gauges fitted for indicating the nitrogen pressure are in good condition; and

b) Check leak tightness of all connections and nipple arrangement. Use soap water for leak detection.

**B-2.2** a) Replace the pressure gauges if found damaged;

b) Blank the connections properly to avoid any leakage and change joints, if required; and

c) Replace the nitrogen purging nipple, if required.

### B-3 MAINTENANCE OF NITROGEN PRESSURE

**B-3.1** To maintain a pressure inside the equipment, periodic refilling is a must. Refilling cycle depends upon the tightness of the joints/connection blanks.

Remove the cap of the refilling attachment and connect the nitrogen cylinder with the pipe to the nipple provided. Nipple provided is the same as normally used on scooter tubes, hence the cap for fitting the nitrogen is same as that for the scooter air refilling. Fig. 6 shows the refilling of the nitrogen.

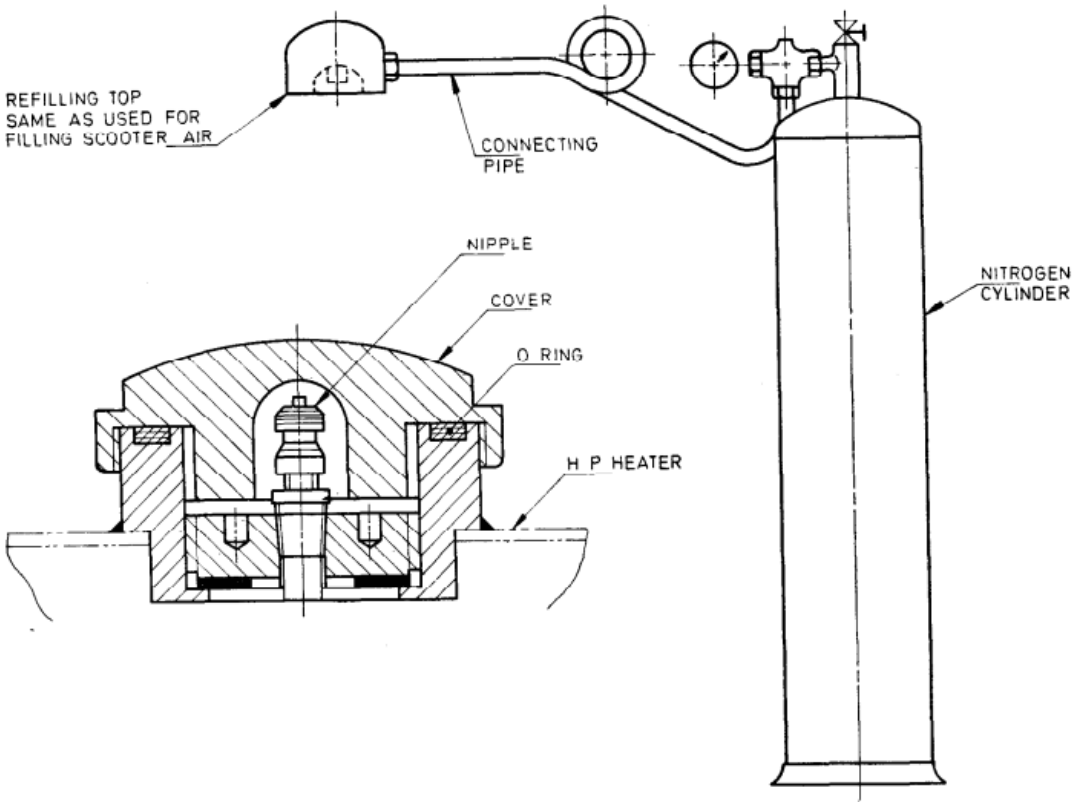



FIG. 6 REFILLING OF NITROGEN

## ANNEX C

(*Foreword*)

## COMMITTEE COMPOSITION

Chemical Engineering Plants and Related Equipment Sectional Committee, MED 17

| *Organization* | *Representative(s)* |
|---|---|
| CSIR — Indian Institute of Petroleum, Dehradun | SHRI PRANAY S. GARG<br>SHRI CHANDRAKANT WADKAR (*Alternate*) |
| Advance Valves Global, Noida | SHRI YASHWANT M. JANNU |
| Auma India Private Limited, Bengaluru | SHRI Y. SRINIVASA RAO<br>SHRI ABHISHEK KUMAR PANDEY (*Alternate*) |
| Bharat Heavy Electrical Limited, New Delhi | SHRI DHAWAL SAXENA |
| Blast Carboblocks Private Limited, Mumbai | DR P. THOMAS<br>SHRI SADASIVA MURTHY P. (*Alternate* I)<br>SHRI AJITH KUMAR N. (*Alternate* II) |
| Central Power Research Institute, Bengaluru | SHRI P. KRISHNA KUMAR |
| Chemtrols Industries Private Limited, New Delhi | SHRI DUSHYANT SINGH |
| Confederation of Indian Industry, New Delhi | SHRI TANOJ CHANDAN<br>SHRI KUNAL SHARMA (*Alternate*) |
| Directorate General Factory Advice Service and Labour Institutes, Mumbai | SHRI HASMUKH K. PARMAR<br>SHRI MRAGANG SHEAKHAR (*Alternate*) |
| Engineers India Limited, Gurugram | SHRI DHIRAN PANCHAL<br>SHRI SATVIK PATEL (*Alternate*) |
| GMM Pfaudler Limited, Anand | SHRI KRISHANU GHOSH<br>SHRI N. K. RAI (*Alternate*) |
| Hindustan Petroleum Corporation Limited, Mumbai | SHRI PRANAY S. GARG<br>SHRI CHANDRAKANT WADKAR (*Alternate*) |
| Indian Oil Corporation Limited, New Delhi | SHRI KARAN AGRAWAL |
| Indian Rubber Manufacturers Research Association, Mumbai | DR K. RAJ KUMAR<br>DR DEBDIPTA BASU (*Alternate*) |
| Indian Valve and Actuator Manufacturers Association (IVAMA), Coimbatore | SHRI R. MURUGANANTHAM<br>SHRI JAY DOSHI (*Alternate*) |
| Kejriwal Casting Limited, Kolkata | SHRI SANDEEP KEJRIWAL |
| L&T Valves, Chennai | SHRI ROHIT SHARMA<br>SHRI SURIYANARAYANAN (*Alternate*) |
| Lathia Rubber Manufacture Company Private Limited, Mumbai | SHRI SANJIV S. LATHIA |
| MECON Limited, Ranchi | SHRI YOGENDRA KUMAR SINGH<br>SHRI ARVIND BHUSHAN (*Alternate*) |
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