DEAERATOR

Acceptance at the workshop:
according to the European Pressure Equipment Directive PED (2014/68/EU)

CE-Marking on the Pressure Vessel:
according to the European Pressure Equipment Directive PED (2014/68/EU)

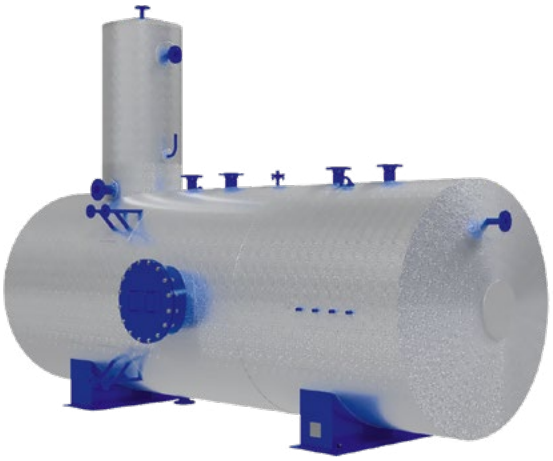
Design code: EN 12953

Deaerator designation

ETM-series two-stage atmospheric pressure deaerators with a submerged bubbling device are designed to remove corrosive gases (oxygen and free carbon dioxide) from feedwater of steam boilers and from make-up water of heat supply systems.

Deaerator is be used in the capacity of the last stage in water treatment systems of steam boilers.

The deaeration plant can be completed by the manufacturer with all required fittings, instrumentation and automation based on Customer requirements specified in the check list.



General view of the deaeration plant

Operation of the deaeration plant

The two-stage gas removal scheme (deaeration, degassing) is used in ETM series deaerator devices: the first stage, jet-powered, is installed inside the deaeration column, the second stage, in the form of a flooded bubbler pipe with perforations along the entire length, is installed inside the deaerator tank in the lower part parallel to the shell.

The deaerator tank is basically a horizontal cylindrical vessel with nozzles, union fittings and a bubbling device installed thereon.

Chemically treated water and return condensate to be deaerated are supplied to the top of the deaeration column. Distribution plates (sieve type) are installed stepwise inside the column. Treated water flows down with being divided into ultra-thin jets, and distributed over the entire cross section of the deaeration column.

Main steam is fed into the steam space of the deaerator. The steam inlet nozzle is located directly under the deaeration column. Steam rises over the column space, being distributed over its entire cross section, and passes through openings of distribution plates in a counterflow to the flowing down water. At this contact, temperature of ultra-thin jets reaches the saturation temperature, and steam condenses. This process results in effective deaeration.

Uncondensed steam leaves the column via the steam pipe located in the upper part of the column. Heated deaerated water flows down into the tank.

The second stage of deaeration — water heating to operating temperature and this temperature maintenance — proceed directly inside the deaerator tank. To this effect the bubbler pipe is installed in the lower part of the deaerator tank. Steam supplied into this pipe is distributed all over the pipe volume and is fed into water filling the tank via bubble holes.

To protect the deaeration plant from damage, nozzles are provided on the tank for vent and drain valves and the overflow device installation. Installation of these valves is mandatory. It is allowed to install a combined hydraulic lock for protection against overflow and for prevention of pressure parameters exceedance.

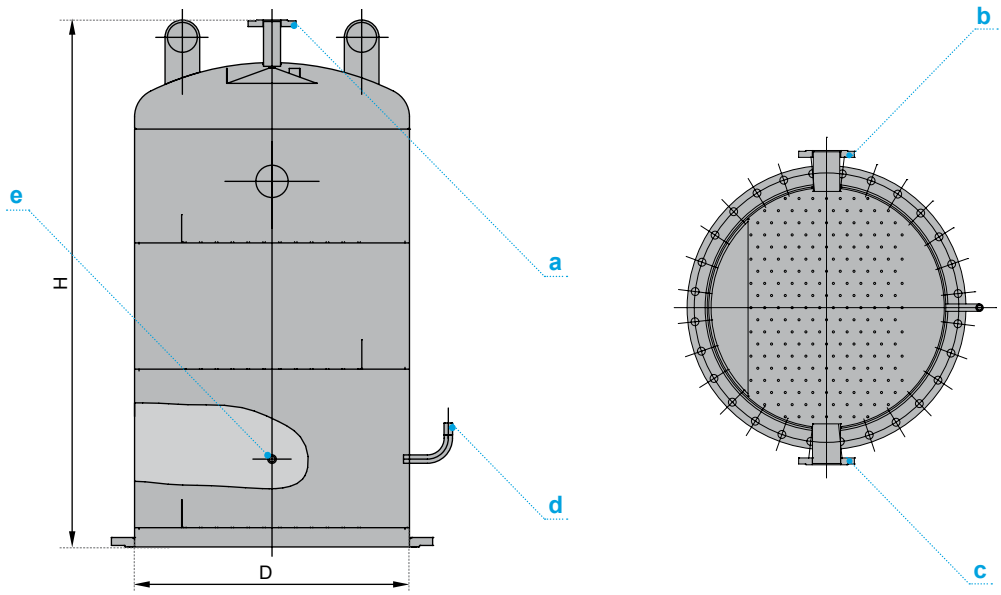
The tank is also provided with supports for installation on the foundation, with inspection hatch and drain pipe.

The deaeration column is provided with CWT water and condensate inlet nozzles and with branch connections for pressure gauge and a pressure transducer (pulse pipe) installation. The steam outlet nozzle is provided in the upper part.

Technical specifications

Description	Numeric value
Operating pressure (exc.), MPa (kgf/cm²)	0.023 (0.23)
Maximum admissible operating pressure, MPa (kgf/cm²)	0.05 (0.5)
Deaerated water temperature, °C	104
Water heating at rated capacity, °C	10–50*
Performance range, m³/h	1.0–150.0
Specific steam consumption at deaerator outlet, kg/t of deaerated water, up to	2
Full design service life, years, not less than	30
Concentration of dissolved oxygen in deaerated water, μg/kg, max	20
Concentration of free carbonic acid in deaerated water, μg/kg, with content of free carbonic acid up to 20 mg/kg and bicarbonate alkalinity up to 0.7 mgEq/kg	not available

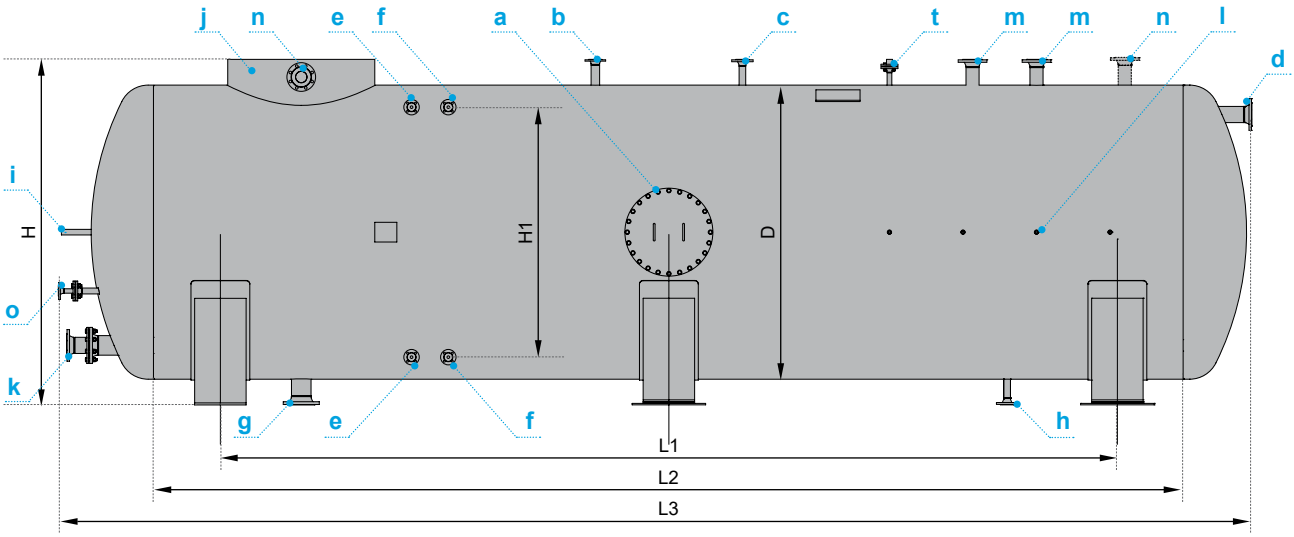
Overall and mounting dimensions



Overall and mounting dimensions, deaeration column

Nozzle designation	Numeric value												
Series	ETM-1	ETM-2	ETM-3	ETM-4	ETM-6	ETM-8	ETM-10	ETM-16	ETM-16-01	ETM-22	ETM-22-01	ETM-30	ETM-40	ETM-50
Capacity, m³/h	0.5–1.6	1.7–3.0		3.1–5.0	5.1–8.0		8.1–11.0	11.1–15.0	15.1–19.0	19.1–24.0	24.1–33.0		33.1–40	40.1–75.0
D, mm	273	377		426	530		630	820	920	1020	1220		1420	1620
H, mm	1122	1270		1350	1566		1741	1782	1747	1803	1940		*	2363
Nominal bore, DN														
a	15	20		25	32		40	40	50	50	80		80	100
b	25	40		40	50		65	80	80	100	100		125	125
c	25	40		40	50		65	80	80	100	100		125	125
d	G ½ — B													
e	G ½ — B													
Weight, kg	43.4	67.0		85.2	142		224	297	342	400	471		*	863

* Dimensions can be changed upon the customer request and shall be specified at the time of order.

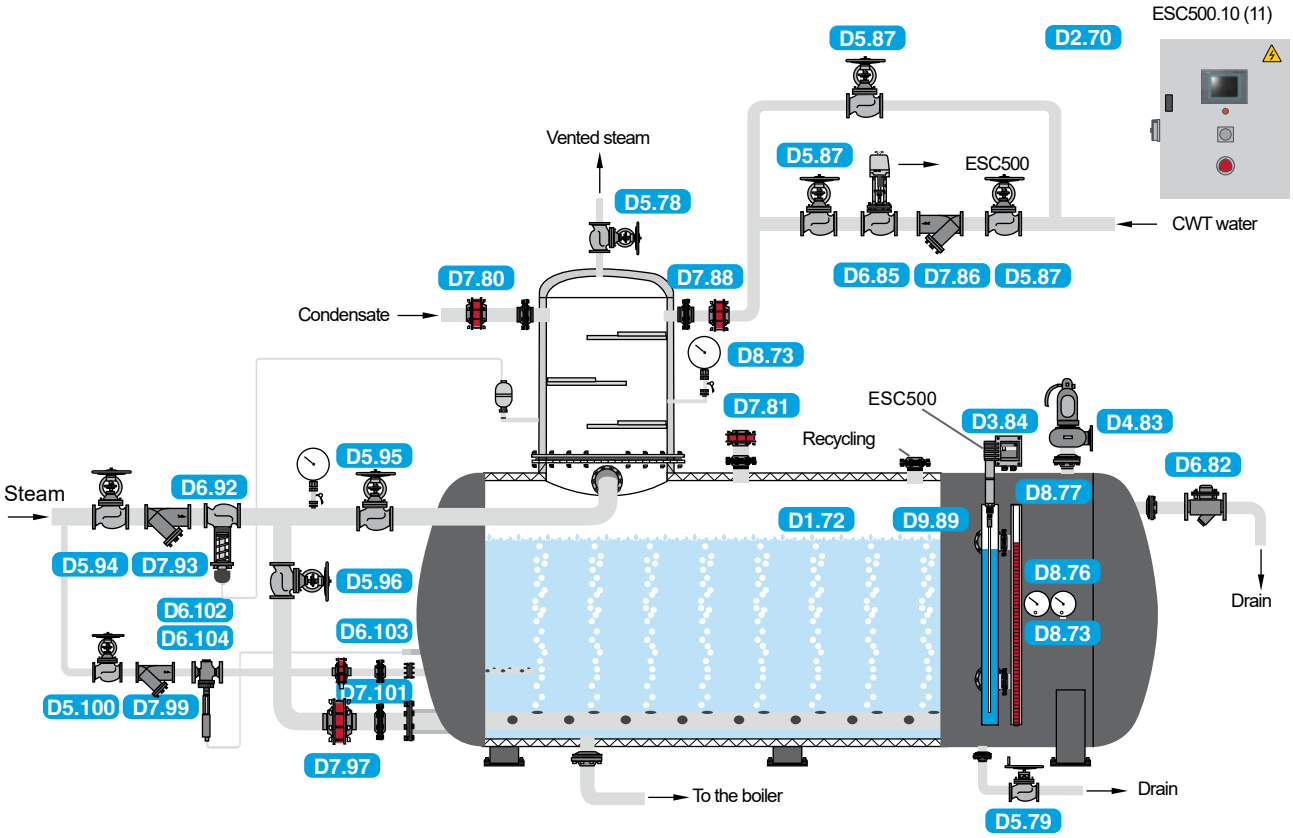


Overall and mounting dimensions, deaerator tank

Nozzle designation	Numeric value													
Series	ETM-1	ETM-2	ETM-3	ETM-4	ETM-6	ETM-8	ETM-10	ETM-16	ETM-16-01	ETM-22	ETM-22-01	ETM-30	ETM-40	ETM-50
Net volume, m^3	1	2	3	4	6	8	10	16	16	22	22	30	40	50
Capacity (range), m^3/h	1.6	1.7–2.2	2.3–3.0	3.1–4.0	4.1–6.5	6.6–8.0	8.1–11.0	11.1–15.0	15.1–19.0	19.1–24.0	24.1–27.0	27.1–33.0	33.1–40.0	40.1–75.0
D, mm	800	1000	1250	1250	1600	1600	1600	2000	2000	2000	2000	2500	2500	2900
L1, mm	1500	1700	1700	1970	2200	2775	3675	4100	4100	6100	6100	5060	7000	7000
L2, mm	1980	2500	2500	3000	3000	4000	5000	5000	5000	7000	7000	5960	8000	8500
L3, mm	2886	3413	3439	3940	4089	5089	6089	6148	6148	8152	8152	7201	*	9945
H, mm	1237	1441	1653	1669	2033	2033	2033	2429	2413	2425	2425	2942	*	3347
H1, mm	800	800	1200	1200	1400	1400	1400	1900	1900	1900	1900	2300	2300	2640
Nominal bore, DN; PN = 16:														
Safety relief valve (b)	50	50	50	50	65	80	100	100	125	125	125	150	150	150
Vacuum breaker (c)	32	50	65	80	100	100	125	150	150	150	150	150	150	150
Overflow of water (d)	80	80	80	80	80	80	80	100	100	100	100	100	100	100
Water level (e, f)	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Feedwater pump (g)	32	32	32	50	65	80	80	100	100	125	125	125	150	200
Water drain (h)	25	25	32	32	32	40	40	40	40	40	40	50	50	50
Temperature transducer (i)	G 1 — B													
Heating with steam (k)	32	40	40	50	50	65	65	80	100	100	100	125	125	150
Dosed chemicals (l)	G ½ — B													
Spare (m) ×2	40	40	50	50	50	80	80	80	80	80	80	100	100	100
To the steam space (n)**	50	50	50	65	80	80	80	100	125	125	125	150	150	150
Fast warming up (o)	25	25	25	25	25	25	32	32	32	32	32	32	32	32
Level transducer (t)	G ¾ — B													
Weight, kg	645	886	1005	1349	1909	1844	2545	3599	3629	4464	4472	6353	*	9606
Nominal bore DN; PN = 0.3:														
Inspection hatch (a)	500													
Column type (j)	250	350	350	400	500	500	600	800	900	1000	1200	1200	1400	1600

* Dimensions can be changed upon the customer request and shall be specified at the time of order.
** Location of steam inlet to the steam space for V = 50 m^3 tank (indicated by dotted lines in figure above).

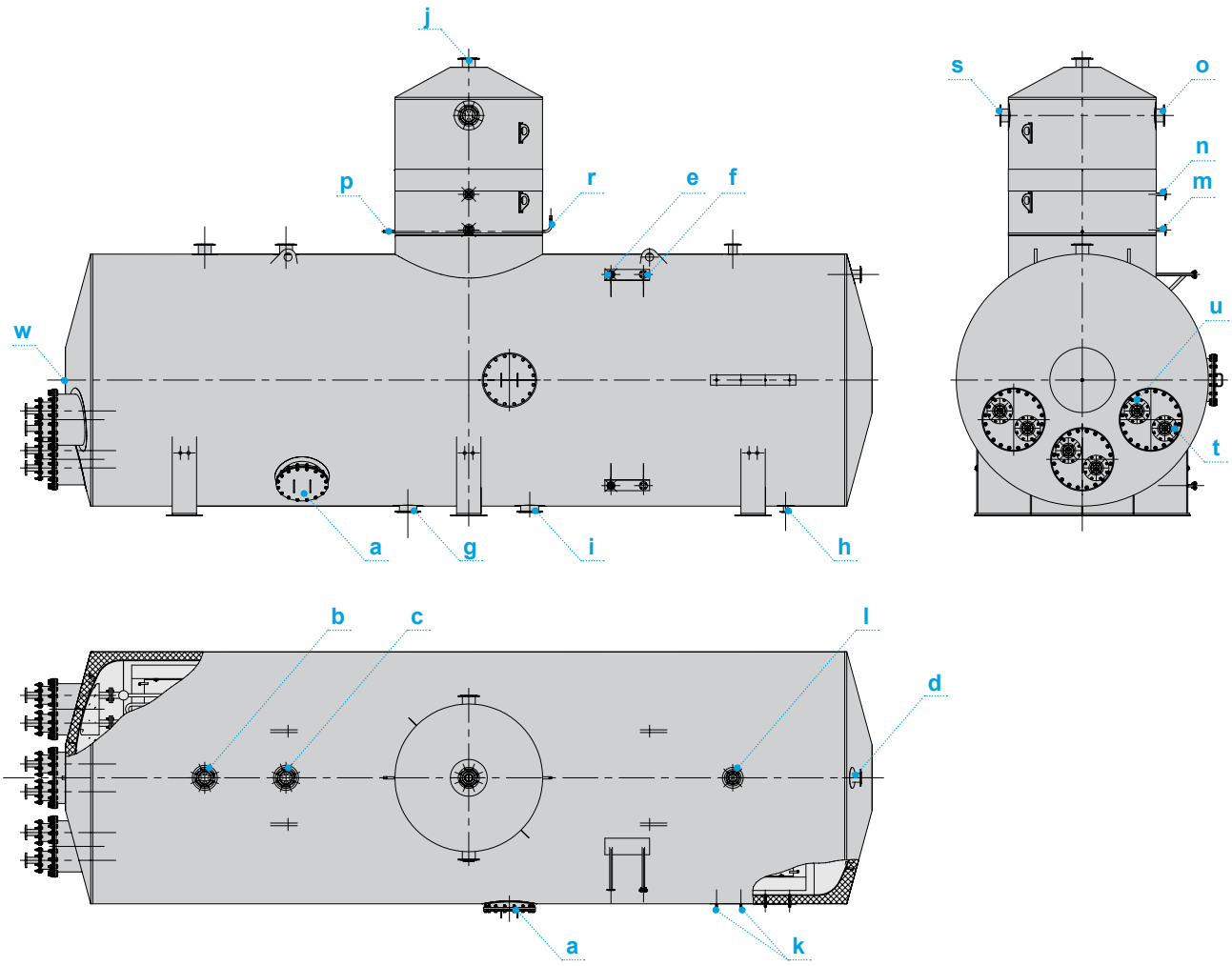
Deaerator connection piping



D1	Main equipment	D4	Safety relief valves	D7	Filters, check valves
D2	Control systems	D5	Shutoff valves	D8	Visual control
D3	Electronic components	D6	Control valves	D9	Other

Special design for superheated water

Special design of deaerators operating on superheated water is used in cases where there no steam is used in atmospheric deaerators of the classical type.



Nozzles assignment

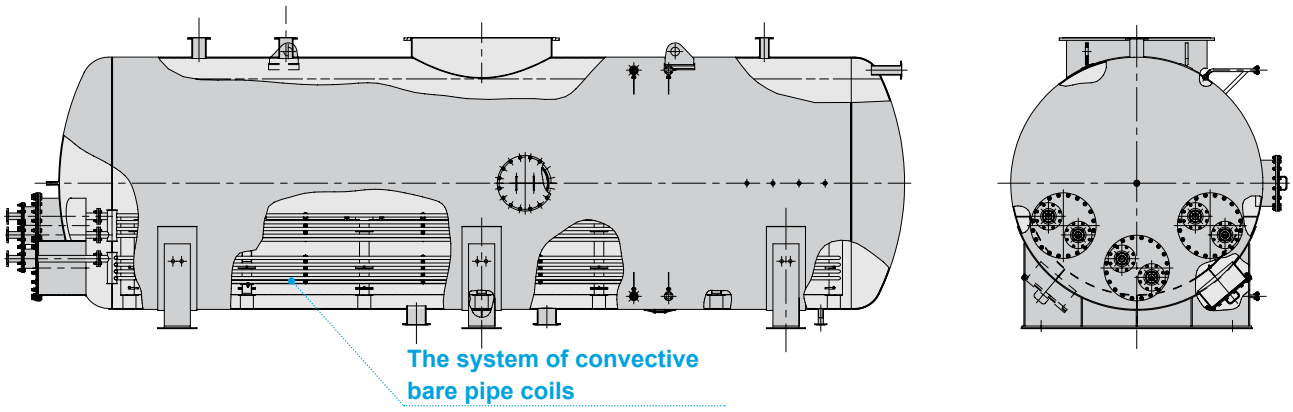
Designation	Purpose	Quantity	Nominal bore, DN	Nominal pressure, PN	
			mm	MPa	kgf/cm²
a	Inspection hatch	3	500	0.25	2.5
b	For safety relief valve	1	150	0.25	2.5
c	Vacuum	1	150	0.25	2.5
d	Water overflow	1	100	0.25	2.5
e	Water level	2	25	0.25	2.5
f	Water level	2	25	0.25	2.5
g	Feedwater pump	1	200	0.25	2.5
h	Water drain	1	50	0.25	2.5
i	Recycling	1	200	0.25	2.5
j	Vented steam	1	150	0.25	2.5
k	For chemicals	4	G ½ — B	—	—
l	Spare	1	100	0.25	2.5
m	Water supply to heat-exchangers	1	32	1.0	10.0
n	Water outlet from heat-exchangers	1	32	1.0	10.0
o	Water inlet	1	150	0.25	2.5
p	Pressure gauge	2	G ½ — B	—	—
r	Measuring scale	2	G ½ — B	—	—
s	Revision	2	150	0.25	2.5
t	Water supply to heat-exchangers	3	65	1.0	10.0
u	Water outlet from heat-exchangers	3	65	1.0	10.0
w	For temperature transmitter	1	G 1 — B	—	—

The deaerator consists of two parts:

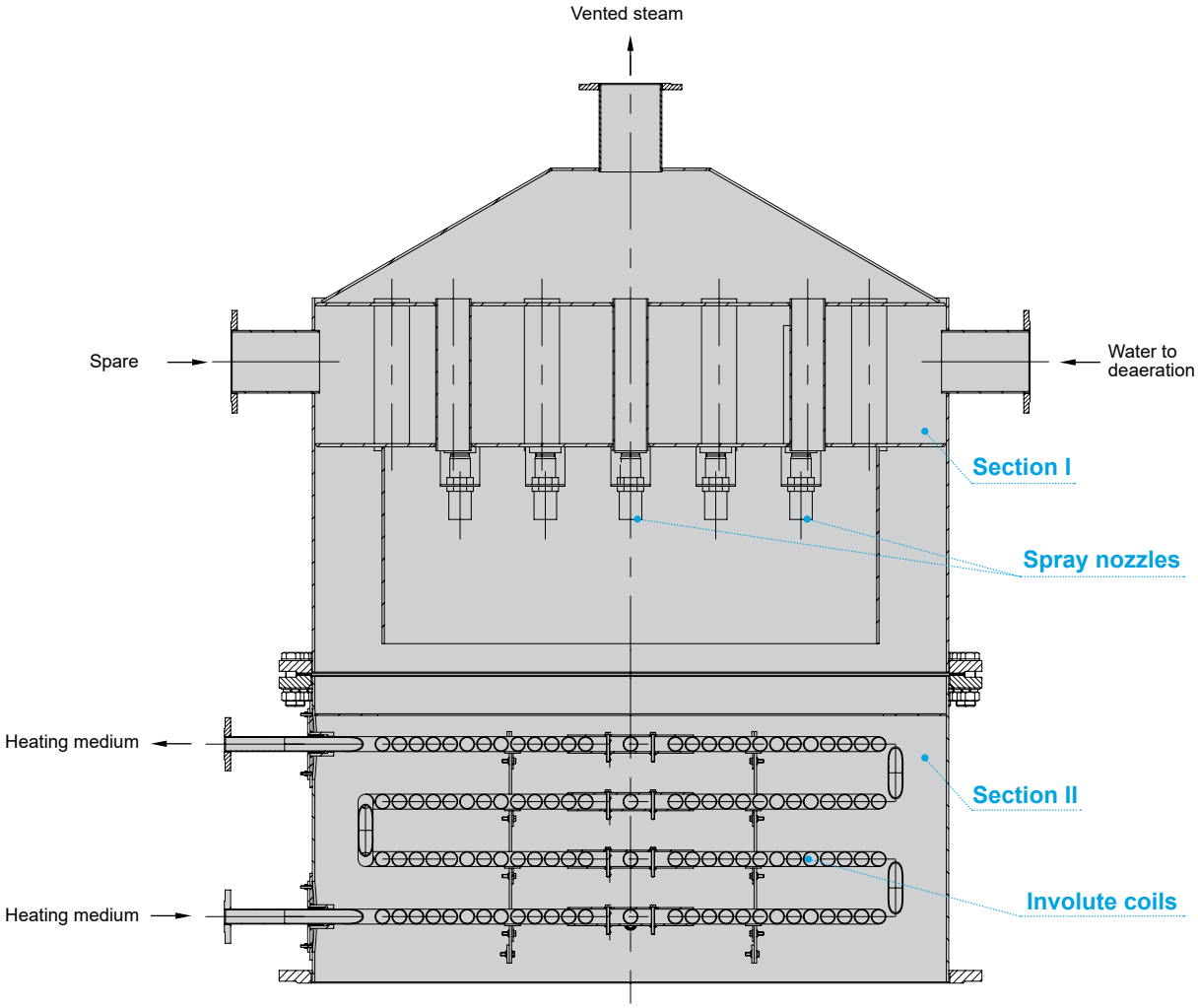
- deaeration tank which volume defines the volume of pre-treated heated deaerated water selected with account for the needs of the boiler room;
- deaeration column which capacity is defined by feed water flow rate required for the needs of the boiler room.

Convective heat-exchange surfaces are arranged in the lower part of the deaeration tank formed by bare pipe coils.

These heat-exchange surfaces are designed to transfer heat from the heating medium circulating inside these pipe coils to water inside the tank.



The deaeration column consists of two sections: I and II.



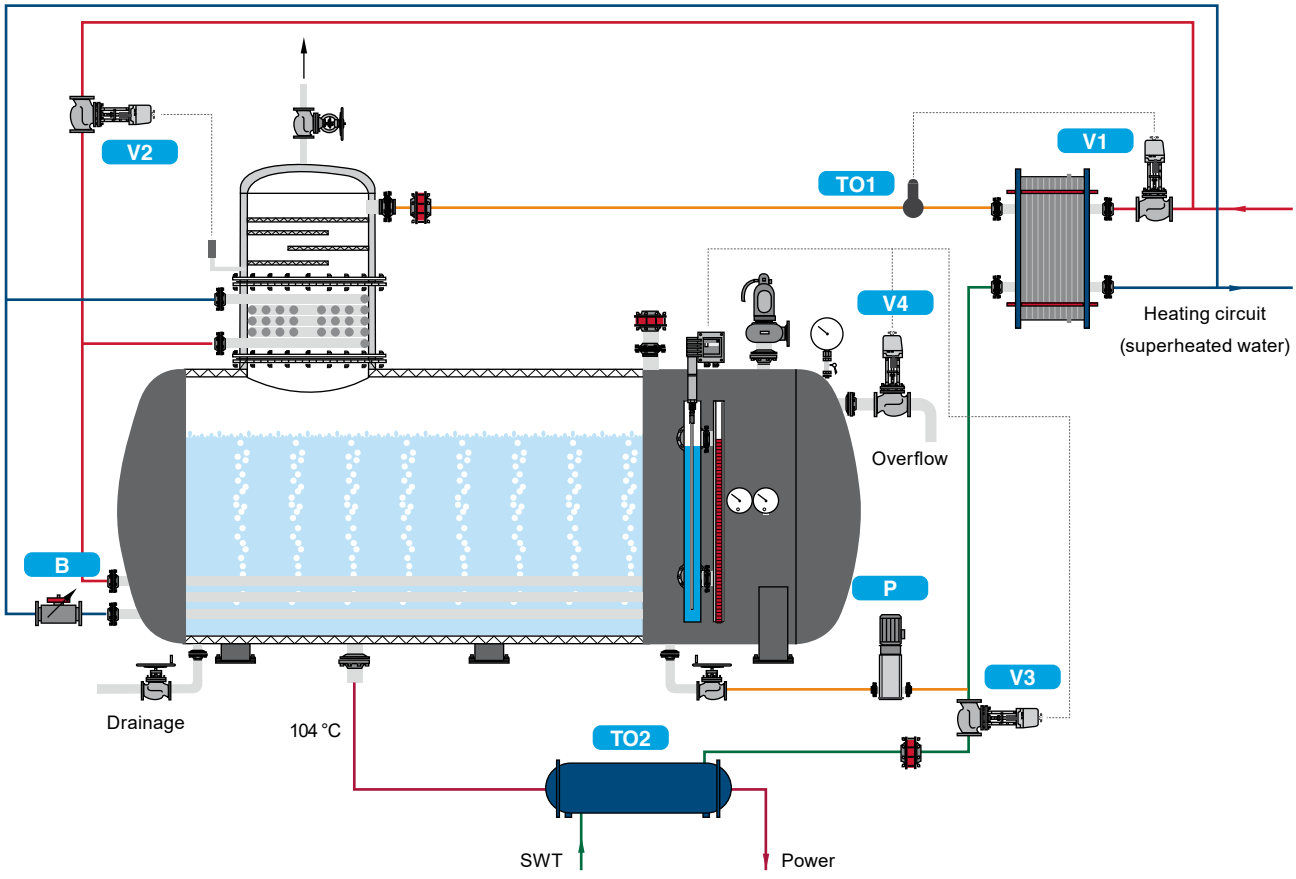
Water to be deaerated is supplied into the working cavity inside Section I. A system of nozzles through which deaerated water is sprayed into the area of Section II is provided in the lower part of the cavity. Spraying is performed in the form of a full cone thus ensuring complete filling of the deaeration column cross section.

Convective heat-exchange surfaces formed of involute multilevel coils are installed in Section II. Heating water with temperature not below 110 °C is circulating inside these coils.

As a result of sprayed water getting onto involute surfaces, a part of water boils, and generated steam rises upward in a counterflow to sprayed water, and, as a result of this process, main volume of liquid supplied to deaeration is deaerated — the FIRST stage of deaeration.

Deaerated water is then supplied into the tank, where it is heated to 104 °C and is accumulated to be returned back to the user.

Principle electrical diagram of deaerator connections is presented below:



TO1 Plate heat exchanger for heating feedwater to temperatures close to saturation point

TO2 Stage I shell-and-tube heat exchanger for feedwater heating

P Recirculation pump

B Balancing valve

V1 Temperature control valve at the heat exchanger outlet

V2 Control valve of heating water flow via deaerator

V3 Feedwater flow control valve

V4 Overflow valve

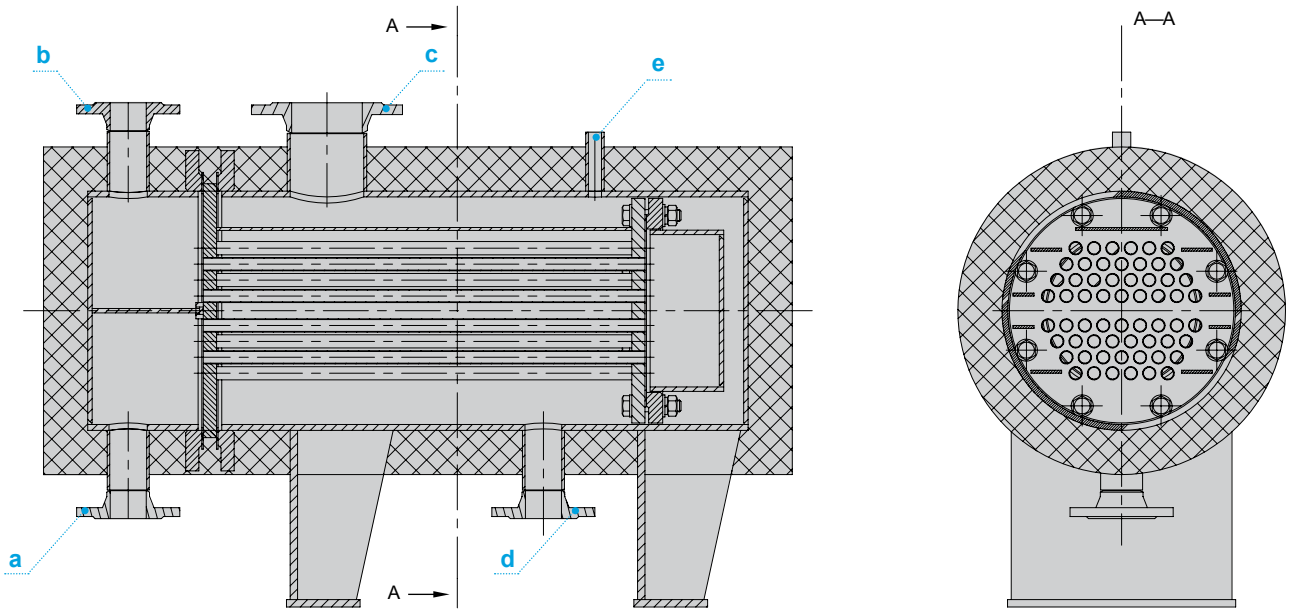
Source water is heated in heat exchangers TO1 and TO2 to a temperature above 104 °C prior to its supply into the deaeration column, then it is sprayed through nozzles on the surface of involute coils, and then it enters the tank where it is deaerated during the tank operation time by continuous boiling process proceeding under the influence of the heat introduced into the tank by heating water circulating in flat convective coils — this is the SECOND deaeration stage.

To intensify this process and to ensure uniformity of tank water qualitative characteristics, the pump P is used which capacity is equal to half the capacity of the main pump. Herewith, water from the tank is used to heat source water in TO1 heat exchanger after which water is returned back into the tank.

Deaerated water taken from the tank can pass through the TO2 heat exchanger, giving up part of its heat to cold water coming from the chemical water treatment plant. Such water temperature reduction at the feedwater pump inlet results in many-fold increase of the pump service life.

Due to the use of convective surfaces, heating of the tank filled with cold water is performed rapidly, and operating parameters of deaerated water rapidly reach rated values.

It is recommended to install evaporation coolers of the shell-and-tube heat exchanger type on the evaporation lines, which cooler will also increase the overall efficiency of the installation in general.



Nozzles assignment

Designation	Purpose	Quantity	Nominal bore, DN	Nominal pressure, PN	
			mm	MPa	kgf/cm²
a	Water inlet	1	50	0.6	6.0
b	Water outlet	1	50	0.6	6.0
c	Steam inlet	1	100	0.6	6.0
d	Condensate drainage	1	50	0.6	6.0
e	Uncondensed gases outlet	1	G ½ — B	—	—

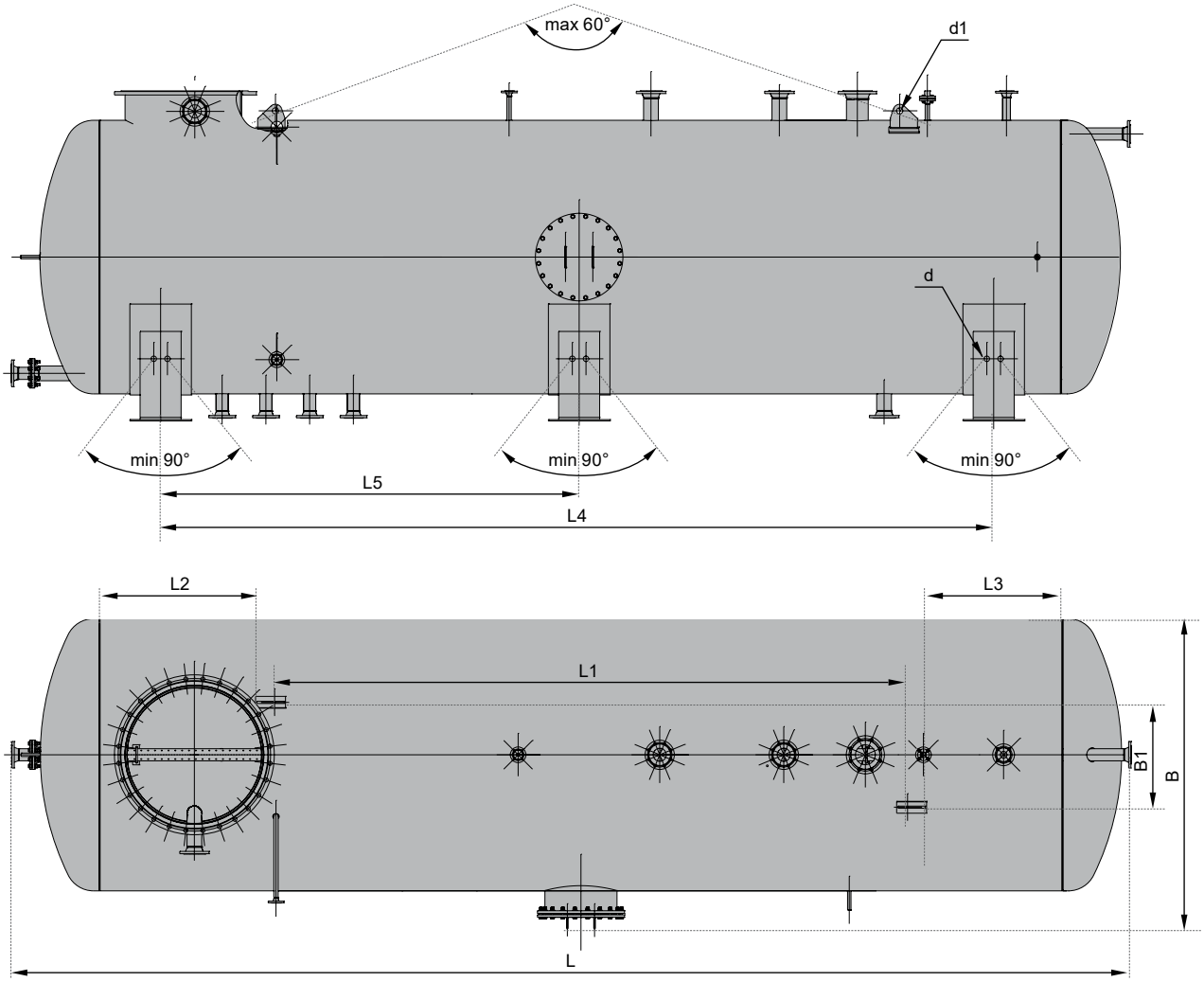
Scope of Supply

Supply package shall include:

- deaerator consisting of: deaerator tank, deaeration column;
- accessory equipment and instruments in conformity with information specified in the check list;
- operating and installation manual;
- datasheet.

Additionally, ladders and service platforms can be included in the supply package.

Transportation



Slinging diagram

Serie	ETM-1	ETM-2	ETM-3	ETM-4	ETM-6	ETM-8	ETM-10	ETM-16	ETM-16-01	ETM-22	ETM-22-01	ETM-30	ETM-40	ETM-50
L, mm	2886	3432	3448	3969	4044	5089	6089	6148	6148	8152	8152	7201	—	9945
L1, mm	950	1120	980	1365	1380	2148	2790	2420	2420	3260	3260	2640	—	2600
L2, mm	450	600	600	715	700	1012	950	1150	1150	1700	1700	1500	—	2750
L3, mm	250	450	600	600	600	600	950	1150	1150	1700	1700	1500	—	2750
L4, mm	1480	1700	1700	1970	2200	2776	4200	4100	4100	6100	6100	5060	—	7000
L5, mm	—	—	—	—	—	—	2100	2050	2050	3050	3050	2530	—	3500
B, mm	1111	1287	1458	1460	1998	1981	1901	2180	2172	2202	2202	2722	—	3057
B1, mm	334	402	492	492	478	474	504	760	754	744	744	922	—	1109
d, mm	40	40	40	40	40	40	40	40	40	40	40	40	—	40
d1, mm	100	100	100	100	100	100	45	45	45	54	54	100	—	64
Weight,kg	645	886	1005	1349	1909	1844	2545	3599	3629	4464	4472	6353	—	9606

* Dimensions can be changed upon the customer request and shall be specified at the time of order.