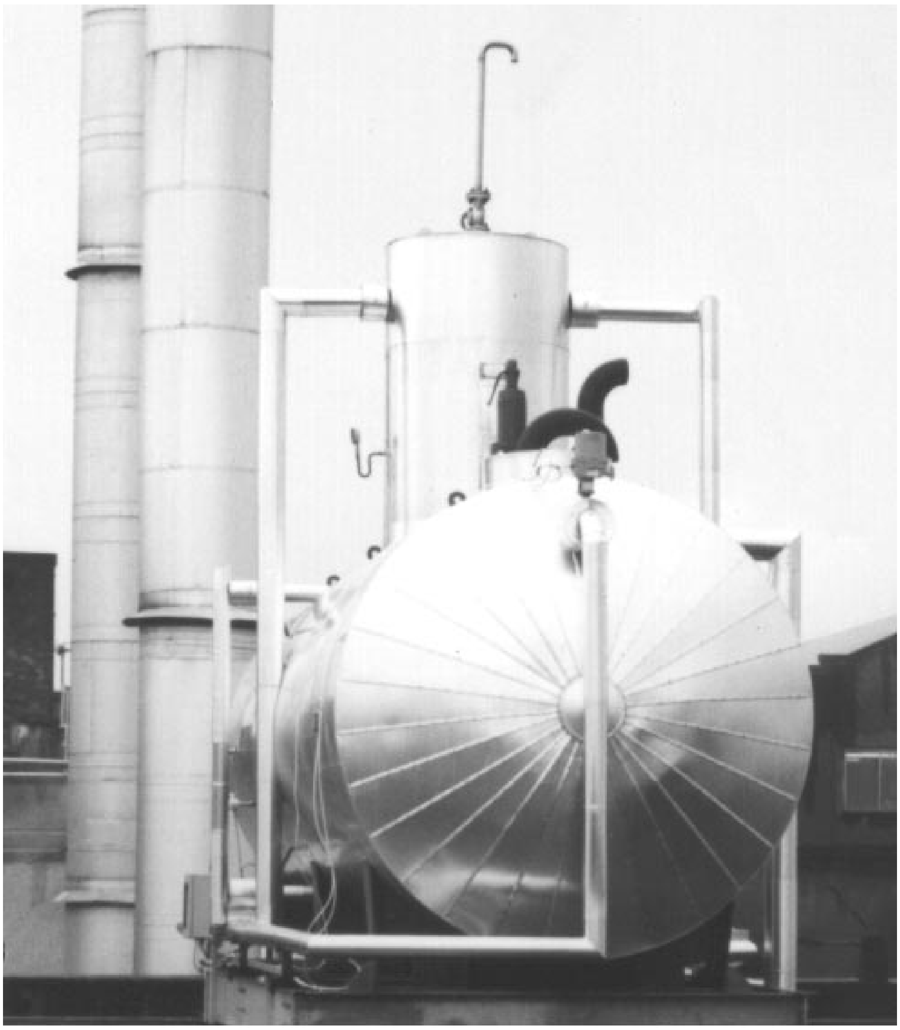
GESTRA Steam Solutions



- **Oxygen removal**
- **Savings on oxygen scavenging chemicals**
- **Energy savings**
- **Improved heat transfer**
- **Carbon Dioxide removal**
- **Improved boiler efficiency**
- **Improved plant operation**

General

It is quite common to find mild steel hotwells and condensate pipework corroding after a short period of time.

The principal reason for this corrosion is the constant introduction of oxygen and carbon dioxide into the boiler feedwater.

An atmospheric hotwell or atmospheric deaerator can only partially remove these gases from the steam and condensate systems.

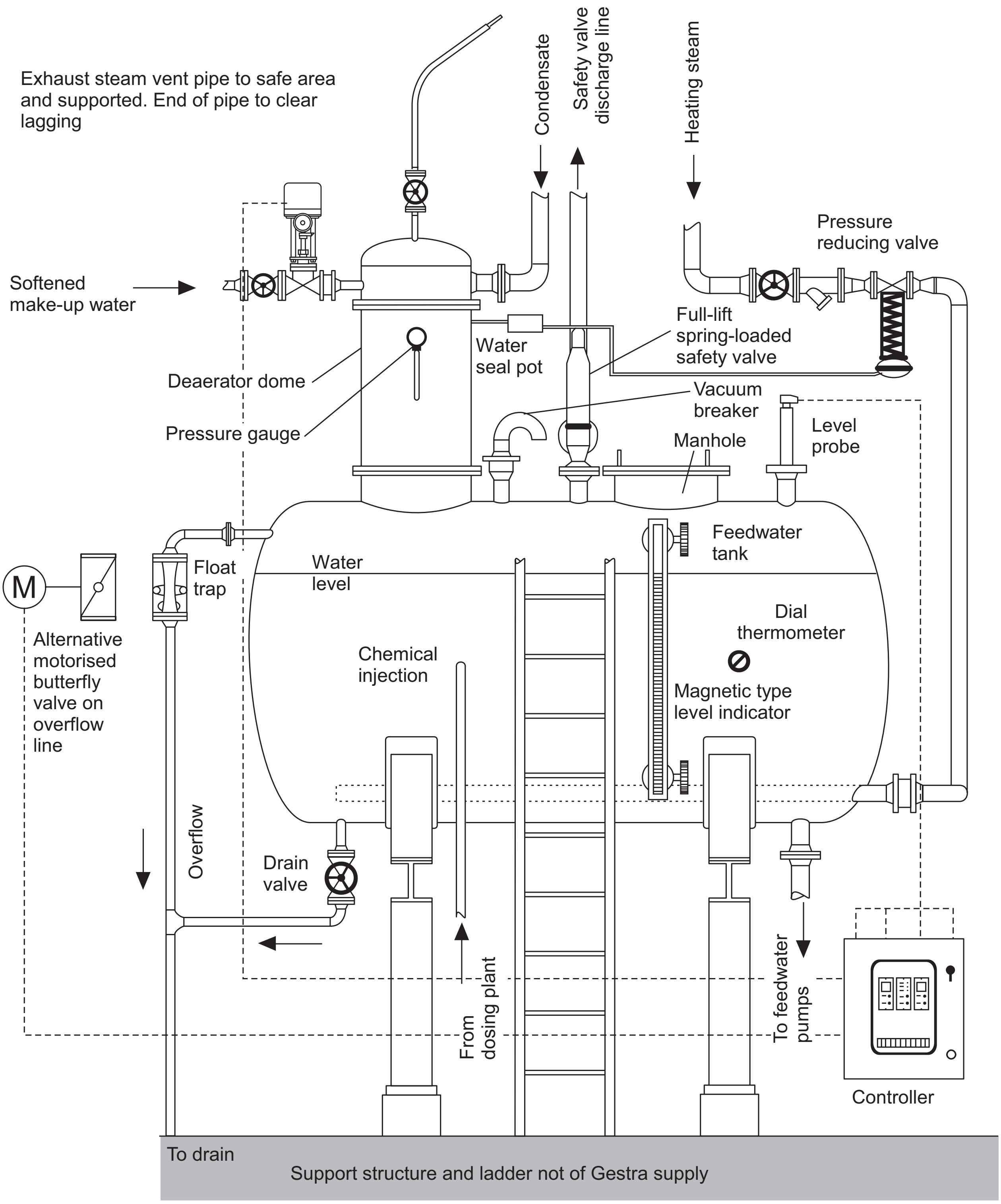
A properly designed pressurised deaerator can bring the dissolved oxygen level to less than 0.02 ppm and at the same time increase the boiler feedwater temperature for improved boiler efficiency.

Design

All wetted parts of the Gestra deaerating dome are constructed in 316 stainless steel. The saw-toothed arrangement at each stage of the deaerating elements has been carefully designed to produce optimum water droplet size for effective deaeration.

The standard Gestra deaerator storage vessel is of carbon steel construction. Storage vessels in stainless

Typical layout



steel are available as an option.

Generally the working level is at about ¾ full with the rest of the space within the tank being saturated with steam to provide a blanket over the water surface.

Maximum design pressure: 1 barg (14.5 psig).

Maximum design temperature: 120°C.

Recommended working pressure: 0.3 barg.

Recommended working temperature: 107°C.

Flow capacity range of deaerator dome: 0.5 to 120 m³/h.

Storage capacity of storage vessel : 1 to 120 m³.

Gestra's standard deaerator is designed in accordance with AD Merkblatt standard for pressure vessels.

Operation

For deaerating purposes the softened water and condensate return are generally introduced through a trickling deaerator bolted onto the horizontal storage tank.

The feedwater is heated to 107° by feeding low-pressure or high-pressure steam into the storage tank. If large quantities of very hot condensate are returned, it may be desirable to pipe the condensate directly into the storage tank.

The distribution of the softened water/condensate mixture as it trickles and cascades down the five deaerating stages of the dome, coupled with the introduction of steam in the counterflow direction, reduces the solubility of gases within the water, so that oxygen and carbon dioxide are diffused in the heating steam bubbles.

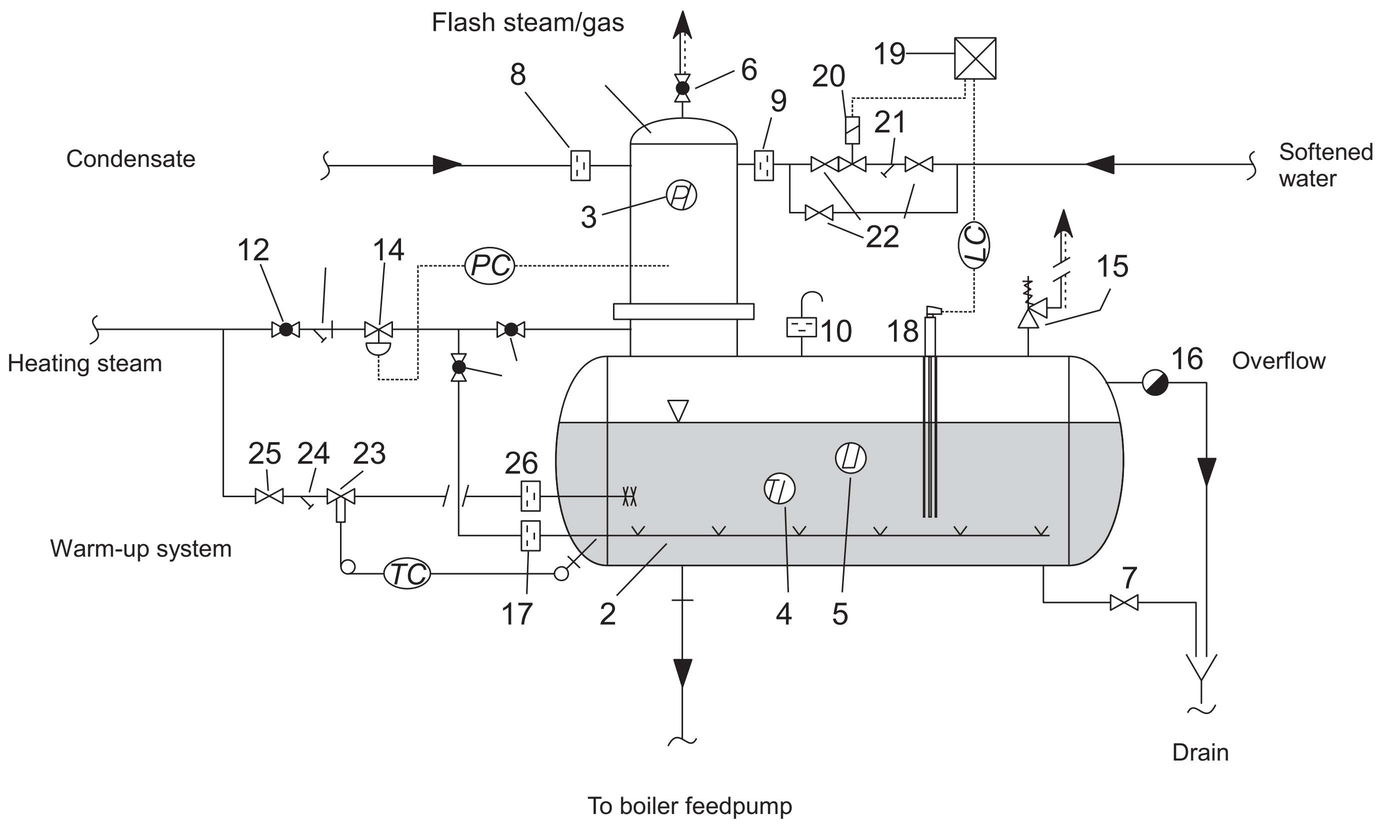
The gases are then discharged to atmosphere through the vent pipe together with some exhaust steam.

Due to the design of the deaerating plant, oxygen values in the feedwater of less than 0.02 mg/l (0.02 ppm) can be achieved.

The main steam for heating is added via a pressure reducing valve. Optional warm-up steam when required is added via a temperature control valve.

As the feedwater temperature is above 100°C, an adequate suction head for the boiler feedpump has to be considered to prevent cavitation within the feedpump.

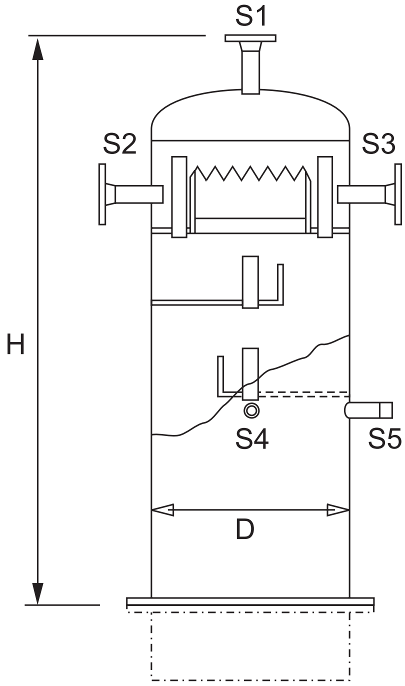
Schematic layout



Deaerator component parts

1. Deaerating dome
2. Feedwater tank
3. Pressure gauge
4. Bimetal dial thermometer
5. Water level indicator with cock
6. Exhaust vent valve with regulating cone.
7. Drain valve
8, 9 & 10. Disco non-return valve
11 & 12. Isolating valve with regulating cone
13. Strainer
14. Steam pressure reducing valve
15. Full-lift spring-loaded safety valve
16. Float trap or motorised valve
17. Disco non-return valve
18. Level electrode
19. Make-up water valve controller.
20. Solenoid valve / motorised valve
21. Strainer
22. Isolating valves & bypass valve
23. Temperature control valve (optional) for warm-up system
24. Strainer
25. Isolating valves
26. Disco non-return valve

Design of deaerator dome



Design B- fixed deaerating elements

Deaerator dome type 'T' Design B

Material: Austenitic S.S. - DIN reference: X6 CrNiMoTi 17 12 2 (1.4571) (ASTM equivalent: A182 F316).

Dome pickled and passivated inside and outside.

Connecting flange for feedwater tank of steel St 37-2, S.S. clad.

Deaerating elements cannot be dismantled.

Note:
The dome and storage vessel can be mixed and matched depending on the capacity of water to be deaerated and the storage time required for the boiler plant. These factors dictate the nominal volume of the storage vessel (working volume is 75% of nominal volume of tank). Where there are height or space restrictions it may be possible to modify the dimensions to suit. Please contact Gestra for details.

Table of connections for deaerator dome	
S1	Flash steam outlet
S2	Condensate inlet
S3	Softened water inlet
S4	Pressure gauge $^3/_8$" BSP
S5	Sensing line $^3/_8$" BSP

Typical Dimensional Details for Deaerator Dome

Type	Type 'T'	250	350	450	550	650	800
Capacity	m^3/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
D	mm	250	350	450	550	650	800
H	mm	1050	1260	1280	1300	1820	1850
Typical connection for feedwater tank*	mm	250	350	450	550	650	800
Connection S1	mm	15	20	25	32	32	40
Weight kg	A	85	115	155	210	275	450
	B	55	75	110	160	220	360

Capacity based on 60% condensate return. For little or no return select one size up.

Type	Type 'T'	900	1000	1200	1400	1600	1800
Capacity	m^3/h	15.1-19	19.1-24	24.1-33	33.1-40	40.1-50	50.1-80
D	mm	900	1000	1200	1400	1600	1800
H	mm	1870	1880	1920	2450	2500	2590
Typical connection for feedwater tank*	mm	900	1000	800	1000	1000	1000
Connection S1	mm	50	50	65	65	80	80
Weight kg	A	570	615	870	1220	1720	2300
	B	430	475	660	970	1340	1600

7* Generally sized to suit storage tank N5 connection.
Dimensional details on capacities up to 120m3/h are available, please consult us.
Example designation for ordering: NDR-B550 = Stainless steel deaerator dome design B, diameter 550mm.

Design of feedwater tank

Feedwater tank DGST

Design A

Material: Carbon Steel.

Steam injector sparge pipe of austenitic S.S. 1.4571.

Inclusive of manhole DN 500mm, PN6.

Design B

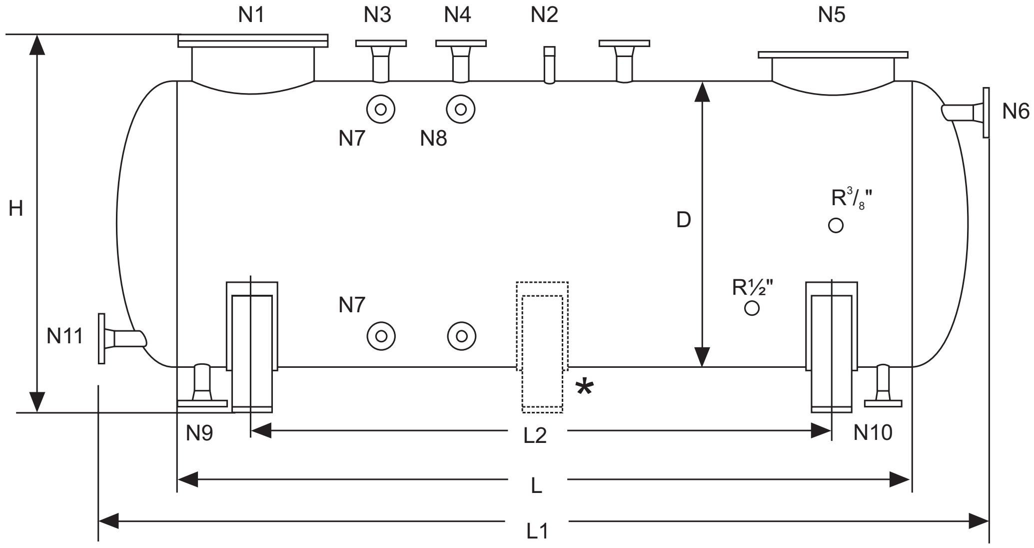
Material: Austenitic S.S. - DIN reference: X6 CrNiMoTi 17 12 2 (1.4571) (ASTM equivalent: A182 F316).

Welds pickled and passivated.

Support saddles of steel St 37-2.

Inclusive of manhole DN500mm, PN6.

Feedwater tank DGST



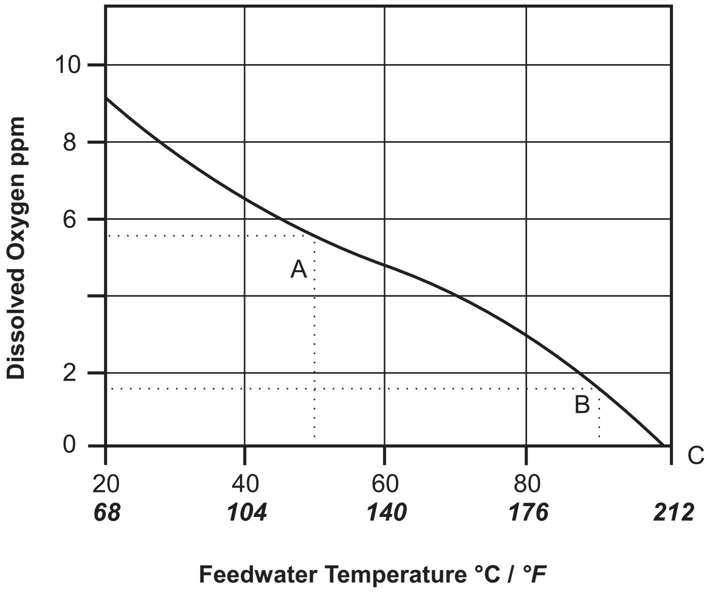
Typical Dimensional Details for Feedwater Tank DGST

Nominal volume	m^3	1	2	3	4	6	8	10	16	22	30	40	50	70
D	mm	800	1000	1200	1200	1600	1600	1600	2000	2000	2500	2500	2900	2900
L	mm	2000	2500	2500	3000	3000	4000	5000	5000	7000	6000	8000	8000	10000
L1	mm	2360	2940	3050	3550	3680	4680	5680	5850	7850	7050	9020	9180	11502
L2	mm	1500	1900	1900	2200	2200	3200	4100	4100	6100	5100	7000	7000	9000
H	mm	1150	1350	1600	1600	1950	1950	1950	2350	2350	2850	2850	3250	3250
Connections:														
Manhole	N1	DN 500mm, PN 6												
Pressure gauge	N2	$^3/_8$“ BSP												
Vacuum breaker	N3	Sizing in accordance with required heating capacity												
Safety valve	N4	Sizing in accordance with required heating capacity												
Deaerator dome	N5	250	350	350	450	550	550	650	800	1000	800	1000	1000	1000
Overflow	N6	Sizing in accordance with capacity												
Water level	N7	20	20	20	20	20	20	20	20	20	20	20	20	20
Measuring pot	N8	20	20	20	20	20	20	20	20	20	20	20	20	20
Pump	N9	25	32	40	50	65	80	80	100	125	125	150	200	250
Drain	N10	25	25	32	32	32	40	40	40	40	50	50	50	80
Heating steam	N11	Sizing in accordance with required heating capacity												
Stand-by	N12	40	40	50	50	50	80	80	80	80	100	100	100	150
Weight	kg	395	570	780	870	1140	1340	1630	2560	3210	3860	4160	6260	8850

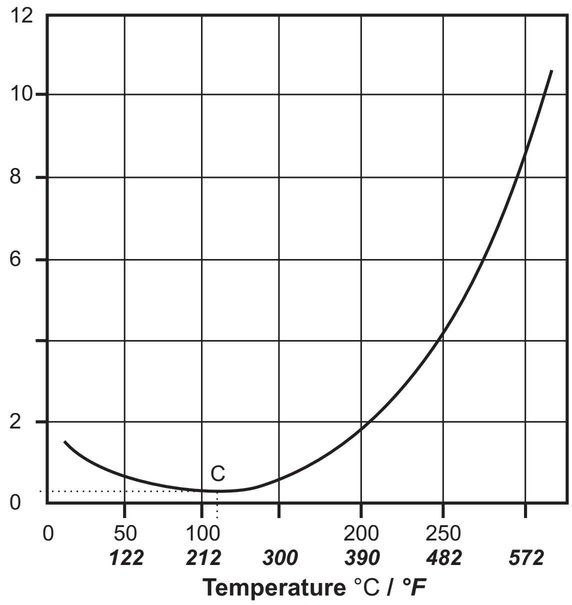
All connections flanged PN to DIN 2633, unless otherwise stated.
Dimensional details on nominal volume up to 120m^3 are available, please consult us.
Example of designation for ordering: SW-A16 = Carbon steel deaerator storage vessel design A with nominal volume of 16m^3.
(**Note:** Working volume is 12m^3 max. i.e. 75% of nominal volume)

Savings

Chemical Savings



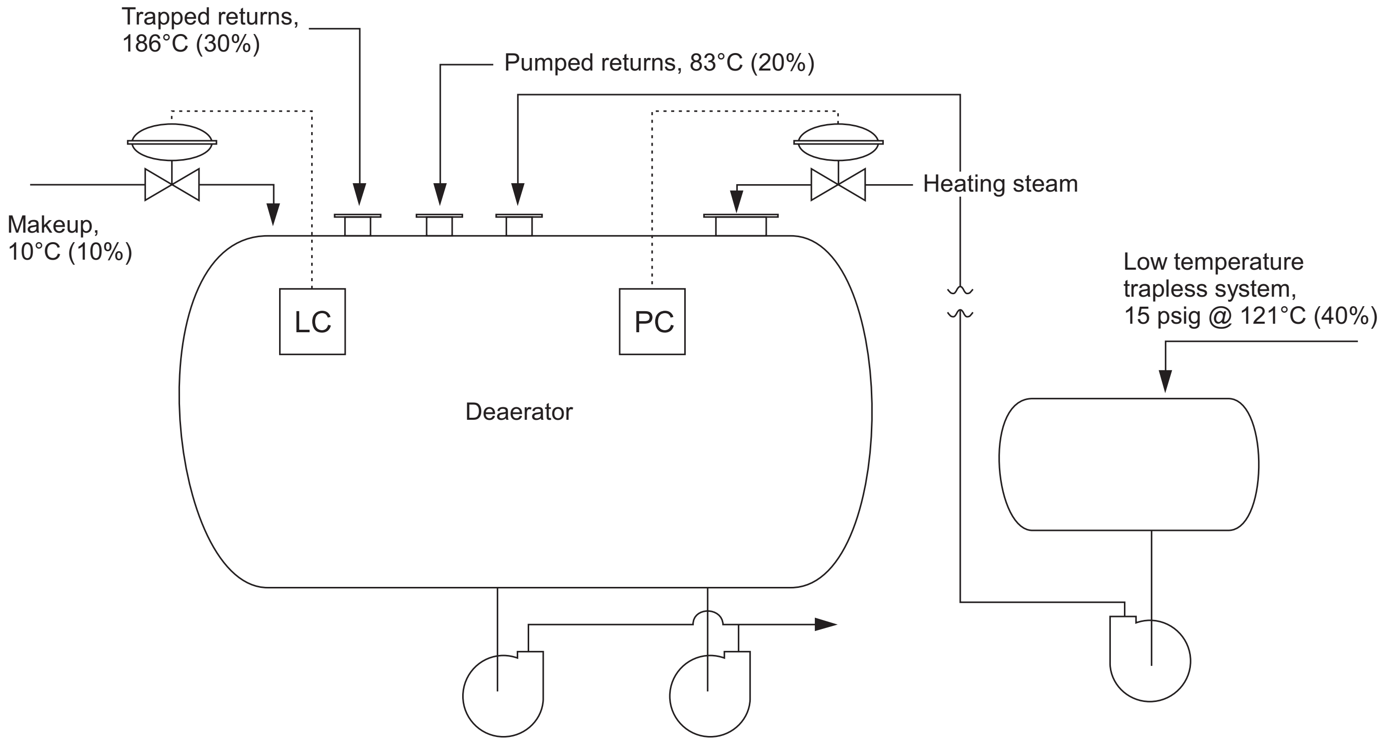
Solubility of oxygen in water at 0.3 bar partial pressure



A	B	C
Atmospheric Feed Tank	Semi-Deaerator	Pressure Deaerator
Temperature assume 50°C (122°F)	Temperature 90°C (194°F)	Temperature 107°C (225°F)
Dissolved oxygen 5.6 ppm	Dissolved oxygen 1.6 ppm	Dissolved oxygen 0.02 ppm
To remove 1 ppm of oxygen requires approximately 8 ppm of Sodium Sulphite and the boiler normally has a reserve of plus 4 ppm of Sodium Sulphite		
Chemical required 5.6 x 8 = 44.8 + 4 = 48.8 ppm	Chemical required 1.6 x 8 = 12.8 + 4 = 16.8 ppm i.e. 66% saving on A	Chemical required 0.02 x 8 = 0.16 + 4 = 4.16 ppm i.e. 75% saving on B and 91% saving on A

Energy Savings

An example to compare conventional hotwell system and a pressurised deaerating system operating as the hub of a typical plant's heat balance.



Source	Open System	Pressurised deaerator system
Low pressure*	38% @ 100°C = 38	40% @ 121°C = 48.4
Pumped	20% @ 83°C = 16.6	20% @ 83°C = 16.6
Trapped*	25% @ 100°C = 25	30% @ 186°C = 55.8
Makeup*	17% @ 10°C = 1.7	10% @ 10°C =1
Average feedwater temperature °C	81.3	121.8
121.8°C - 81.3°C = 40.5°C X 4.19 kJ/kg°C = 170 kJ/kg saved.		
* Volumes differ because of loss of condensate caused by flashing to atmosphere		

Example

Heat Savings

Heat saved on pressurised deaerator system is 170 kJ/kg.

Assume boiler plant steam output 10,000 kg/hr.

Heat saved per hour is 170 x 10000 = 1,700,000 kJ.

Equivalent steam saved.

Assume boiler at 10 barg (145 psig)

From steam tables there are 2363 kJ/kg @ 10 barg.

$\therefore \quad \frac{1700000}{2363}$ = **719 KG/HR OF STEAM**

Assume cost of raising 1000kg of steam is £12-00 with a boiler efficiency of 80%.

For a 24 hour day, 7 day week and 50 weeks per year the savings would be:

$719 \times \frac{80}{100} \times \frac{12}{1000} \times 8400 =$ **£57,980 per year**

In practice there would be approximately between 0.1 to 1% loss due to vented gases and flash steam from the deaerator vent pipe.

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GESTRA Steam Solutions

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Consider these advantages prior to any purchase decision

- Trickling and cascading water type design.
- No moving parts, no spring loaded nozzle and no trays or packed column. Hence no maintenance of dome required.
- Counter flow method.
- Pressure controlled for faster response during load changes. Wide turndown. Operates at 0.3 barg, 107°C.
- Supplied as complete engineered system including all ancillary equipment.
- Level electrode direct mounted in tank.
- Capacity size in data sheet based on 60% condensate return.
- Split heating steam to dome and storage tank above 10,000 kg/h.
- Stainless steel dome is pickled and passivated internally and externally.
- Storage tank nominal capacity from 1m^3 to 120m^3 working volume is 75% of nominal.
- 70% of heating steam flowrate supplied via specially designed single sparge pipe.
- Dome capacity between 500kg/h to 120,000 kg/h.
- Improved boiler efficiency.
- State of the art Gestra electronic level control system.
- Complete ancillary system engineered, sized and supplied. Less hassle factor.
- Simple to commission and operate, very little maintenance time required.
- Guaranteed to lower oxygen content of feedwater down to 0.02ppm by deaeration alone. Lower levels of oxygen content can often be achieved. The rest of the oxygen can be removed by the minimum of oxygen scavenging chemicals.
- Flexible design to suit different site applications. Mix and match dome and storage vessel.
- Very competitively priced.
- Quantifiable energy savings.
- A pressurised deaerator is recommended if economisers are fitted.
- Continuous blowdown heat recovery can be incorporated into the deaerator cycle.
- Provision for a warming up steam system for storage tank above 6m^3.
- Back-up service provided.