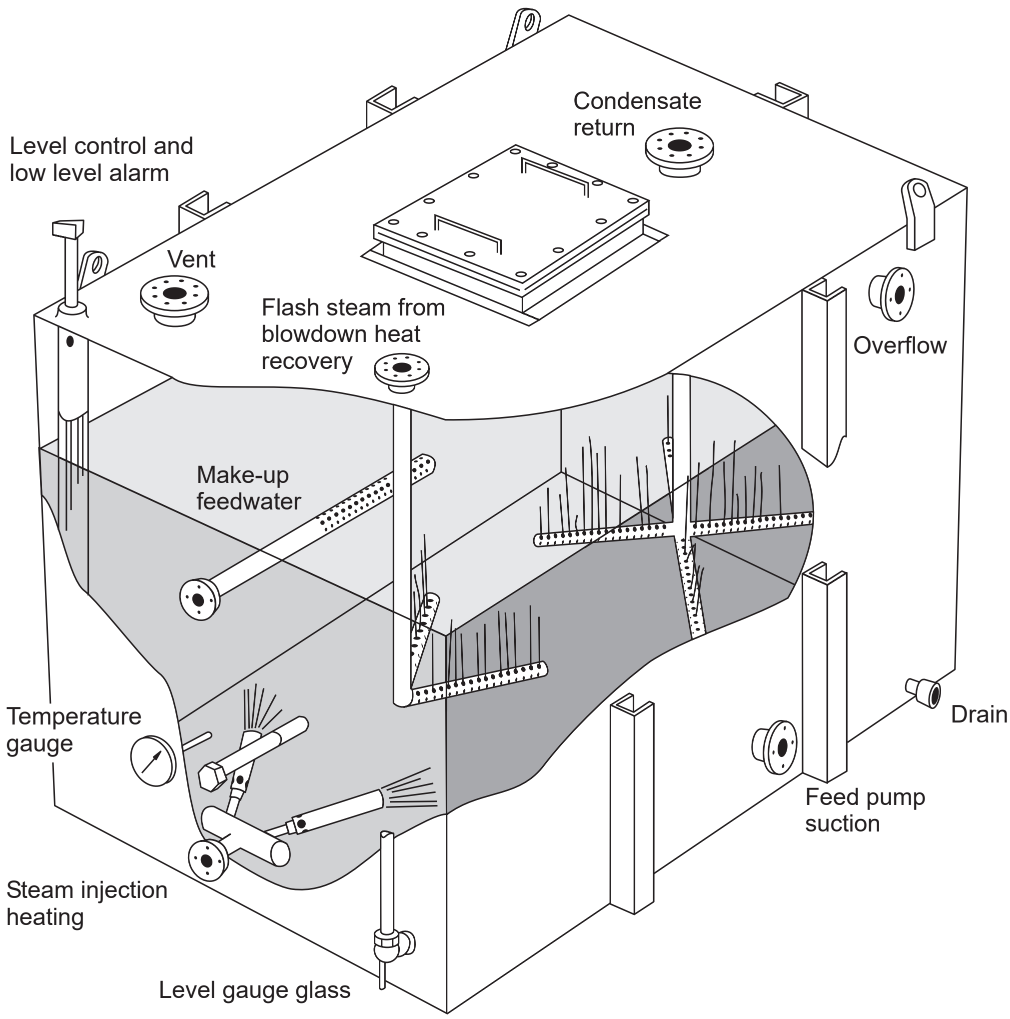
Typical layout



The Semi-Deaerator conditions the boiler feedwater in a complete package unit which includes:

- Distribution of the condensate return.
- Control and deaeration of the make-up feedwater.
- Blowdown flash steam heat recovery.
- Feedwater heating and temperature control.
- Adequate storage of boiler feedwater.

The Semi-Deaerator is designed as a unit:

- To avoid the wasteful plume of steam often seen venting from the boiler feed tank.
- To save a substantial proportion of oxygen scavenging chemicals by efficient partial deaeration of the feedwater.
- To solve once-and-for-all the problem of corrosion. The tank and all the internal pipework is made of stainless steel.

The Gestra Semi-Deaerator is a deaerating feedtank for heating and reducing the oxygen content of boiler feedwater

Deaeration of the feedwater

The Gestra Semi-Deaerator conditions the boiler feedwater in three stages.

1. Upper zone-distribution
The cold water is distributed at low velocity just below the water surface.

2. Intermediate zone-heating
As the cold water drops slowly in the tank it meets the rising steam bubbles from the flash steam in the condensate return and from the blowdown heat recovery system. The flash steam is condensed, the make-up water is heated and dissolved oxygen is driven off.

3. Lower zone-scrubbing
The already hot water now reaches the steam injection stage where live steam is injected vigorously into the water. The scrubbing action of the steam removes the oxygen leaving a very low oxygen concentration, The heat and water contents of the steam are of course recovered with the feedwater.

Oxygen in boiler feedwater

If oxygen is allowed to remain in boiler feedwater it causes boiler and condensate line corrosion. In practice the dissolved oxygen is removed by chemical dosing, most often with sodium sulphite, but this can prove expensive.
The Gestra Semi-Deaerator uses mechanical deaeration to remove the bulk of the oxygen, dramatically reducing the cost of chemical dosing.

Example

1. Present conditions

Consider that the present feedwater temperature averages 50°C. From the graph the dissolved oxygen content is about 5.6 ppm.
To react with this oxygen 5.6 x 8 = 44.8 ppm of sodium sulphite would be required plus say an extra 4 ppm excess to maintain a reserve in the boiler.
If an average of 5000 kg/h of steam is generated, sodium sulphite is required at a rate of:

$$5000\,\frac{kg}{h} \times \frac{48.8}{1\,000\,000} = 0.24\ kg/h$$

Since a typical liquid catalysed sodium sulphite contains only 45% as sodium sulphite, and costs about £1000 per1000 kg, over a full year the cost of sodium sulphite would amount to:

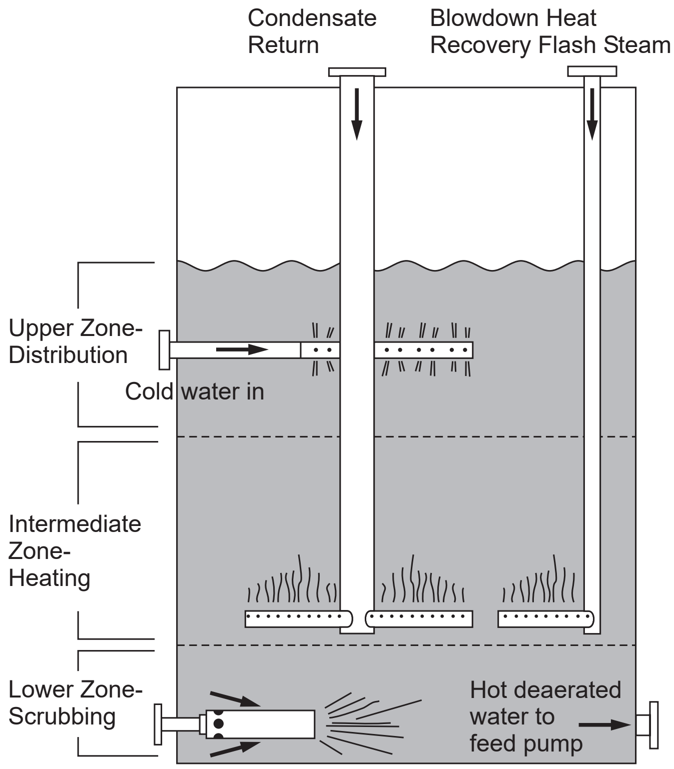
$$0.24\frac{kg}{h} \times 24x7x52\frac{h}{yr} \times \frac{100}{45} \times \frac{£1000}{1000kg} = £4659 \text{ per year}$$

In practice, due to variations in feedwater temperature extra dosing would be required to maintain the sulphite reserve in the boiler further increasing costs.

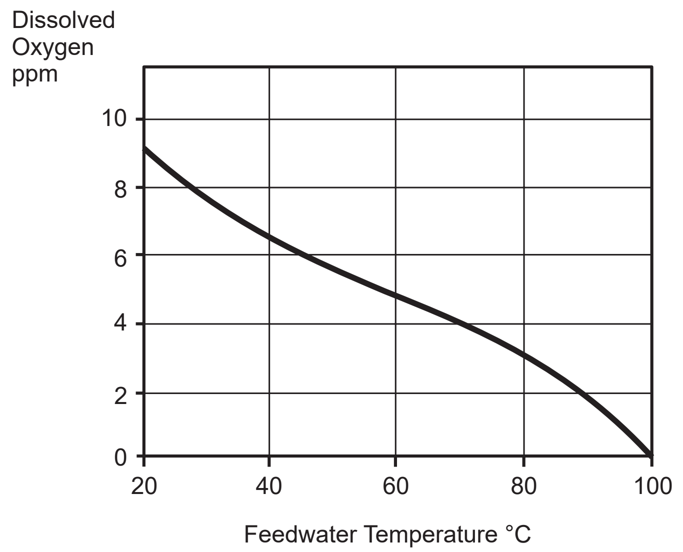
2. Condition after installing the Gestra Semi- Deaerator

The feedwater is now maintained at a constant 90° (the actual maximum depends on the height of the tank and feedpump design but 90°C is usually no problem).

From the graph the dissolved oxygen content is about 1.6 ppm requiring 1.6 x 8 = 12.8 ppm of sodium sulphite plus the 4 ppm excess.



Schematic layout of the Gestra Semi-Deaerator showing the three zones



Graph showing dissolved oxygen content of feed water at any temperature

With the same 5000 kg/h steam generation rate;

$$5000\frac{kg}{h} \times \frac{16.8}{1\,000\,000} = 0.084 \text{ kg/h of sulphite is required.}$$

The total cost per year is now:

$$0.084\frac{kg}{h} \times 24x7x52\frac{h}{yr} \times \frac{100}{45} \times \frac{£1000}{1000kg} = £1630 \text{ per year}$$

The saving on Oxygen scavenging chemicals is therefore £3029 per year.
In practice the more stable conditions and accurate temperature control in the Gestra Semi- Deaerator coupled with a smaller blowdown requirement can reduce the excess sulphite required to maintain an adequate reserve in the boiler, further reducing costs.

Control of the make-up feedwater

The standard Semi-deaerator includes the connection and protection tube for Gestra electrode level controls with no moving parts. Level controls are 'on- off' to control the level between two points. This prevents trickle flow and ensures proper operation of the water softener and avoids 'hardness slip'. Distribution of the cold water is through sparge pipes to ensure steady conditions in the tank.

The standard level electrode system includes provision for a low water level warning. Control valves can be supplied to suit any application.

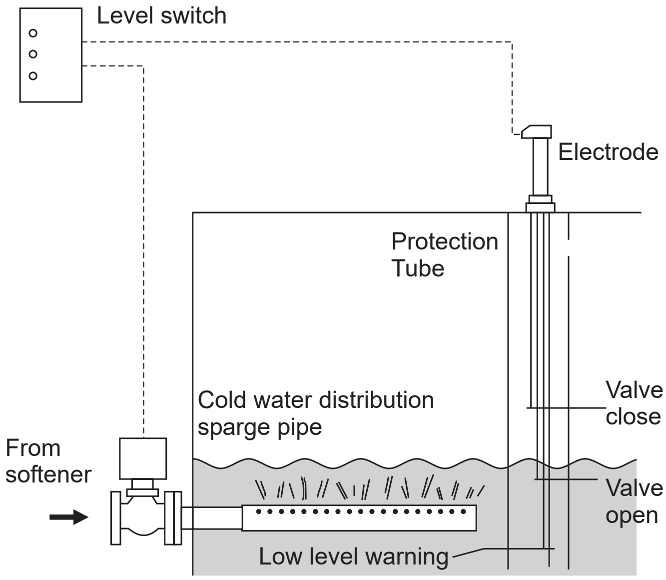
Storage tank size

The quantity of feedwater storage required depends on the boiler plant steam generation rating, the proportion of condensate return and whether other water storage facilities are available on site.

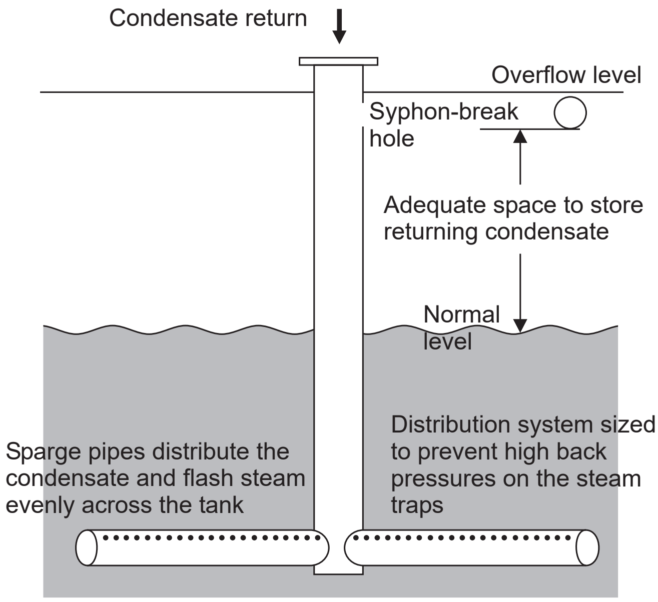
A typical minimum amount of storage would allow the boiler plant to run without any make-up feedwater for between ½ and 1 hour. For very large storage requirements we suggest a cold softened water storage tank at ground level, with a pumped supply to the elevated Gestra Semi-Deaerator. In this case the Semi-Deaerator can be supplied with modulating level controls instead of the on-off system.

Condensate return

Condensate return often contains flash steam. If this is not properly handled there is the danger that the expensive heat and water content in the flash steam is simply vented to atmosphere. The Gestra Semi-Deaerator includes a properly sized distribution system to ensure that all the heat can be reused in the boiler. The fuel savings here can be dramatic, and easily amount to a 5% saving on total fuel costs. The Gestra system also ensures that returning condensate does not pick up oxygen from the atmosphere.



Control and distribution of the cold make-up feedwater

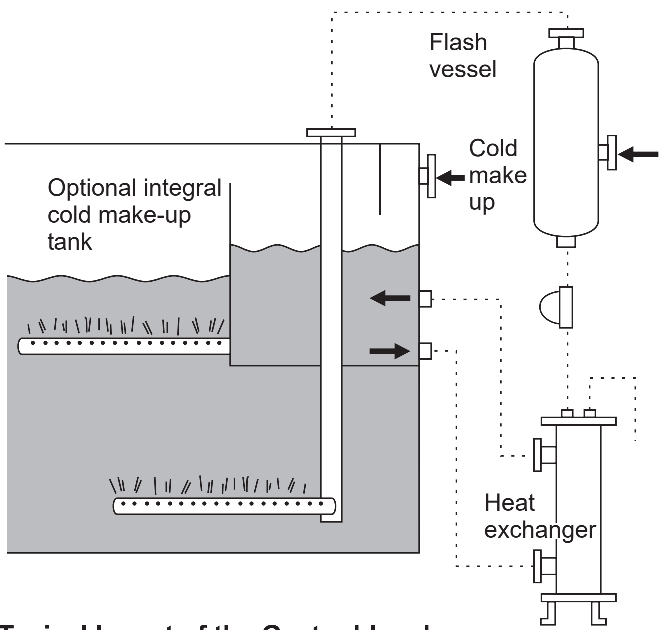


Distribution of the condensate return

Blowdown heat recovery

The Gestra blowdown heat recovery systems are a well established method of saving fuel. The systems can now be fully integrated with the Semi-Deaerator.

1. Flash steam recovery.
   The standard distribution system is built-in to recover the heat and water content of the flash steam.
2. Residual blowdown heat recovery.
   When required a cold make-up tank can be provided with connections for circulating water through the residual blow-down heat exchanger. Adequate circulation is normally provided by the natural thermosyphon effect.



Typical layout of the Gestra blowdown heat recovery system

Gestra UK Ltd
Unit 1 Sopwith Park, Royce Close, Andover, SP10 3TS
Tel: 01635 46999
Email: enquiries@uk.gestra.com
Web: www.gestra.com

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GESTRA Steam Solutions

FCD GSEDS0054-02 Issued 03/13

Equipment Details

The semi-deaerator is of all welded construction from 5mm thick plate supplied complete with lifting eyes and bolted manhole. External vertical stiffeners of steel channel are provided where necessary to support the tank sides, but the base requires supporting on a solid floor or on structural steelwork.

Standard Sizes, Capacities and Weights

Semi-Deaerator Type	Tank External Dimensions (mm)			Working Tank Capacity		Weight (kg)	
	Height	Width	Length	Gallons	Litres	Empty	100% Full
TANK 1	1250	1250	2500	650	2930	830	4800
TANK 2	1500	1250	2500	780	3520	940	5700
TANK 3	1500	1250	3000	940	4220	1080	6820
TANK 4	1500	1500	3000	1120	5060	1230	8110
TANK 5	2500	1250	2500	1300	5860	1320	9290
TANK 6	2000	1500	3000	1500	6750	1460	10600

Standard Connections

Vent
Overflow
Drain
Feed Suction (outlet)
Make-up inlet (with internal sparge pipe)
Condensate Return (with internal sparge pipes)
Blowdown flash steam (with down pipe)
Steam injection (fitted for internal injector)
Temperature feeler connection
Temperature gauge connection
Level gauge glass connection
Level control (with protection tube)

Additional or special connections are available at extra cost.
Connection sizes up to 50mm (2") are BSP screwed sockets (except condensate return and blowdown flash steam).
Sizes above 50mm (2") are flanged BS 4504 PN 16

Survey

Gestra offer full back-up information on the Semi-deaerator including survey forms and schematics of the various sizes. Gestra design the various sparge pipes, injectors and connections to suit the particular plant flowrates and lay out the semi-deaerator internals to achieve good distribution and deaeration.

Assistance with site surveys can be provided.

Materials

All wetted parts including connection sockets and flanges, internal pipework and sparges, manhole fittings and cover are of austenitic stainless steel.
Austenitic stainless steel solves all the problems of general corrosion found with mild steel boiler feedwater tanks. We have also chosen a special low carbon grade of austenitic stainless steel type 304L for the tank construction since this is also resistant to intergranular corrosion.
However, under certain special conditions austenitic stainless steels may be susceptible to corrosion by chlorides.
Our experience with this material has been excellent and we know of no operating problems with feedtanks or internal pipework of 304L.