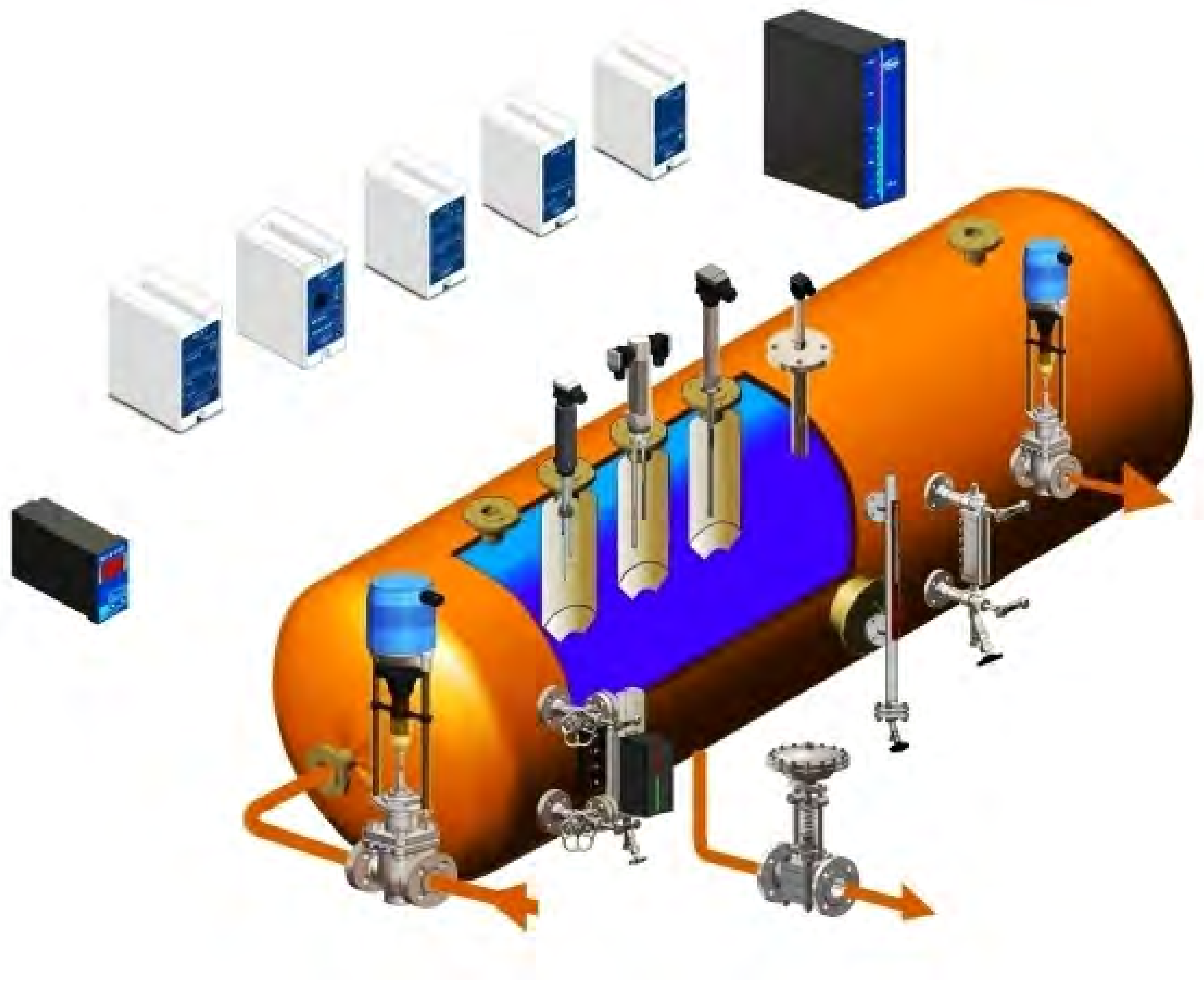
ARMSTRONG
FLOW CONTROL

Boiler Controls & Waste Heat Recovery

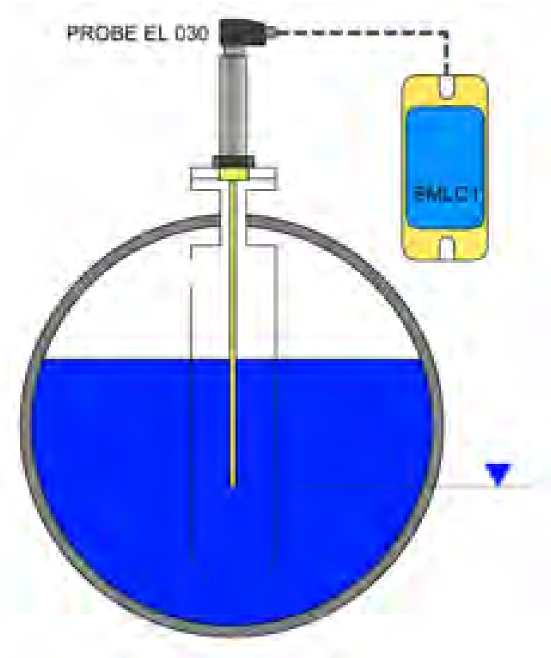
IGEMA BOILER LEVEL & TDS CONTROLS



IGEMA offers boiler level and TDS control products of the highest quality standard, being certified to ISO 9001.
Made in Germany, *IGEMA* products are manufactured in compliance with the European Pressure Directive 97/23, and the current standards for steam boiler operation, such as TRD – German Technical Regulations for Steam Boilers, AD 2000 – Workgroup for Pressure Vessels, ASME boiler codes etc.
Type Approvals have been obtained from virtually all significant international classification societies, such as TUV Rheinland, German Lloyd, Det Norske Veritas, Lloyds Register to name a few.

PROBE-TYPE LEVEL CONTROLS & ALARMS

FOR ATTENDED AND UNATTENDED BOILERS



UNATTENDED BOILERS – Self-Checking Low Level Alarm

The combination of probe EL 30 and controller SMLC1 represents a High Integrity Water Level Limiter of Special Design.

Featuring an insulated compensating electrode in addition to the measuring tip, these probes are designed to respond to any conceivable failure condition, such as scaling due to boiler water impurities, open or short circuit of internal and external wiring or leakage of boiler water.

The SMLC1 controller checks system integrity continuously. It incorporates a cyclic self-test function. If it fails to react to a simulated fault, the burner safety circuit is activated.

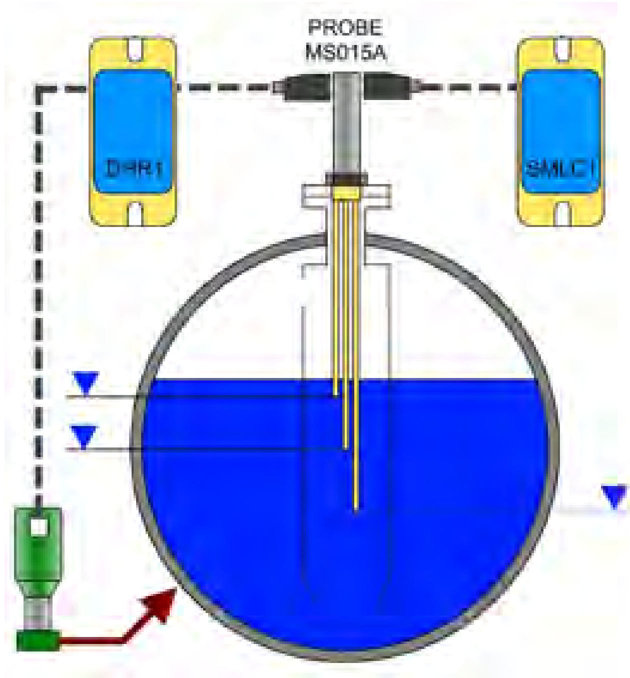
Similar models are available for High Level Alarm and for boiler pressure to 200 bar.

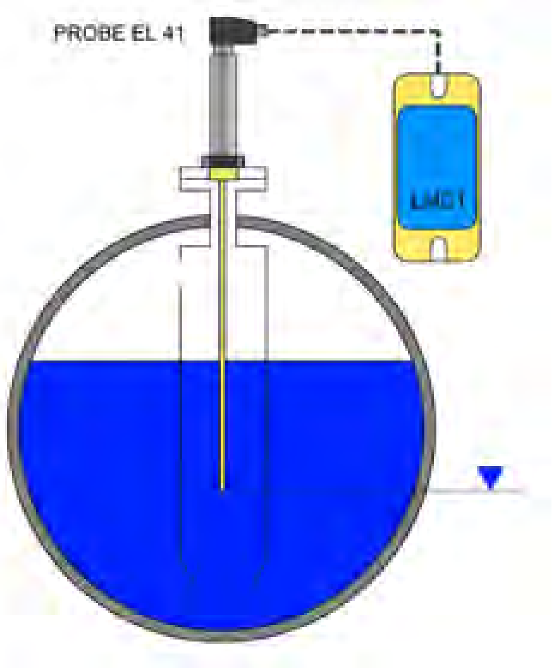
UNATTENDED BOILERS – Self-Checking Low Level Alarm and Feed Pump On-Off Control

The probe MS015A combines a High Integrity Water Level Limiter of Special Design with two additional standard design probes.

The self-checking SMLC1 controller serves as the Water Level Limiter, while the DHR1 controller switches the feed pump on and off as signalled by the additional standard probes.

This represents a compact and economical system, since only a single probe entry into the boiler shell is required for both self-checking low level alarm and feed pump on-off control.





ATTENDED BOILERS – Standard Low Level Alarm

The combination of EL 41 probe and controller LMC1 are used for applications where there is no requirement for Self-Checking.

This high quality equipment is designed to comply with the relevant European boiler codes such as TRD and Water Level 2000.

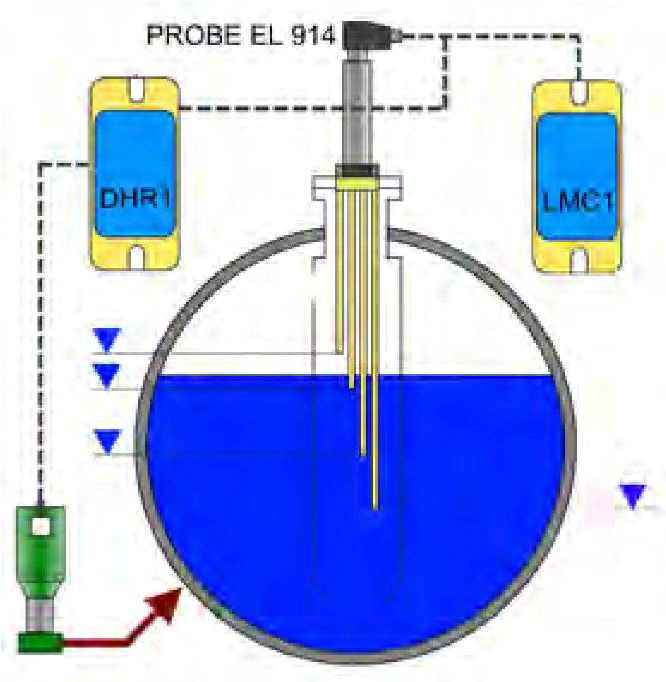
Alternative probes for high level alarm and for boiler pressures to 200 bar are available.

ATTENDED BOILERS – Standard Low Level Alarm with Feed Pump On-Off Control and High Level Alarm

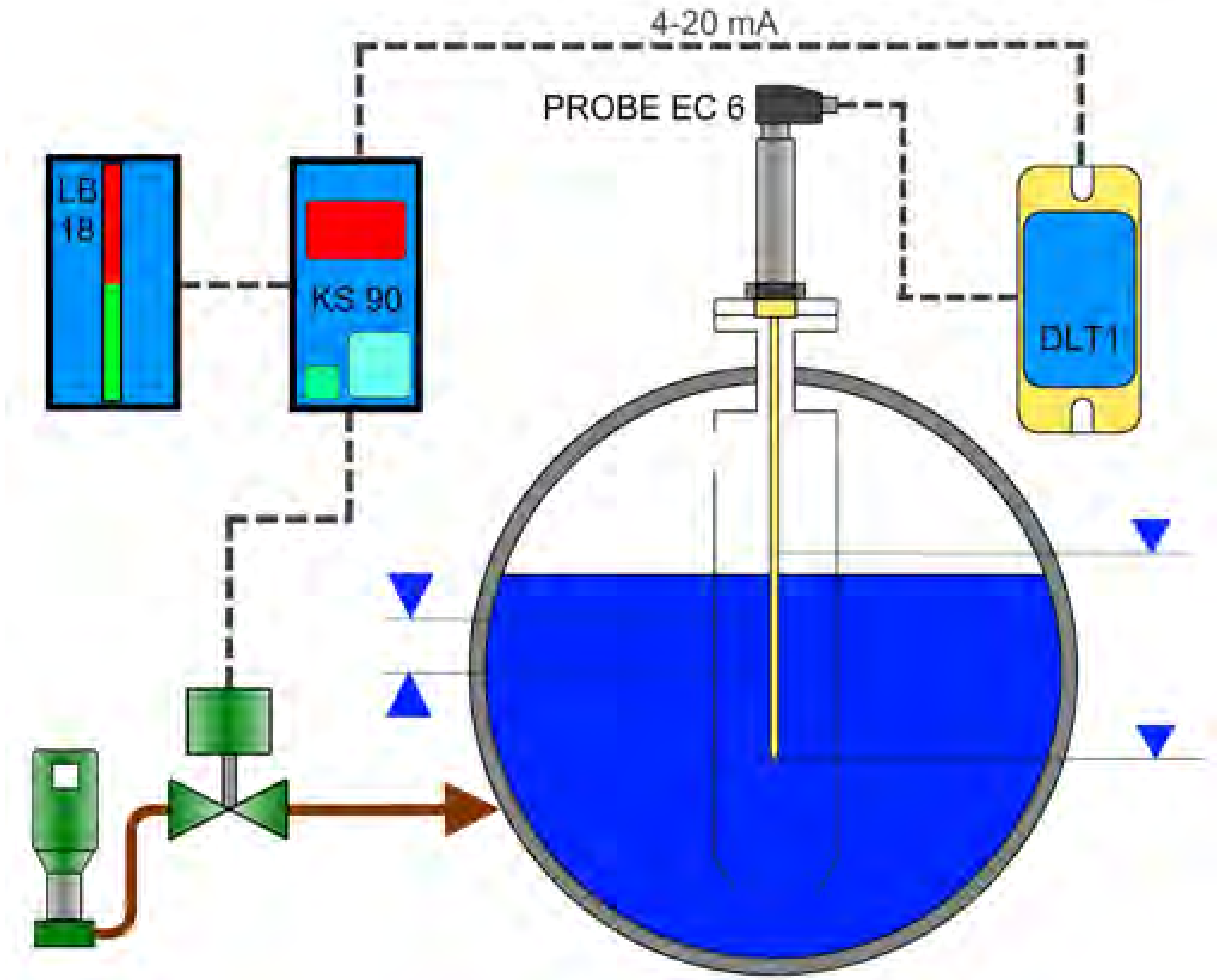
The multiple probe EL 914 is used for many applications requiring up to 4 individual switching or alarm points.

Combined with the DHR1 feed pump on/off controller with high level alarm, and an LMC1 controller for low level alarm, this gives an example of the versatility of the EL 914 multiple probe.

This probe is also available with 2 points (EL 912) or 3 points (EL 913).



MODULATING BOILER LEVEL CONTROLS



The basic **IGEMA** modulating control system comprises a capacitance probe EC 6, and a DLT 1 level transmitter.

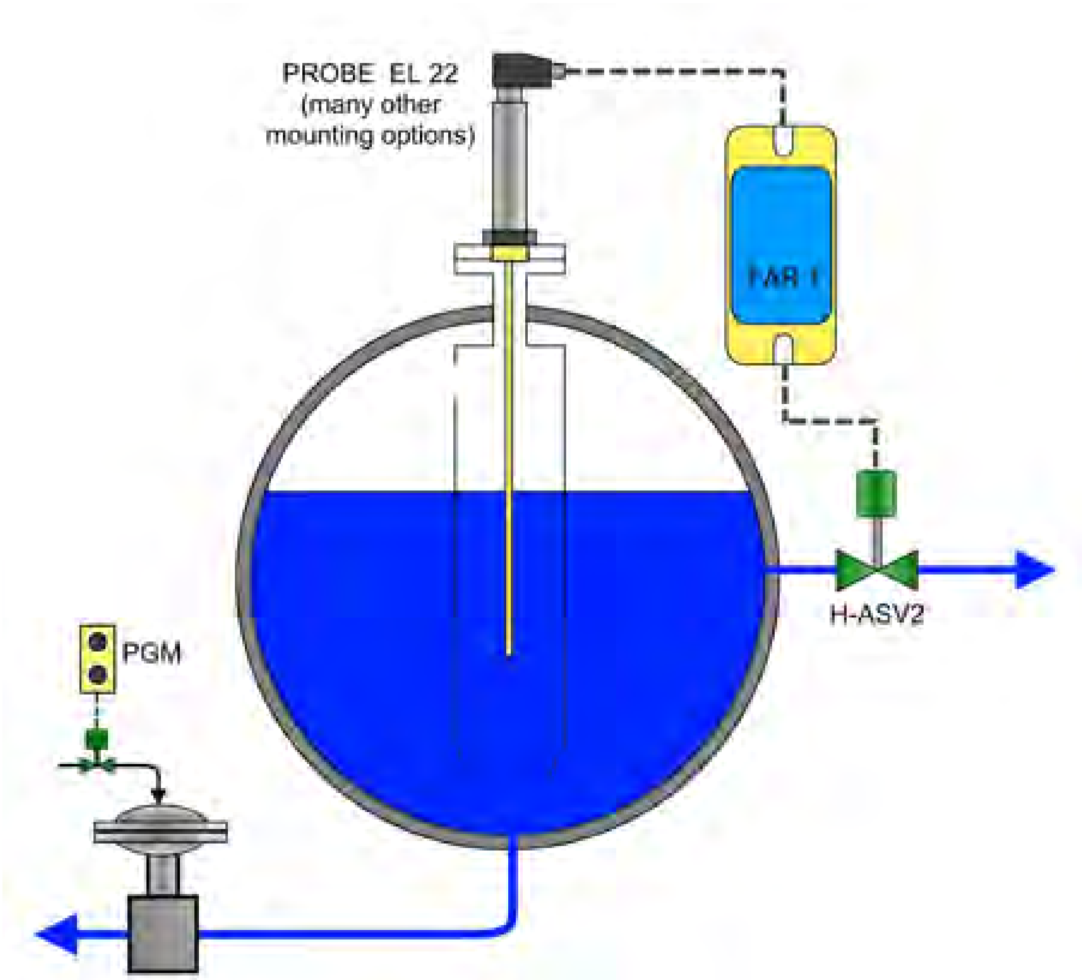
This combination provides for a 4-20mA output signal proportional to the desired level control range.

The PID controller KS 90 or KS 40 accepts the 4-20mA signal and provides an appropriate output to the electric actuator of the feedwater control valve.

This relatively simple system has been found to provide excellent control for the majority of boilers, usually with a bypass orifice to ensure feed pump minimum flow requirements.

For situations with extremely rapid load swings, it is possible to add a feed forward signal from a steam flow meter, and/or feed back from a feed water flow signal to compensate for the effects of boiler water level sag or swell.

BOILER BLOWDOWN CONTROLS



INTERMITTENT BLOWDOWN FOR SEDIMENT AND SLUDGE CONTROL

If continuous blowdown is employed for TDS control, the requirement for intermittent blowdown to remove settled sludge and other solids from the bottom of the boiler drum can be reduced to a few seconds per day.

IGEMA bottom blowdown valves are available for pressures to 50 bar.

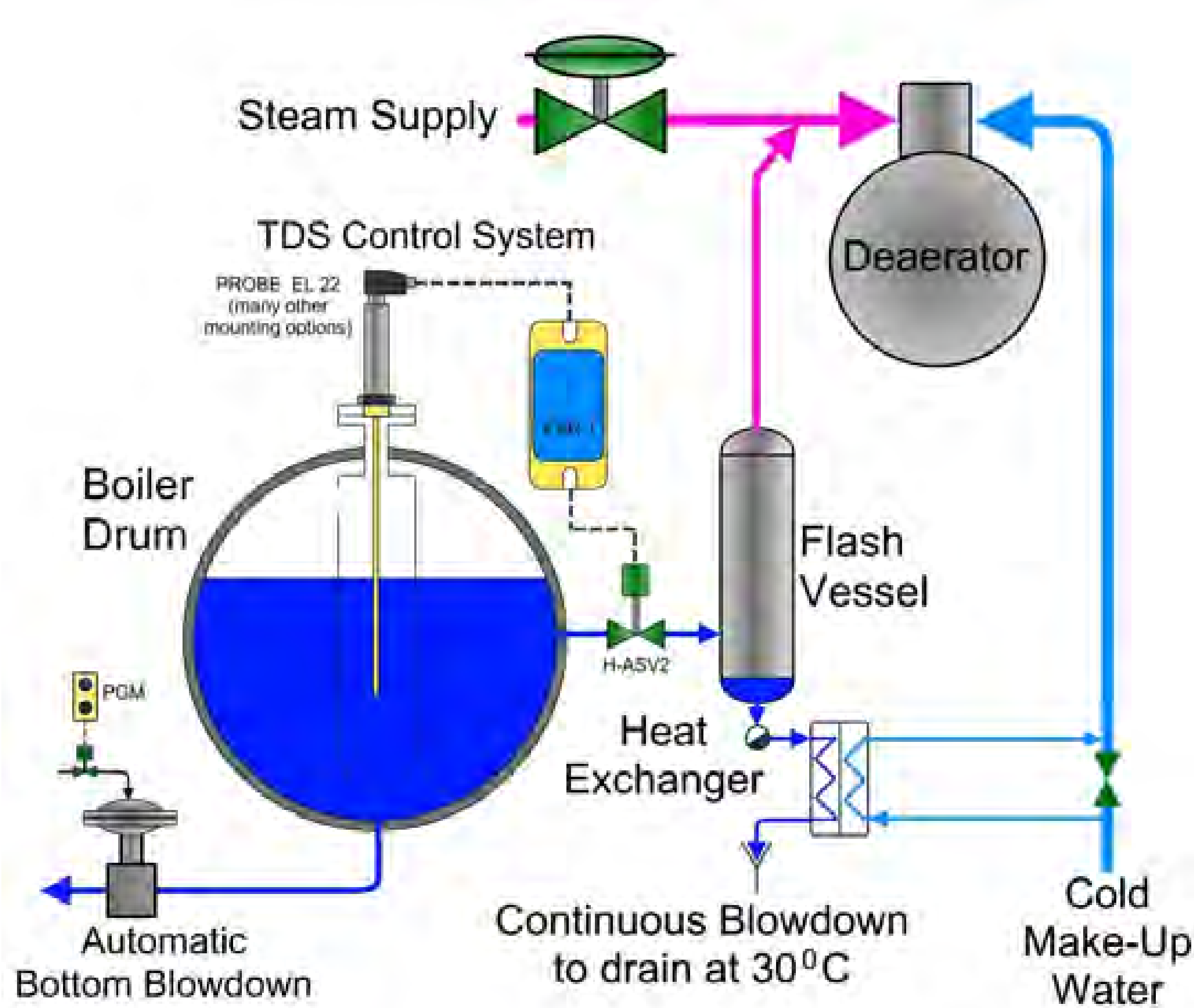
Control can be manual or via timer-controlled pneumatic actuator.

CONTINUOUS BLOWDOWN FOR TDS (Total Dissolved Solids) CONTROL

Boiler water conductivity is closely related to TDS. An appropriate IGEMA conductivity electrode measures conductivity, which is amplified by the FAR1 blowdown setpoint controller. The output signal from the FAR1 is applied to the electric actuator of the H-ASV2 continuous blowdown valve.

This system not only ensures that boiler water TDS stays within allowable limits. It also saves energy by limiting the amount of heat and treated water discharged from a boiler to the absolute minimum.

BOILER BLOWDOWN & HEAT RECOVERY



ENERGY-EFFICIENT BOILER BLOWDOWN HEAT RECOVERY

Boiler water discharging as continuous blowdown contains both the sensible heat at boiler pressure and the latent heat content due to let-down from boiler pressure to near-atmospheric pressure.

With a THERMGARD 2-stage blowdown heat recovery system, typically some 80% of this otherwise wasted heat content is saved.

In addition, a significant amount of treated boiler water is saved, due to condensation of flash steam in the deaerator or feed tank.

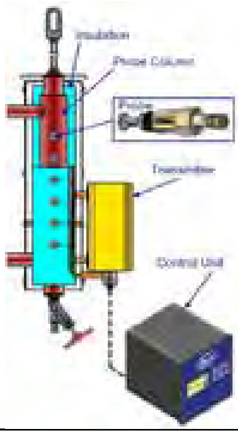
Payback periods of less than 2 years are the norm. In applications where there is a high amount of make-up causing high continuous blowdown, the payback is sometimes only a few months.

OTHER IGEMA EQUIPMENT

Illuminated boiler level gauges – any application to 200 bar

Float-Type level controls for boiler pressure to 200 bar.

Also for Self-Checking Applications



Remote Level Indication

Boiler Conductivity Probes

Bi-Colour Level Gauges

Aspects you should consider:

- *Requirements for efficient boiler blowdown.*
- *Manual or Automatic TDS control, intermittent or continuous.*
- *Benefits of continuous blowdown.*
- *Calculation of blowdown rate.*

- *Blowdown heat recovery.*
- *Flash steam recovery.*
- *Residual sensible heat recovery.*
- *Calculation of heat recovery potential and payback period.*
- *Integration with feed tank or deaerator.*

Boiler Blowdown has two distinct separate purposes:

*1. To ensure that the concentration of total **dissolved** solids (TDS) is kept below a certain maximum allowable level.*

*2. To prevent the accumulation of **suspended** solids that collect at the bottom of the boiler drum.*

The TDS concentration gradually increases due to evaporation. To ensure steady conditions, blowdown for TDS control should be continuous.

Suspended solids removal from the bottom of the boiler needs only a puff of blowdown for a few seconds once or twice per shift.

Feedwater = Condensate Return + Make-Up water.

Feedwater has to be treated to inhibit corrosion and scale formation.

Standard industrial boiler water treatment: *Base Exchange water softening + Chemical dosing + Blowdown to limit TDS to a safe level.* ***This is managed by a chemical specialist.***

Excessive TDS causes scaling, foaming and carry-over of boiler water.

Excessive blowdown causes higher energy and treated water costs.

Good blowdown control results in economical boiler operation.

Good blowdown control is essential for all aspects of boiler water treatment.

THEREFORE THE CHEMICAL SPECIALIST IS VITALLY INTERESTED IN PROPER BLOWDOWN PROCEDURES.

WHAT DO THE CHEMICAL COMPANIES SAY?

(extract from a boiler water treatment company info sheet)

The main purpose of blowdown is to maintain the solids content of the boiler water within prescribed limits. This would be under normal steaming conditions. However, in the event contamination is introduced in the boiler, high continuous and manual blowdown rates are used to reduce the contamination as quickly as possible.

Bottom Blowdown

By definition, bottom blowdown is intermittent and designed to remove sludge from the areas of the boiler where it settles. The frequency of bottom blowdown is a function of experience and plant operation. Bottom blowdown can be accomplished manually or electronically using automatic blowdown controllers.

Continuous Blowdown

Frequently used in conjunction with manual blowdown, continuous blowdown constantly removes concentrated water from the boiler. By design, it is in the area of highest boiler water concentration. This point is determined by the design of the boiler and is generally the area of greatest steam release. With modern boilers having high circulation, this point can be practically anywhere.

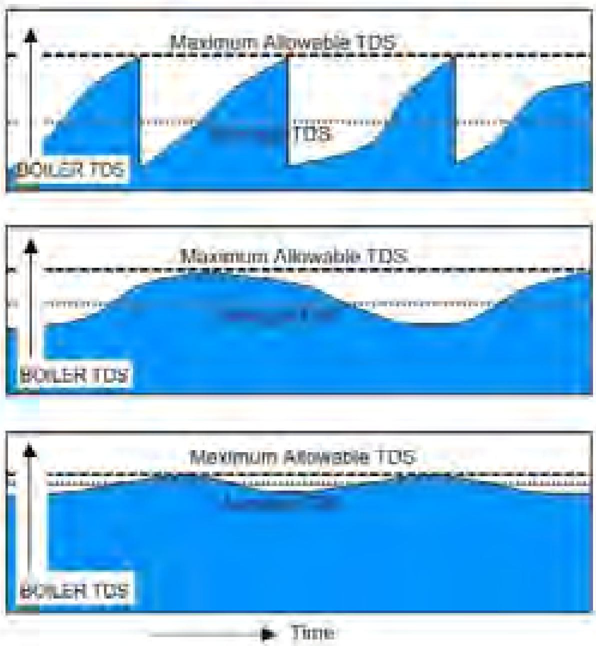
Continuous blowdown allows for excellent control over boiler water solids. In addition, it can remove significant levels of suspended solids. Another advantage is that the continuous blowdown can be passed through heat recovery equipment.

TDS CONTROL - THE CASE FOR AUTOMATIC CONTINUOUS BLOWDOWN

ONLY INTERMITTENT BLOWDOWN
The boiler water TDS falls after each blowdown, then gradually increases over time. The average TDS is therefore well below the maximum TDS allowable, consequently wasting heat and water.

MANUAL CONTINUOUS BLOWDOWN
The constant blowdown rate keeps the average TDS much closer to the maximum. However, TDS still varies in line with changing operating conditions and boiler load variations.

AUTOMATIC CONTINUOUS BLOWDOWN
Operating changes can be compensated for by continuously measuring boiler TDS and controlling the blowdown rate. The average TDS is now practically identical to the maximum allowable, and the amount of blowdown is reduced to the minimum.



CALCULATION OF CONTINUOUS BLOWDOWN RATE

Continuous blowdown and automatic TDS control ensures:

Least amount of heat loss.

Least amount of treated water loss.

Stable chemistry inside boiler.

No upsets due to foaming or carry-over.

Heat recovery can be considered.

Blowdown rate = (F / B – F) x Steam Rate

F = TDS feedwater   B = TDS boiler water

TDS feedwater is the sum of TDS make-up water, percentage of condensate return and TDS due to treatment chemicals.

TDS boiler water is the desired maximum TDS in the boiler.

SAVINGS DUE TO AUTOMATIC TDS CONTROL

Example for **5 t/h, 10 bar** watertube boiler, **6000 hours/year**, cost of fuel **$ 10/GJ**, cost of treated feedwater **$ 2/kL**:

Blowdown water heat content = 782 kJ/kg at 10 barg (sensible heat boiler water).

TDS of feedwater = **150 ppm**

Max. allowable TDS = **2500 ppm**

Actual average TDS with intermittent blowdown to ensure the max. allowed TDS is not exceeded = **1500 ppm**

Blowdown rate = F/B-F x 5000 kg/h

For **intermittent** blowdown = 150/1500-150 x 5000 kg/h = **555 kg/h**

Heat loss = 555 kg/h x 782 kJ/kg = 0.43 GJ/h x $ 10/GJ x 6000 h/y

Heat loss cost = $ 25,800/year

For **continuous** blowdown = 150/2500-150 x 5000 kg/h = **319 kg/h**

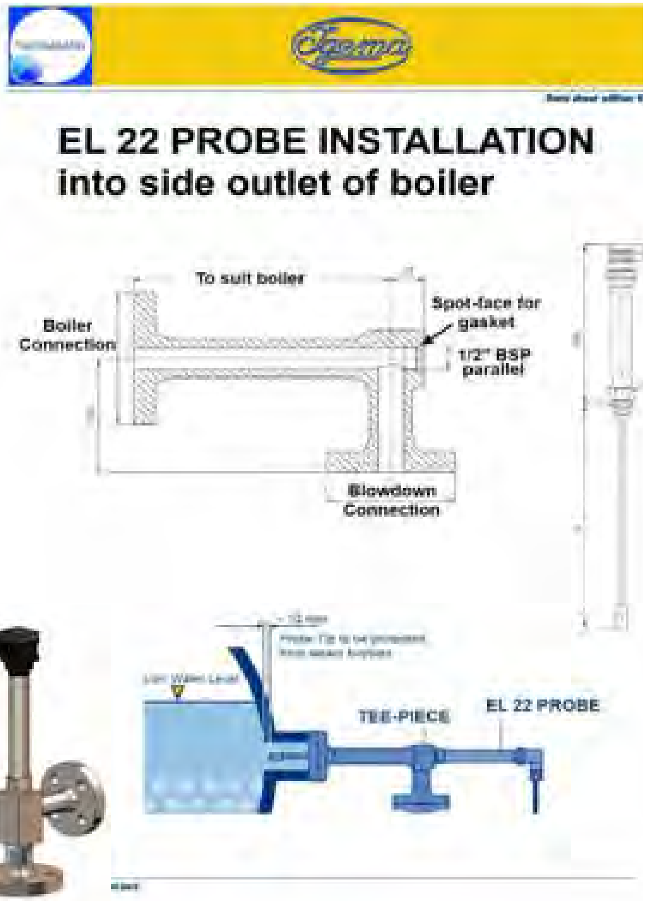
Heat loss = 319 kg/h x 782 kJ/kg = 0.25 GJ/h x $ 10/GJ x 6000 h/y

Heat loss cost = $ 15,000/year

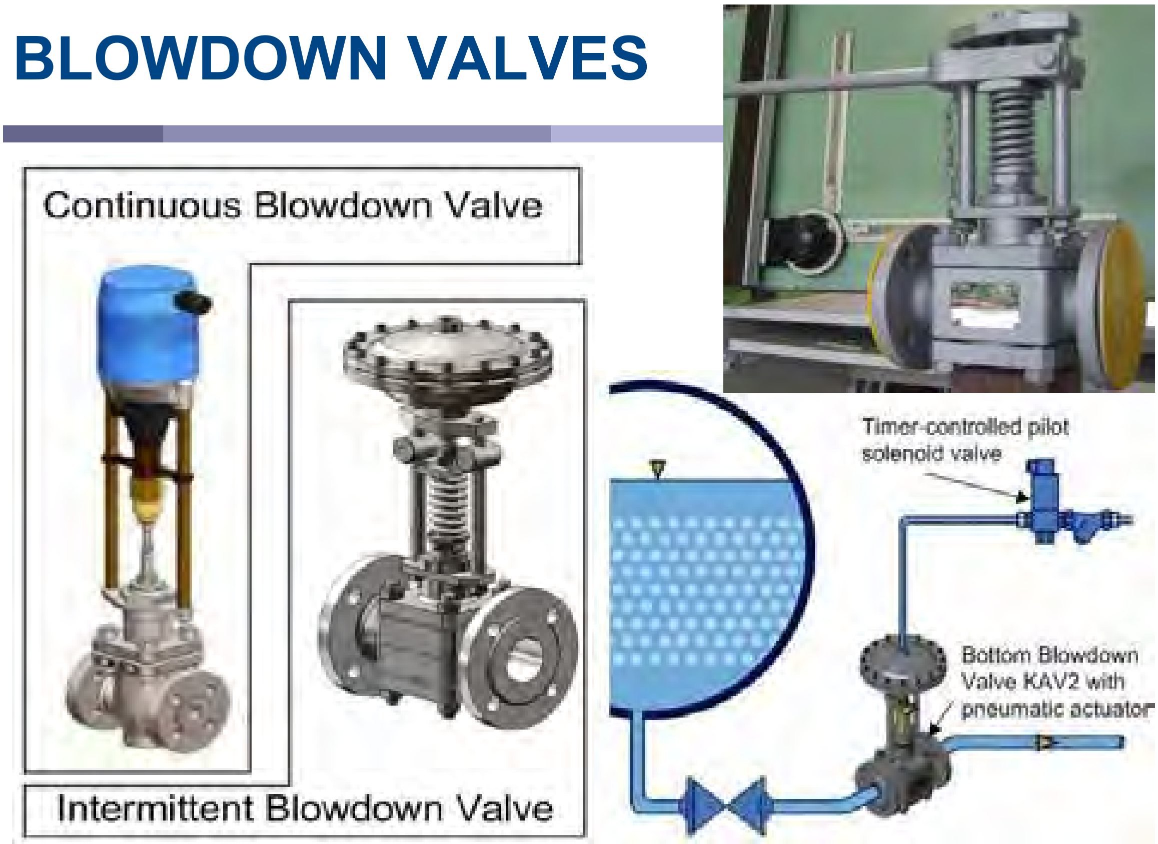
SAVING DUE TO AUTO. BLOWDOWN = $ 10,800 /YEAR

There is also a saving of treated water cost of 1416 kL/y = $ 2,832/YEAR

AUTOMATIC TDS CONTROL SYSTEM



BLOWDOWN VALVES



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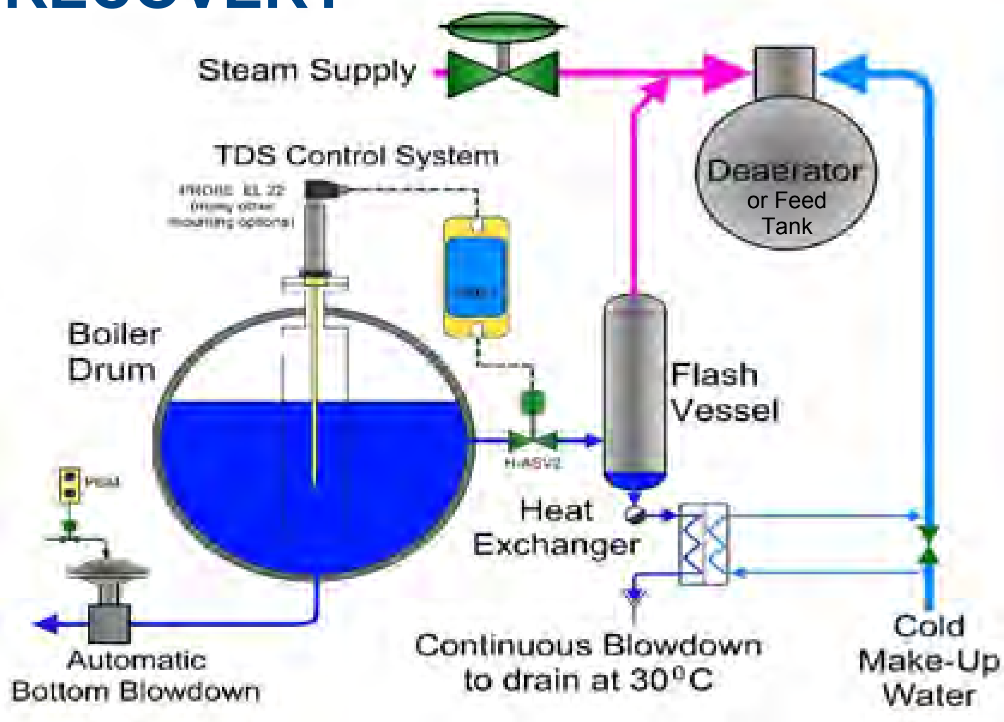
CONTINUOUS BLOWDOWN HEAT RECOVERY



SAVINGS DUE TO FLASH STEAM RECOVERY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel$ 10/GJ:

Flash Steam = Blowdown flow 319 kg/h x (h_{f1} – h_{f2} / h_{fg2})

Sensible heat water before expansion h_{f1} = 782 kJ/kg at 10 barg.

Sensible heat water after expansion h_{f2} = 419 kJ/kg at 0 barg.

Latent heat steam after expansion h_{fg2} = 2257 kJ/kg at 0 barg.

Sensible heat make-up water h_{f3} = 104 kJ/kg at 25° C.

Flash steam= 319 kg/h x (782–419/2257) = 51.3 kg/h x 2257 kJ/kg= 0.116 GJ/h saved

Sensible heat recovery due to flash steam condensation in feed tank:

Flash steam x (h_{f2} – h_{f3}) = 51.3 kg/h x (419-104) = 0.016 GJ/h saved

SAVINGS DUE TO FLASH STEAM RECOVERY:

0.116 + 0.016 GJ/h x $ 10/GJ x 6000 h/y = $ 7920/year

In addition, 308 kL / year of treated water is saved due to flash steam condensing in feed tank or deaerator = $ 616/year.

SAVINGS DUE TO RESIDUAL BLOWDOWN RECOVERY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel $ 10/GJ:

Residual Blowdown = Blowdown 319 kg/h – Flash Steam 51.3 kg/h = 267.7 kg/h

Residual Blowdown Recovery = 267.7 kg/h x Δt x spec. heat of water

Δt = 100 – 25 = 75° C, spec. heat of water = 4.19 kJ/kg°C

= 267.7 kg/h x 75°C x 4.19 kJ/kg°C = 0.084 GJ/h saved

Residual Blowdown Recovery through Plate Heat Exchanger

= 0.084 x $ 10/GJ x 6000 h/y = $ 5040/year

AUTOMATIC TDS CONTROL & HEAT RECOVERY SUMMARY

Example for 5 t/h, 10 bar watertube boiler, 6000 hours/year,
cost of fuel $ 10/GJ, cost of treated feedwater $ 2/kL:

FUEL COST SAVINGS

DUE TO AUTO. BLOWDOWN	= $ 10,800 /year
DUE TO FLASH STEAM	= $ 7,920/year
DUE TO RESIDUAL BLOWDOWN	= $ 5,040/year
	SUB-TOTAL = $ 23,760/YEAR

WATER COST SAVINGS

DUE TO LOWER BLOWDOWN RATE WITH AUTOMATIC TDS CONTROL	= $ 2,832/year
DUE TO FLASH STEAM CON-DENSING IN FEED TANK	= $ 616/year
	SUB-TOTAL = $ 3,448/YEAR

TOTAL SAVINGS $ 27,208/YEAR

Equipment cost including installation ~ $ 20,000
Simple pay-back period ~ 7.5 months

BLOWDOWN HEAT RECOVERY EQUIPMENT

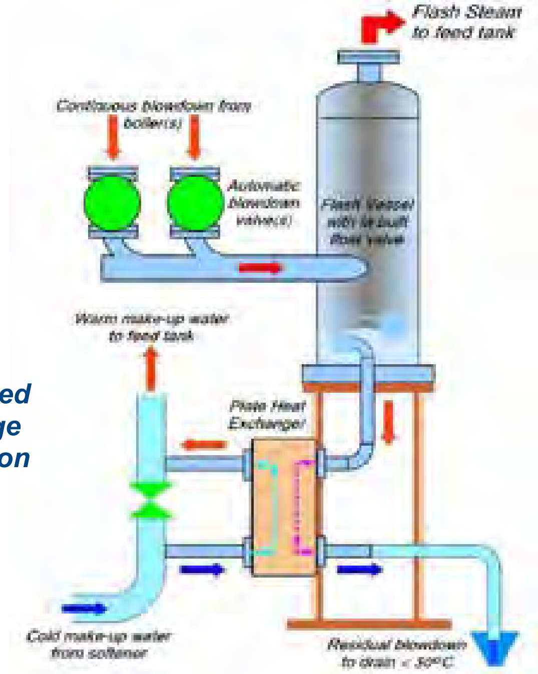
Flash Vessel

Plate Heat Exchanger

Float Trap

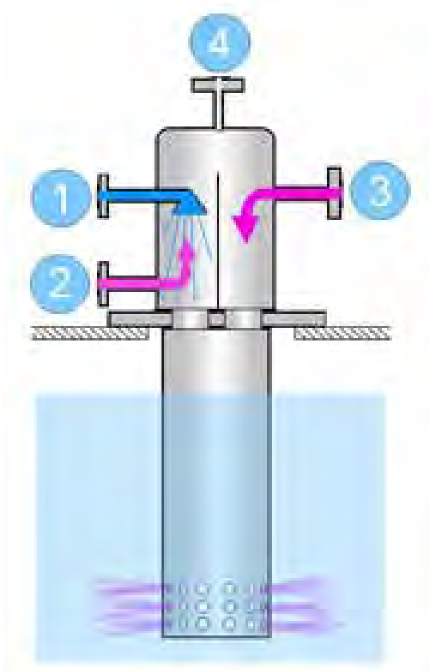
INTEGRATION into boiler house

Any number of boilers can be connected to a single flash vessel



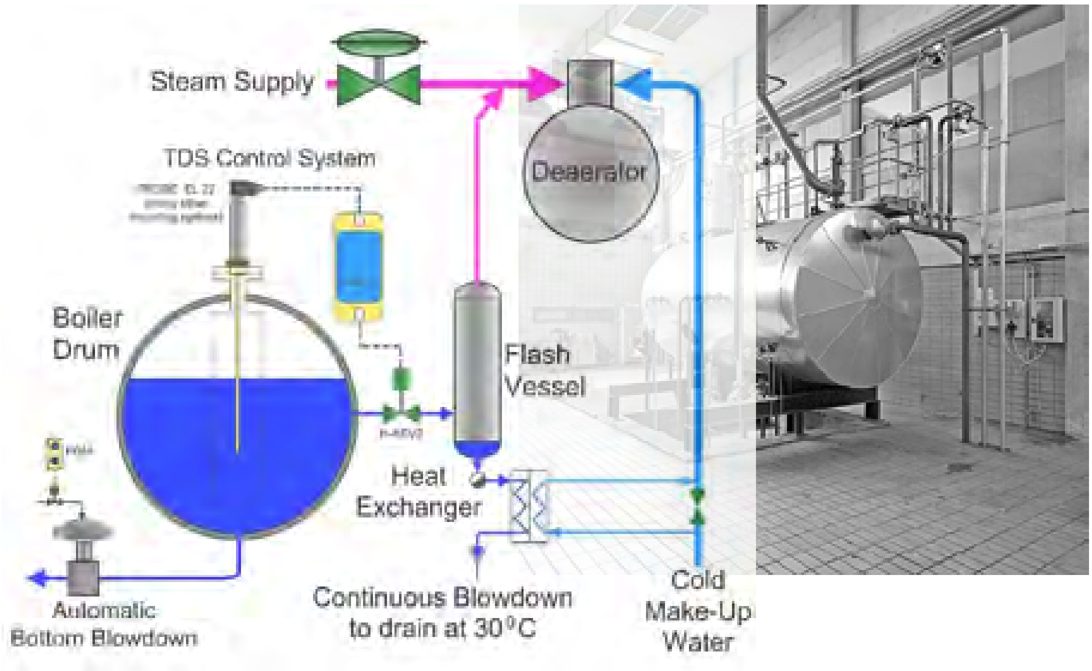
System can be supplied as a pre-piped package for easy site installation

INTEGRATION WITH FEED TANK



Flash steam needs to be diffused into feed tank to prevent large steam bubbles from escaping via the atmospheric vent

INTEGRATION WITH DEAERATOR



ecoFLUE

MODULAR FLUE GAS HEAT RECOVERY

for Steam Boilers, Hot Water Heaters and Dryers

Without flue gas heat recovery, about 20% of the natural gas input to boilers, dryers etc. is wasted through the flue to atmosphere. This presents an excellent opportunity for significant fuel cost and energy savings, as well as reducing the carbon footprint of the facility.

The ***ecoFLUE*** creates hot water from otherwise wasted flue gas heat, up to about 85 ^{0}C.

Modular design of the ***ecoFLUE*** matches the available heat recovery to the available cool water heat sink.

A single module is suitable for a nominal boiler capacity of 100 kW. Additional modules are simply stacked together for larger boiler or dryer capacities.

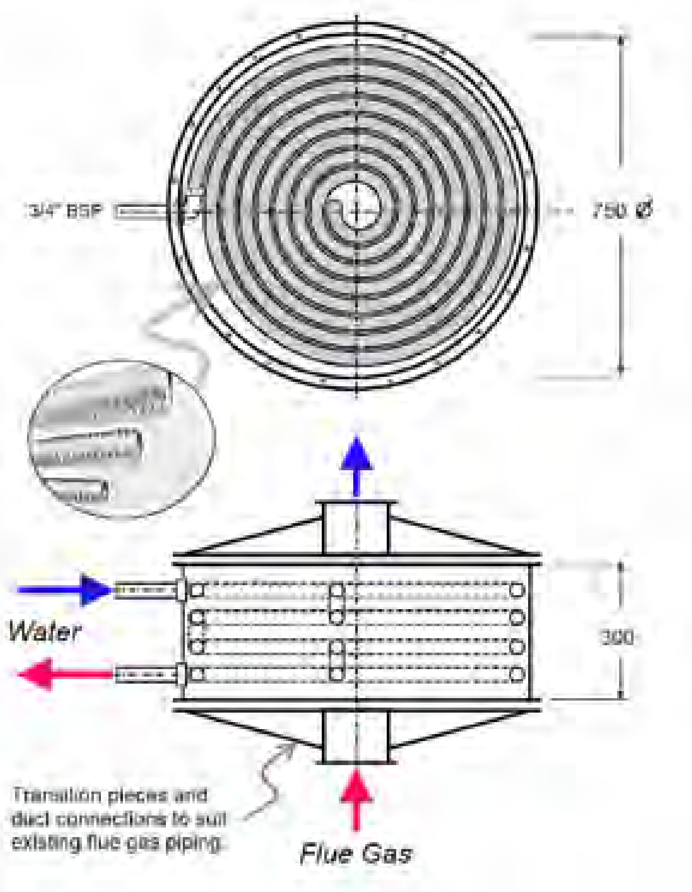
The heart of the ***ecoFLUE*** is a multi-tiered spiral coil of flexible stainless steel tubing, which is inherently suitable for absorbing thermal expansion and contraction.

Corrugated flexible tubing has approx. twice the surface area of plain pipe, which, together with the spiral geometry, translates into a very compact heat exchanger.

Conventional finned tube economiser coils use dissimilar metals for fins and tubes, which are subject to corrosion and mechanical issues. Flexible tubes for our spiral coils are 304 or 316 stainless steel.

The shell of the ***ecoFLUE*** is also 304 stainless steel, therefore the entire unit can withstand the corrosive nature of flue gas condensate.

If a sufficiently large heat sink is available in the form of cold water <30 ^{0}C, we strongly recommend using the ***ecoFLUE*** as a flue gas condenser, since a large proportion of energy in the flue gas is in the form of latent heat.



Test pressure for the flexible stainless steel tubing is 1500 kPag (215 psig).
Burst pressure is 20 000 kPag (2900 psig).
However, the recommended relief valve setting is 400 kPag (60 psig) to ensure long life under the most arduous conditions.
The flue gas temperature limit for the standard ***ecoFLUE*** is 300 ^{0}C.

For condensing applications, a 2-zone recovery system is usually most efficient, to generate hot water at say 50 and 85 ^{0}C.

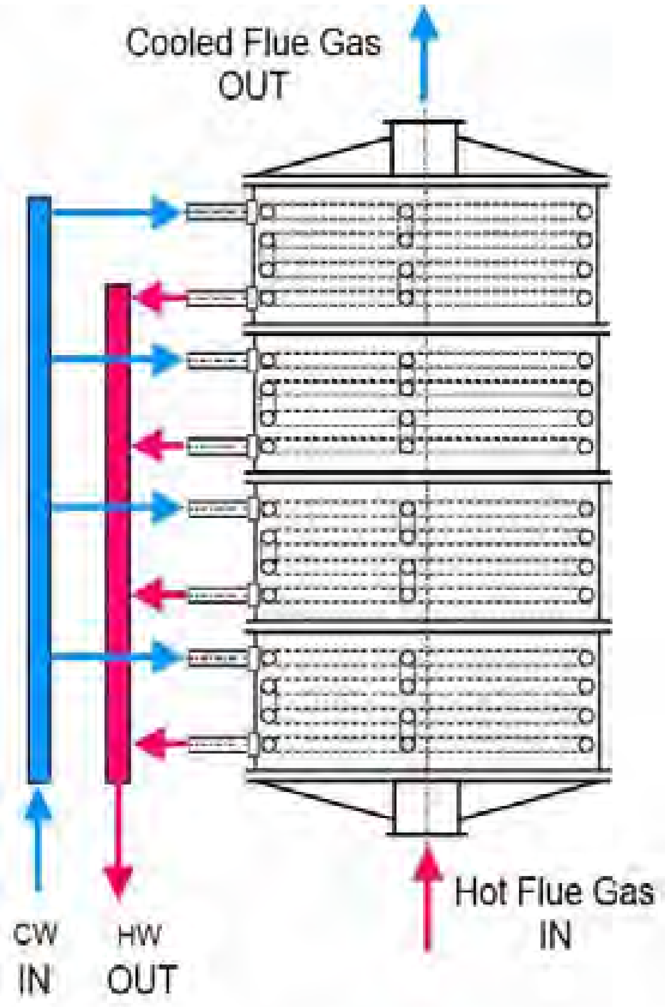
In many situations, the hot water outlet from the ***ecoFLUE*** is directed to an insulated buffer storage tank, especially when the boiler is on/off controlled.

To prevent a steam pressure from being generated inside the ***ecoFLUE*** coils, a pressure relief valve is required at the hot water outlet.

Many control options are possible to integrate the ***ecoFLUE*** into an existing boiler system.

The ***ecoFLUE*** is suitable for use with most forced draft burners which can tolerate an additional pressure drop of < 75 Pa (0.3" H_2O).

A draft inducer is available for installations with atmospheric burners.



Stacked heat exchanger sections shown connected in parallel. Connection in series is also possible.

The straightforward layout and compact size of the ***ecoFLUE*** makes installation an easy task.

Essentially, the ***ecoFLUE*** replaces a short length of flue duct.

Installation can be into either vertical, horizontal or inclined flue ducts.

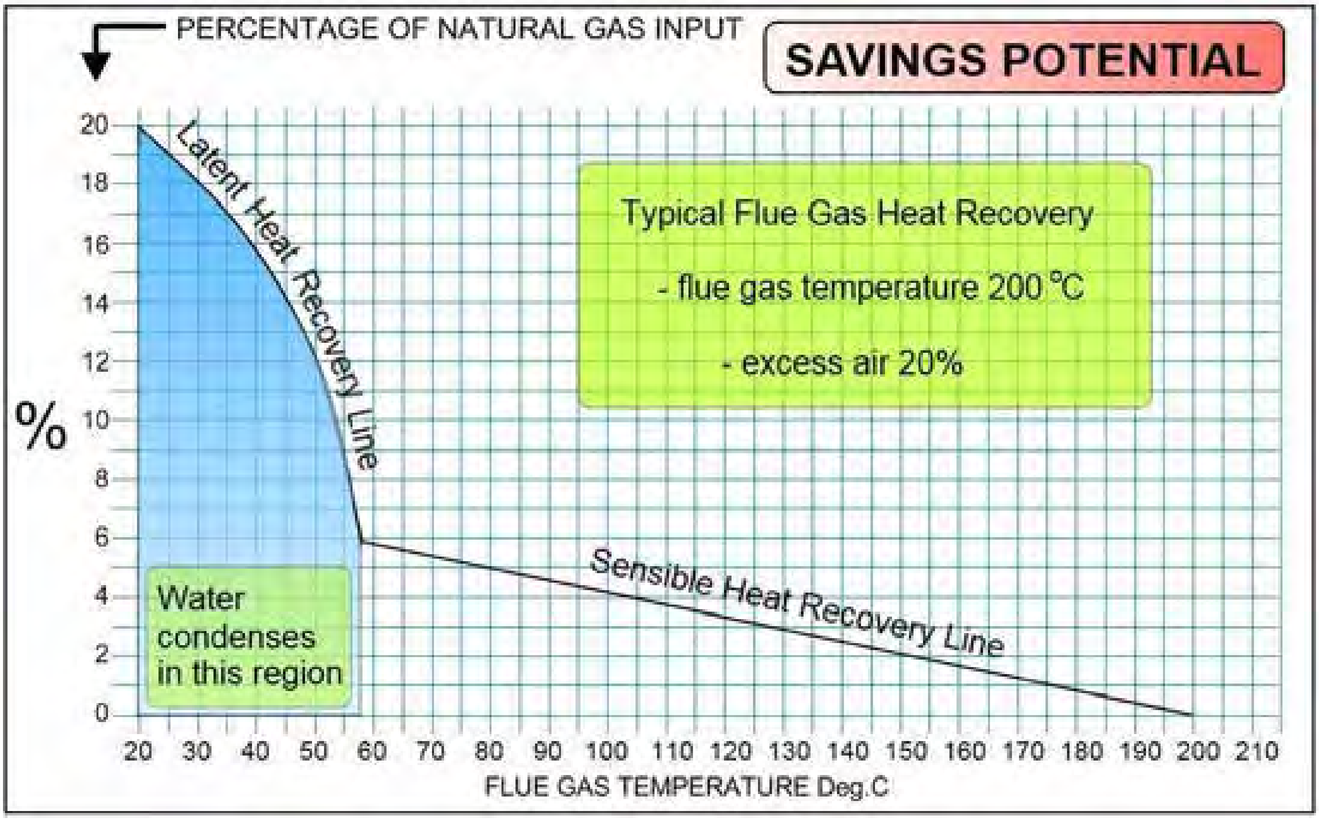
The actual flue connections are tailored to suit each individual plant.

Larger ***ecoFLUE*** units than the standard 100 kW modules can be provided to special order.

CONTACT US TO CHECK OUT THE FUEL COST SAVINGS FOR YOUR PLANT TODAY!

The following graph illustrates the savings potential for heat recovery from the ***ecoFLUE***.

Flue gas (at 200 ^{0}C for this example) flows through the ***ecoFLUE***, and cool water flows through the heat exchange coils, absorbing heat from flue gas. Until the flue gas temperature reaches about 57 ^{0}C, this heat reduction follows the straight inclined line of the graph. This represents Sensible Heat recovery.



At about 57 ^{0}C the water vapour dewpoint is reached, and water will now start to condense out of the flue gas. The heat of condensation (Latent Heat) which had to be added in the boiler is now released.

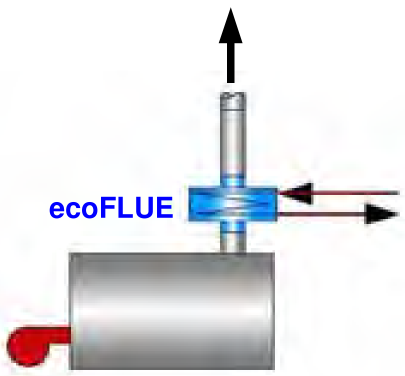
The start of condensation can be observed by the sharp rise in the Latent Heat Recovery Line. It can also be seen that just a small reduction of flue gas temperature in the condensing region results in a significant increase in heat recovery potential.

For this reason the coldest water available in your plant should be used as the heat sink for flue gas heat recovery.

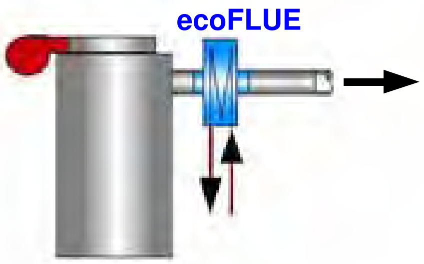
Effectively, the ecoFLUE converts any boiler into a modern condensing boiler.

Contact us for a heat recovery graph and energy savings calculation for your particular installation.

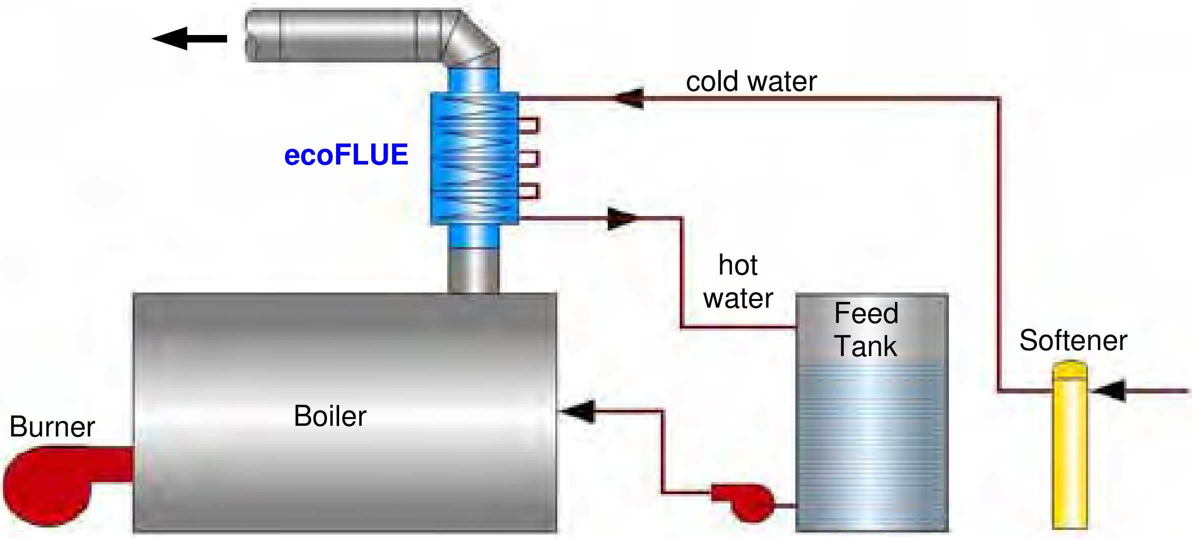
INSTALLATION OPTION



Installation in vertical flue



Installation in horizontal flue



Installation on 400 kW boiler for feedwater pre-heating