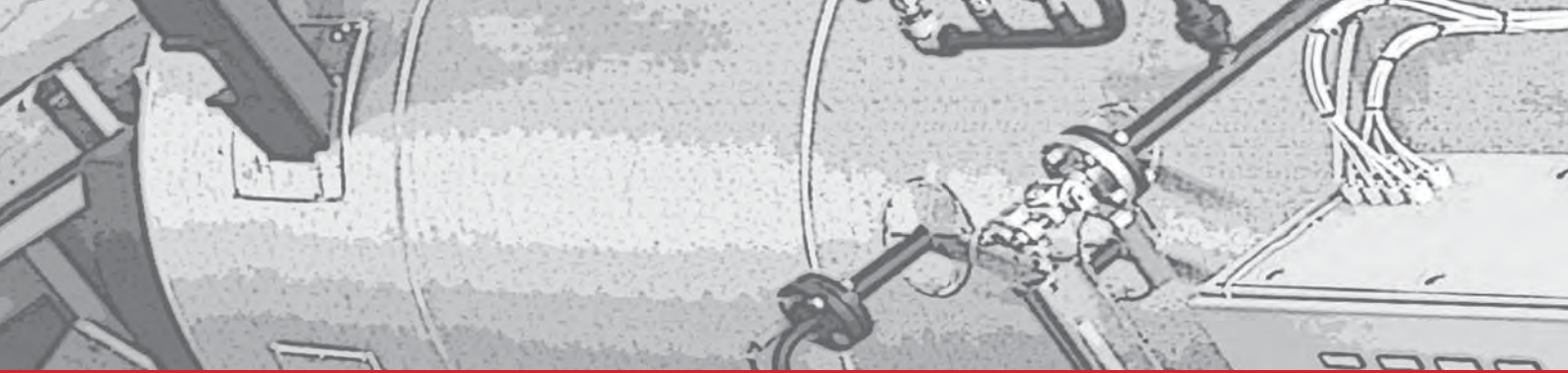


Technical Book

Steam Generators UM

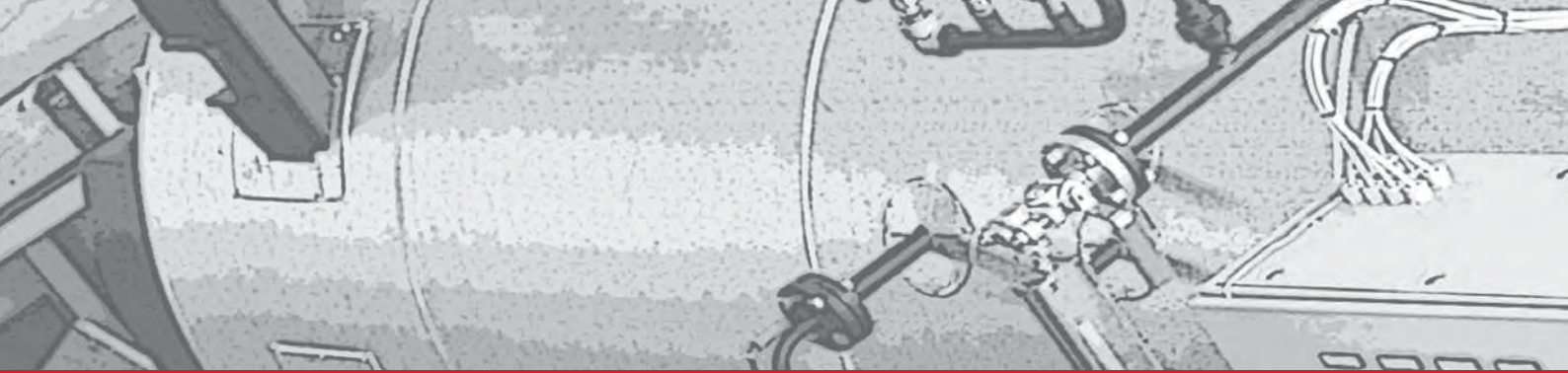




FLASH COIL STEAM GENERATORS **UNI-MATIC**

- 1. General Information**
- 2. Competitive Advantages**
- 3. Technical Specifications**
- 4. P&ID**
- 5. Dimensions and Connections**
- 6. Generator Layout**
- 7. Installation**
- 8. Maintenance**
- 9. Scope of Supply**
- 10. Appendix 1. Fuel consumption calculation**
- 11. Appendix 2. Thermodynamic characteristics of saturated steam**





1. GENERAL INFORMATION

Flash coil steam generators of the series UNI-MATIC (UM) with forced circulation guarantee a steam production range between 300 and 3000 kg/h; design pressure is up to 12 bar.

Models of the steam generators series UNI-MATIC:

- **UM 30: up to** 300 kg/h
- **UM 50: up to** 500 kg/h
- **UM 100: up to** 1.000 kg/h
- **UM 150: up to** 1.500 kg/h
- **UM 200: up to** 2.000 kg/h
- **UM 300: up to** 3.000 kg/h

UM-UNIMATIC UM flash coil steam generators' fields of application are laundries, textile industry, food & beverage, rubber, cellulose industry, agrotechnology, woodworking and others.

UNI-MATIC UM generators are supplied as packaged units, complete with all necessary equipment and ready to be connected to site utilities.

As optional, an air preheater can be purchased additionally to the steam generator. Preheater enables the boiler to increase efficiency by 2%, therefore reaching 90% at full load.

UM model reaches operating conditions 2-3 minutes after ignition of the burner.

UNI-MATIC model UM is available both in vertical and horizontal version - UM compact design is also suitable for small plants, although always guaranteeing high quality performances.

UNI-MATIC UM generators are designed and produced according to ISPELS code, PED directive 97/23/CE



Figure 1
Flash Coil Steam Generator UNI-MATIC UM, vertical version with air pre-heater

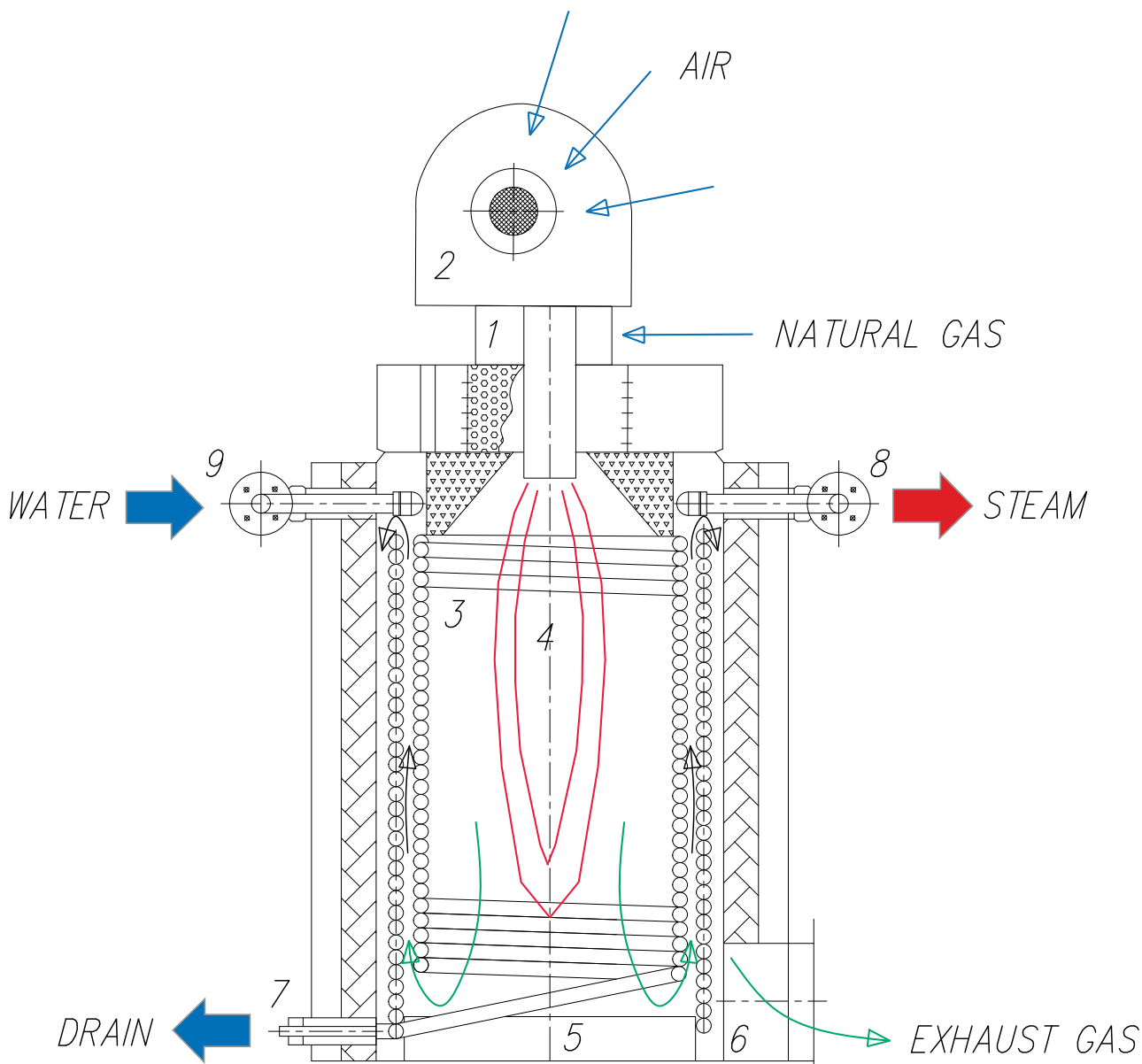


Figure 2
Flash Coil Steam Generator UNI-MATIC UM, horizontal version

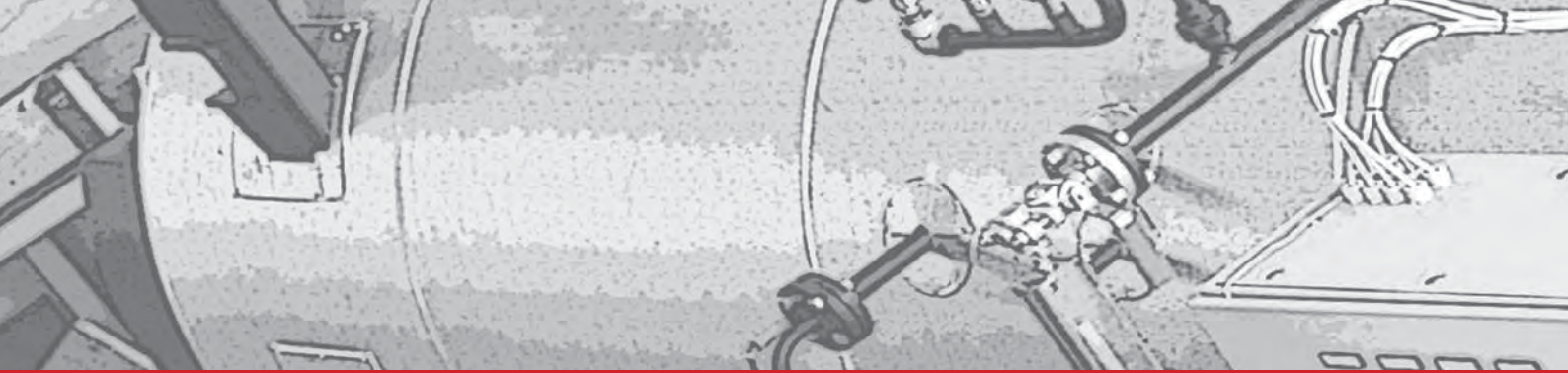


Figure 3

Flash coil steam Generator UNI-MATIC UM functional diagram



1	Burner	6	Exhaust Gas Outlet
2	Burner Fan	7	Drain
3	UNI-MATIC Inner Coil	8	Steam Outlet Flange
4	Burner Flame	9	Water Inlet Flange
5	Bottom Refractory		



2. COMPETITIVE ADVANTAGES

- **Two versions: vertical and horizontal**
- **Maximum efficiency and high reliability**
- **Easy maintenance.** The upper cover facilitates inspection and cleaning of the combustion chamber and the internal parts of the steam generator.
- **Fast to reach operating conditions.** Thanks to the absence of thermal inertia, UNI-MATIC UM steam generator is highly efficient in periodic processes. It takes 2÷3 minutes to reach operating condition after burner ignition.
- **High reliable supply of feeding water.** Feeding pump flow sections are made of **Kevlar**, a syntetic composite material which guarantees maximum reliability and efficient supply of feeding water.
- **Easy-to-use and reliable automatic combustion regulation with the following regulating types:**
 - **“on/off” regulation** of gas fuel feeding to the burner, burner air vent and feeding water pump. Liquid fuel supply to burner nozzle is achieved through electromagnetic opening/closing valve.
 - **two-stages regulation** (1st stage - min. 50%, 2nd stage - 100%), through regulation of the amount of air and gas in the combustion chamber, regulation of feed water supply with two-position valves on the fuel, air and water lines combined with on/off regime of water and gas supply. Liquid fuel supply to burner’s nozzle is achieved through an opening/closing valve.
 - **modulating regulation** of steam production with 30-100% range, achieved with an electronic control of air and fuel supply and servocontrolled valves. Feeding water supply is regulated through plunger pump with frequency transformer. Liquid fuel oil supply to burner’s nozzle is achieved through opening/closing electromagnetic valve with fuel pressure regulation through a bypass valve.
- **Safety.** The quantity of water, and thus steam, is limited, allowing therefore a high level of safety for personnel if compared to standard steam boilers types.



Figure 4
Safety and control instruments on an horizontal UNI-MATIC UM steam generator.



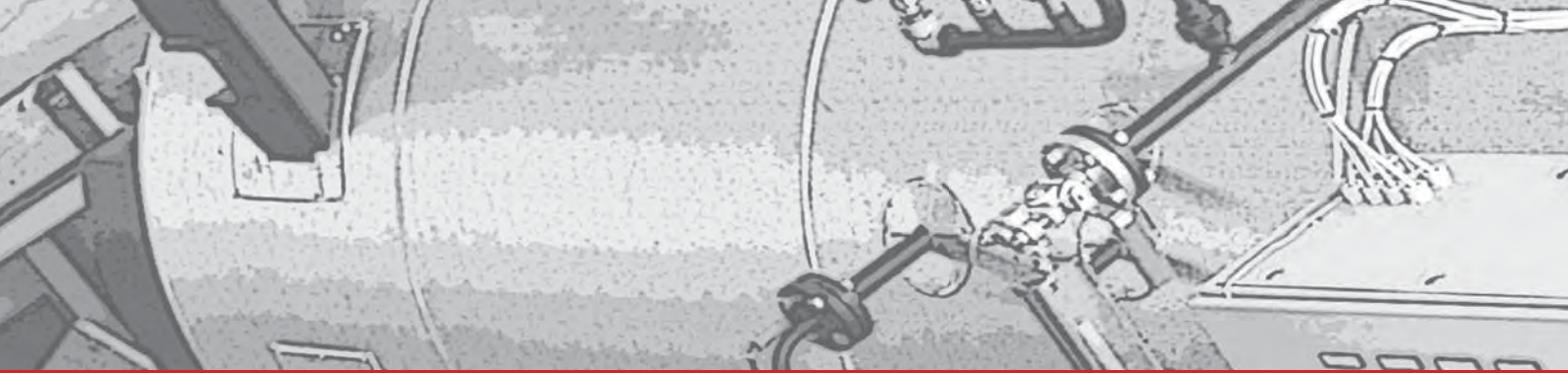
Figure 5
Control panel for UNI-MATIC UM steam generator.

3. TECHNICAL SPECIFICATIONS - CAPACITY AND CONSUMPTION

Table 1
Technical Specifications of steam generator UNI-MATIC UM.*

UNIMATIC - TECHNICAL DATASHEET							
Features	Unit	UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
Steam production	Kg/h	300	500	1.000	1.500	2.000	3.000
Design pressure	bar	11,7	11,7	11,7	11,7	11,7	11,0
Max working pressure	bar	10.0	10.0	10.0	10.0	10.0	9.0
TOTAL ELECTRIC POWER							
Heavy fuel oil	KW	4,3	5,3	9,6	12,9	16,0	24,0
Natural gas or diesel oil	KW	2,3	2,3	4,6	5,9	7,0	12,0
FUEL CONSUMPTION AT 100% OF THE LOAD							
Heavy fuel oil	Kg/h	21,1	35,1	70,3	105,4	140,6	210,9
Natural gas	Nm ³ /h	24,1	40,1	80,2	120,3	160,4	240,6
Diesel oil	kg/h	20,1	33,4	66,8	100,3	133,7	200,5
FUEL CALORIFIC POWER							
Heavy fuel oil	Kcal/kg	9.700					
Natural gas	Kcal/Nm ³	8.500					
Diesel oil	Kcal/kg	10.200					
Standard electric power data	380 V / 50 Hz / 3 phases with neutral						
Auxiliaries voltage	220 V						
Feeding and boiler water norm	EN 12952 - 12:2003 (up to European standard)						

* - These are generalized technical information for all UNI-MATIC range model.
Please ask for specific measures indications and eventual available modifications.



3. TECHNICAL SPECIFICATIONS - THERMAL EFFICIENCY

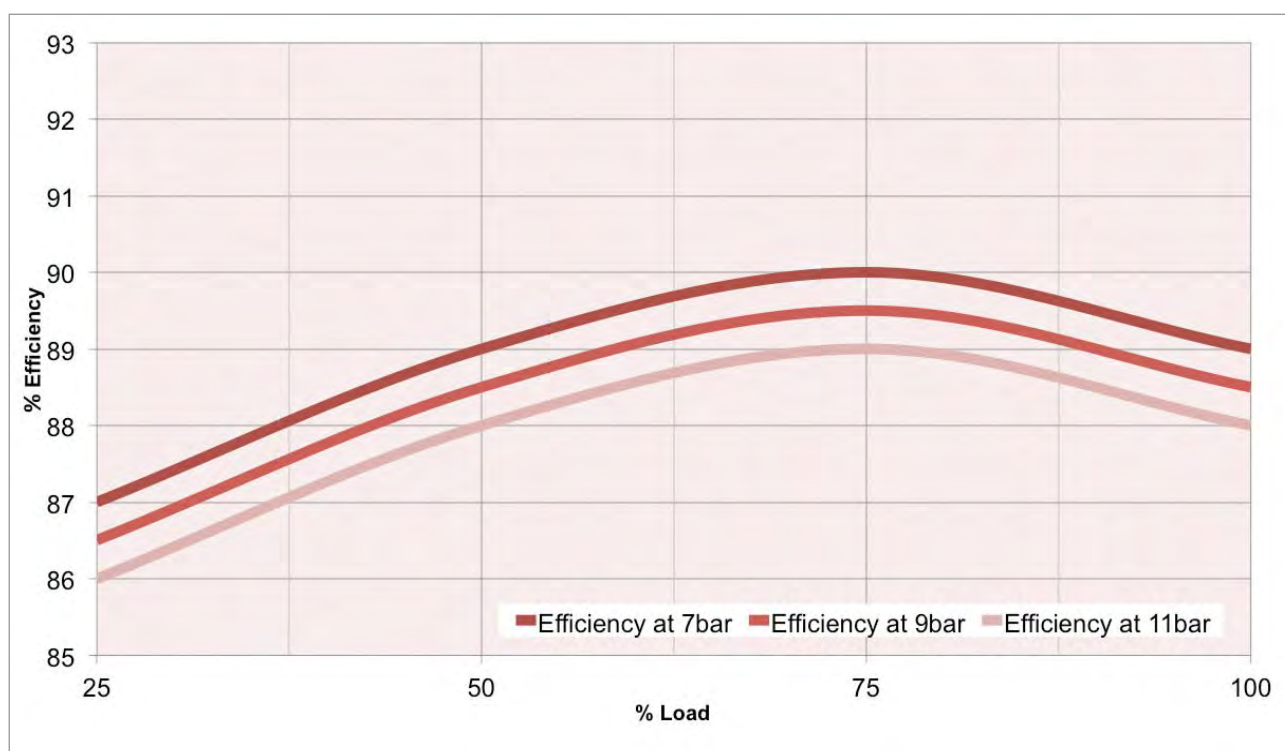


Figure 6

The coefficient of performance (COP) of the boiler UNI-MATIC UM crossed with the load, under different working pressures. Air preheater not included.

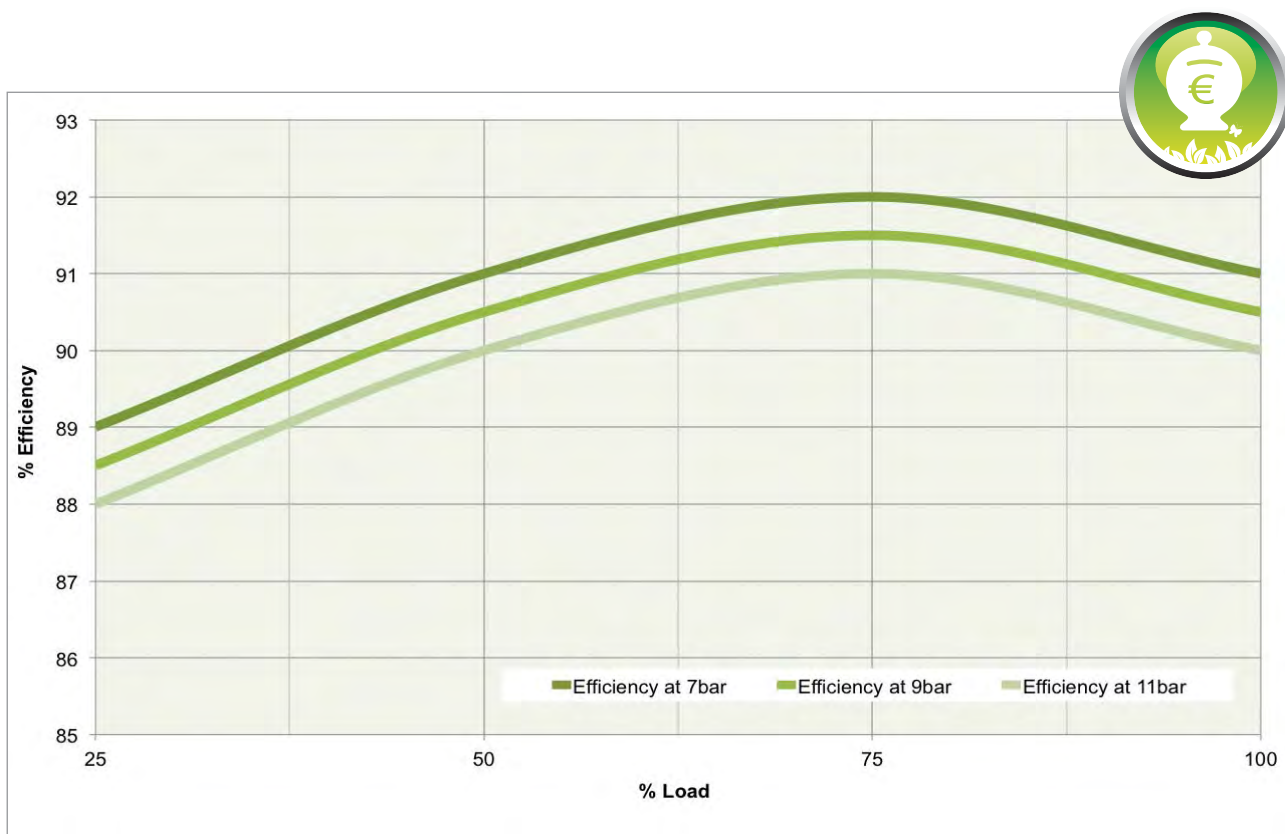
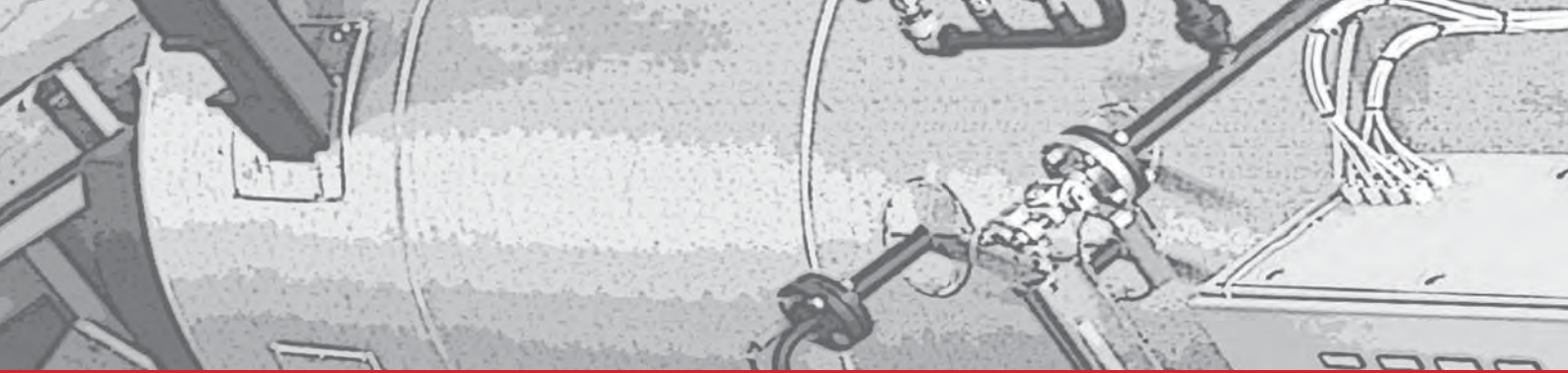


Figure 7

A plot of the coefficient of performance (COP) of the boiler UNI-MATIC UM with air preheater.



3. TECHNICAL SPECIFICATIONS - WATER SUPPLY REQUIREMENTS

The generator must be supplied with water with hardness less than 0.1° F made up of the condensation recovery and the make-up water softened by a purifier (cation resin) or demineralised. The water supply must always come from the supply tank; a direct connection to the mains water or to the purifier is not allowed.

The suction piping must be as straight as possible and its diameter must be larger than that of the connection on the pump (see connection diagram).

The supply water must be at a temperature of at least 70° C as lower temperatures cause deterioration in the generator coils.

If the water temperature is lower than the value indicated above the supply water must be heated.

The tank capacity must be adequate for the boiler capacity and normally at least the same as the consumption of an hour operation at maximum load. The tank must be fitted with a drainage tube with cock direct to the sewers for regular drainage and to

empty the tank for cleaning.

Water pump must not suck from the bottom of the tank but slightly higher to avoid the entry of impurities. If the **oxygen scavenger** is required please refer to the technical specifications of the product in use.

Table 2

Water supply specifications. In order to maintain its best performance the steam generator must be supplied with water conforming to the below specifications.

Total hardness	Less than 0,05 °F
pH	8.5-10.0
Alkalinity	Max 1000 ppm
Silicone (Si O ₂)	Max 100 ppm

Table 3

Minimum pressure / suction head for water. The tank must be raised up and have sufficient head for correct pump operation and to avoid phenomena of cavitation due to insufficient supply

Temperature °C	Had Height mH ₂ O	Pressure bar	Pressure MPa	Temperature °C	Liquid Column Height mH ₂ O	Pressure bar	Pressure MPa
0	0.00	0.00	0.00	50	1.25	0.12	0.012
5	0.00	0.00	0.00	55	1.75	0.17	0.017
10	0.00	0.00	0.00	60	2.00	0.20	0.02
15	0.20	0.02	0.002	65	2.50	0.25	0.025
20	0.20	0.02	0.002	70	3.00	0.29	0.029
25	0.25	0.02	0.002	75	4.00	0.39	0.039
30	0.50	0.05	0.005	80	5.00	0.49	0.049
35	0.80	0.08	0.008	85	6.00	0.59	0.059
40	0.90	0.09	0.009	90	7.00	0.69	0.069
45	1.00	0.10	0.01	95	9.00	0.88	0.088



Table 4

Feedwater Quality Requirements for best UNI-MATIC UM operation and preservation

PARAMETERS	UNIT	FEED WATER PROPERTIES ACCORDING TO EN 12953	
		0,5 < X < 20	X > 20
OPERATING PRESSURE (X)	bar (= 0,1 MPa)	0,5 < X < 20	X > 20
APPEARANCE	/	Clean, free from suspended solids	
DIRECT CONDUCTIVITY AT 25°C	µS/cm	Not specified	
pH VALUE AT 25 °C (a)	/	> 9,2 (b)	> 9,2 (b)
TOTAL HARDNESS (Ca + Mg)	mmol/l	< 0,01 (c)	< 0,01
IRON (Fe) CONCENTRATION	mg/l	< 0,3	< 0,1
COPPER (Cu) CONCENTRATION	mg/l	< 0,05	< 0,03
SILICA (SiO ₂) CONCENTRATION	mg/l	Not specified	
OXYGEN (O ₂) CONCENTRATION	mg/l	< 0,05 (d)	< 0,02
OIL/GREASE CONCENTRATION (see EN 12953-6)	mg/l	< 1	< 1
ORGANIC SUBSTANCES CONCENTRATION	/	See footnote (e)	

(a) with copper alloys in the system the pH value shall be maintained in the range be from 8.7 to 9.2

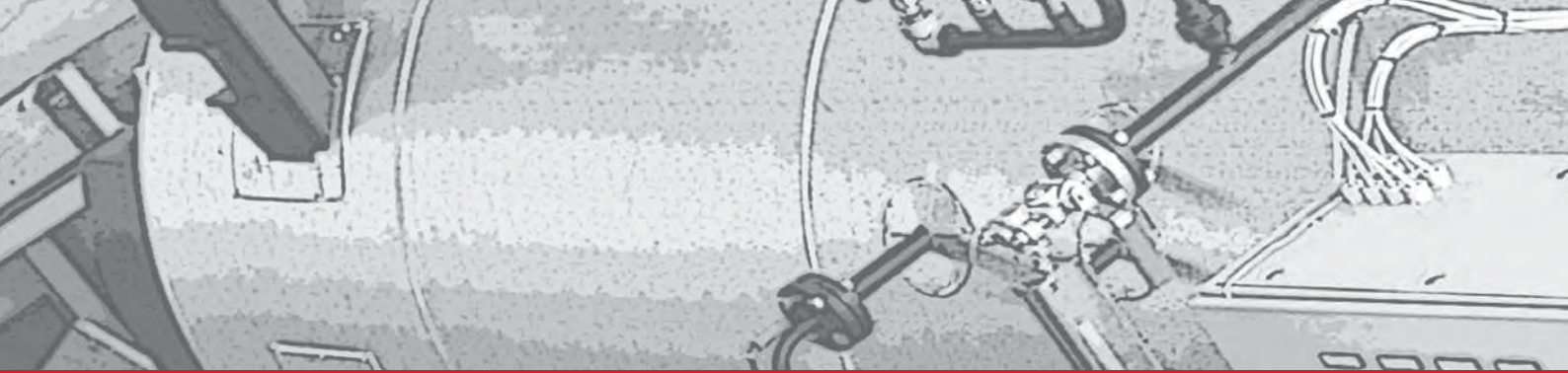
(b) with softened water pH value > 7.0 - see the manual of the boiler

(c) If the operating pressure is <1 bar, the max total acceptable hardness should be 0.05 mmol / l

(d) Instead of observing this value at intermitted operation or operation without deareator if forming agents and/or excess of oxygen scavenger shall be used.

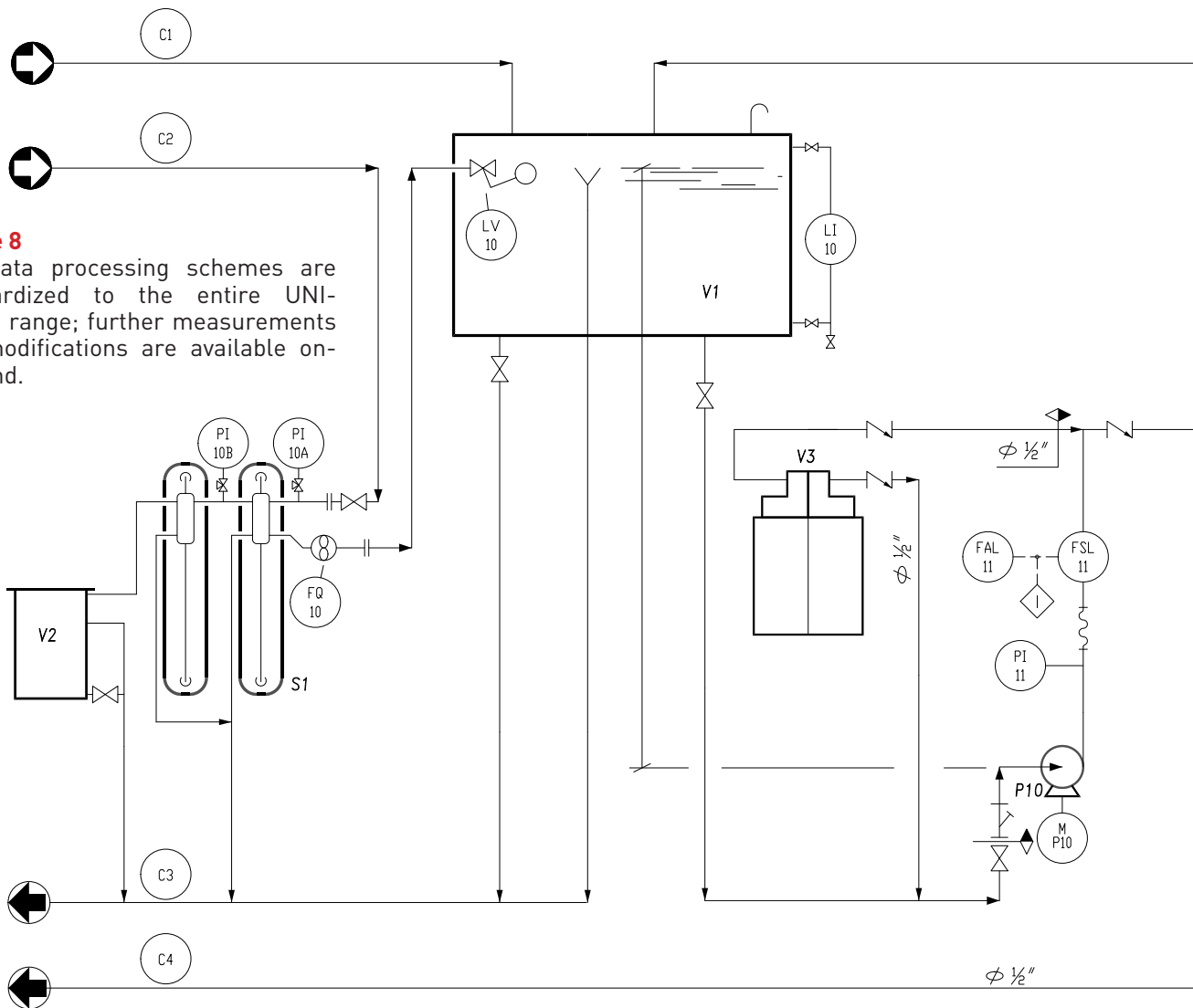
(e) Organic substances are generally a mixture of several different compounds. The composition of such mixtures and behaviour of their individual components under the conditions of boiler operation are difficult to predict.

Organic substances may be decomposed to form carbonic acid or other acidic decomposition products which increase the acid conductivity and cause corrosion or deposits. They also may lead to foaming and/or priming which shall be kept as low as possible.

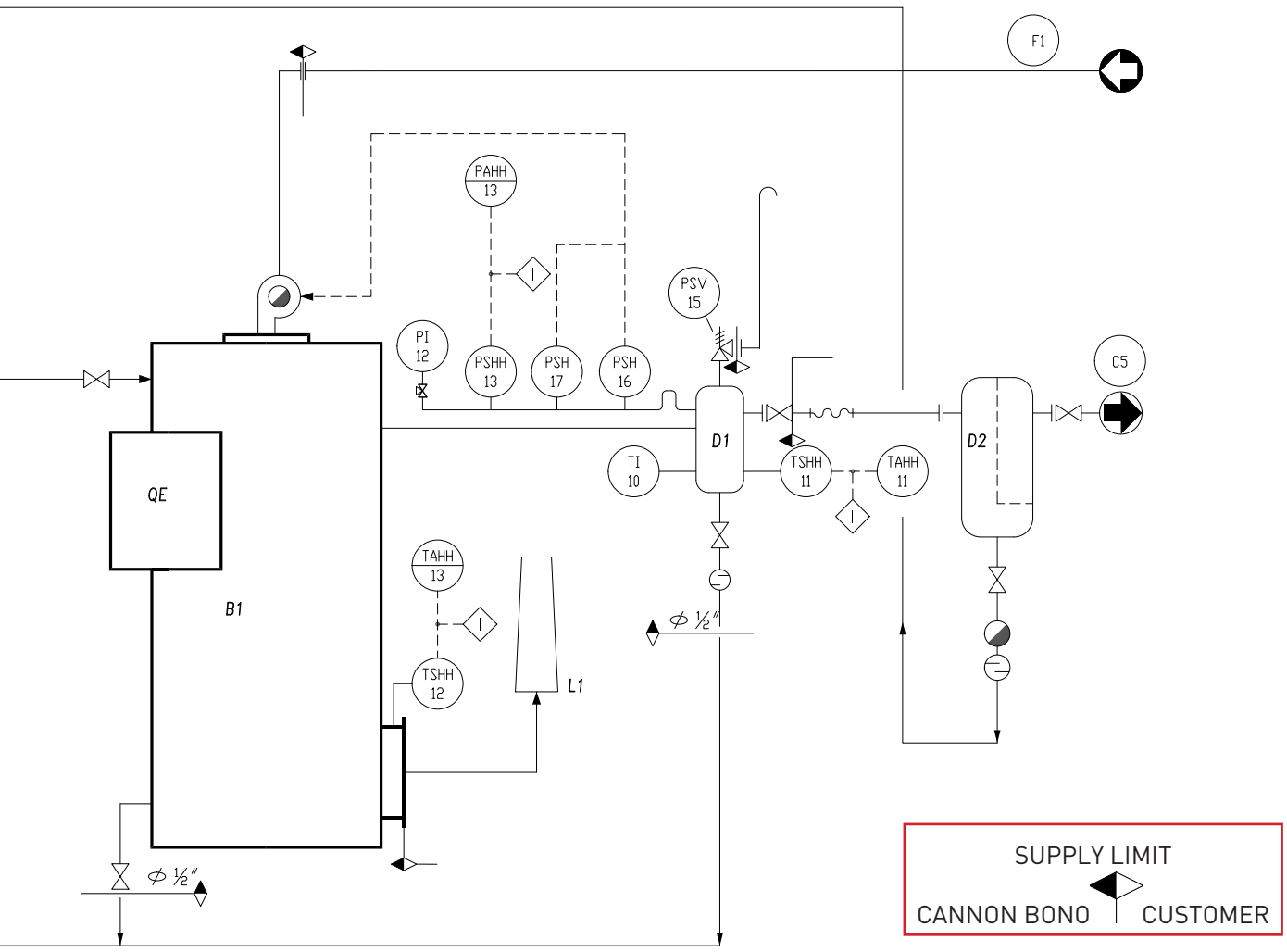


4. P&ID

Figure 8
The data processing schemes are standardized to the entire UNIMATIC range; further measurements and modifications are available on-demand.



UM - P&ID Elements Description					
B1	Steam Generator UM	S1	Water Softener	C3	Drain to Sewer Pipe
L1	Chimney	V1	Feed Water / Condensate Tank	C4	Drain to Hot Pit Pipe
QE	Electrical Cabinet	V2	Brine Tank	C5	Steam to User Pipe
D1	Instrument Header	V3	Chemical Dosing Station	F1	Feed Fuel Pipe
D2	Steam Separator	C1	Condensate Return Pipe		
P10	Feed Water Pump	C2	Feed Water Pipe		



UM - P&ID Ancillaries Symbols Meaning					
LV	Level Valve	M	Motor	TI	Temperature Indicator
LI	Level Indicator	PAH	Pressure Alarm High	TAH	Temperature Alarm High
PI	Pressure Indicator	PAHH	Pressure Alarm High Above PAH	TAHH	Temperature Alarm High Above TAH
FQ	Flow Indicator Totaliser	PSH	Pressure Switch High	TSH	Temperature Switch High
FAL	Flow Alarm Low	PSHH	Pressure Switch High Above PSH	TSHH	Temperature Switch High Above TSH
FSL	Minimum Flow Switch	PSV	Pressure Safety Valve		

5. DIMENSIONS AND CONNECTIONS

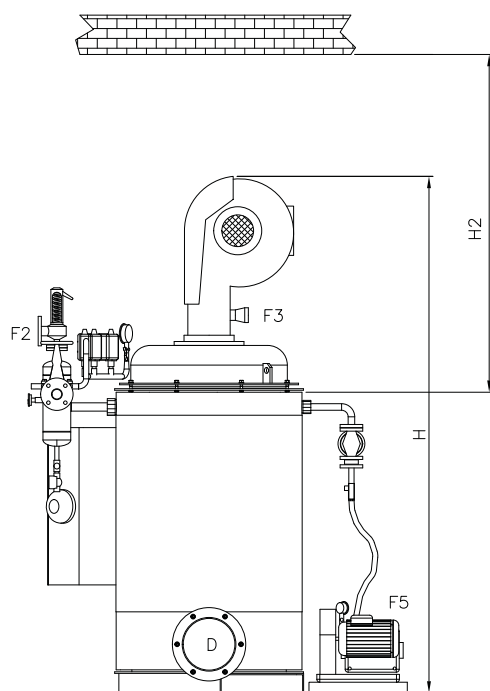


Figure 9

Steam generator UNI-MATIC UM vertical steam generator overall dimensions

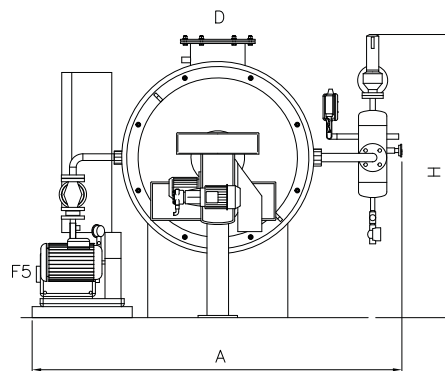
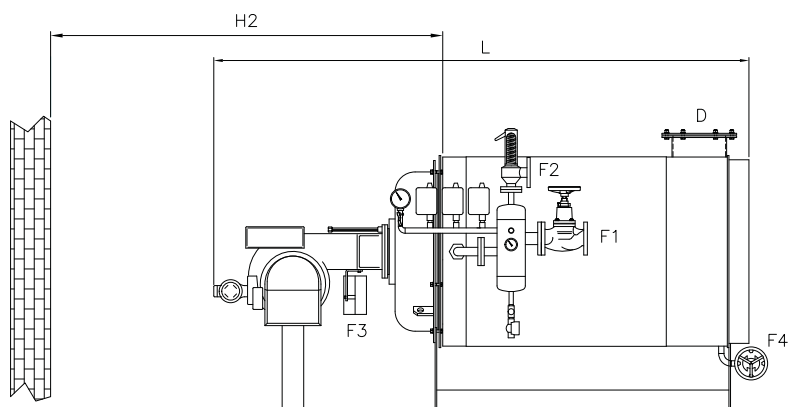
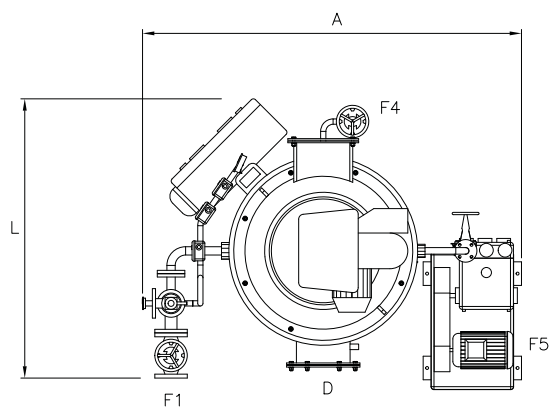


Figure 10

Steam generator UNI-MATIC UM Horizontal version steam generator overall dimensions

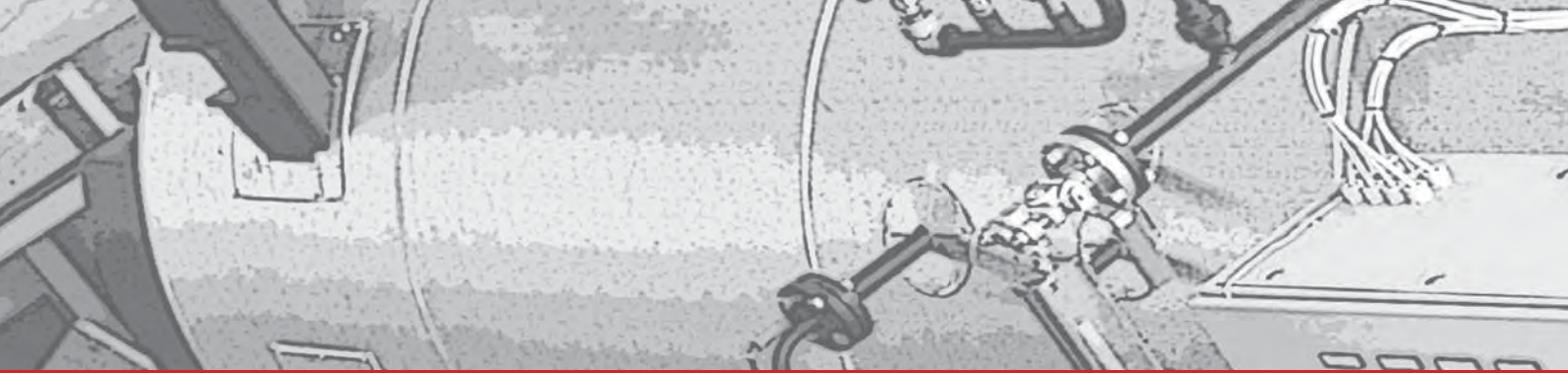


Table 5

Dimensions of flash coil steam generators UNI-MATIC UM. These dimensions are generalized to the entire range of models UNI-MATIC. Measurement and modification are available on-demand.

OVERALL DIMENSIONS AND CONNECTIONS OF STEAM GENERATORS UNI-MATIC UM								
MODEL			UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
VERTICAL VERSION DIMENSIONS								
L	Length	mm	1450	1550	1800	1900	2100	2700
A	Width	mm	1350	1350	1700	1700	1800	2000
H	Height	mm	2100	2100	2660	2750	3400	3750
HORIZONTAL VERSION DIMENSIONS								
L	Length	mm	2100	2100	2660	2750	3400	3750
A	Width	mm	1350	1350	1700	1700	1800	2415
H	Height	mm	1450	1550	1800	1900	2100	2385
GENERAL TECHNICAL DATA								
D	Stack connection	mm	125	162	263	314	346	400
F1	Steam outlet	DN	32	32	50	50	65	80
		PN	16	16	16	16	16	16
F2	Safety valve	DN	20/40	20/40	20/40	25/40	25/40	32/50
		PN	25/16	25/16	25/16	25/16	25/16	25/16
F3	Natural gas connection		1"G	1 ½"G	2"G	2"G	2"G	2 ½"G
F4	Coil drain outlet		½"G	½"G	½"G	½"G	½"G	½"G
F5	Feed water inlet		1 ¼"G	1 ¼"G	1 ¼"G	1 ½"G	1 ½"G	2"G
H2	Coil extraction distance	mm	1100	1300	1750	1950	2000	2700
Total volume		l	33	49	79	110	240	271
Pipes diameter		mm	33.7	33.7	33.7	33.7/38	33.7/51	38/51
Heating surface		m ²	6	8.8	14	18	32	34
Water capacity		l/h	345	575	1150	1750	2300	3300
Standard feeding water temperature		°C	70÷95*					
Empty weight		t	1.2	1.2	1.5	2.0	2.8	3.1

* - In case of feed water temperature above 70 °C, please contact Bono Energia technical specialists for pump flow section configuration



6. GENERATOR LAYOUT

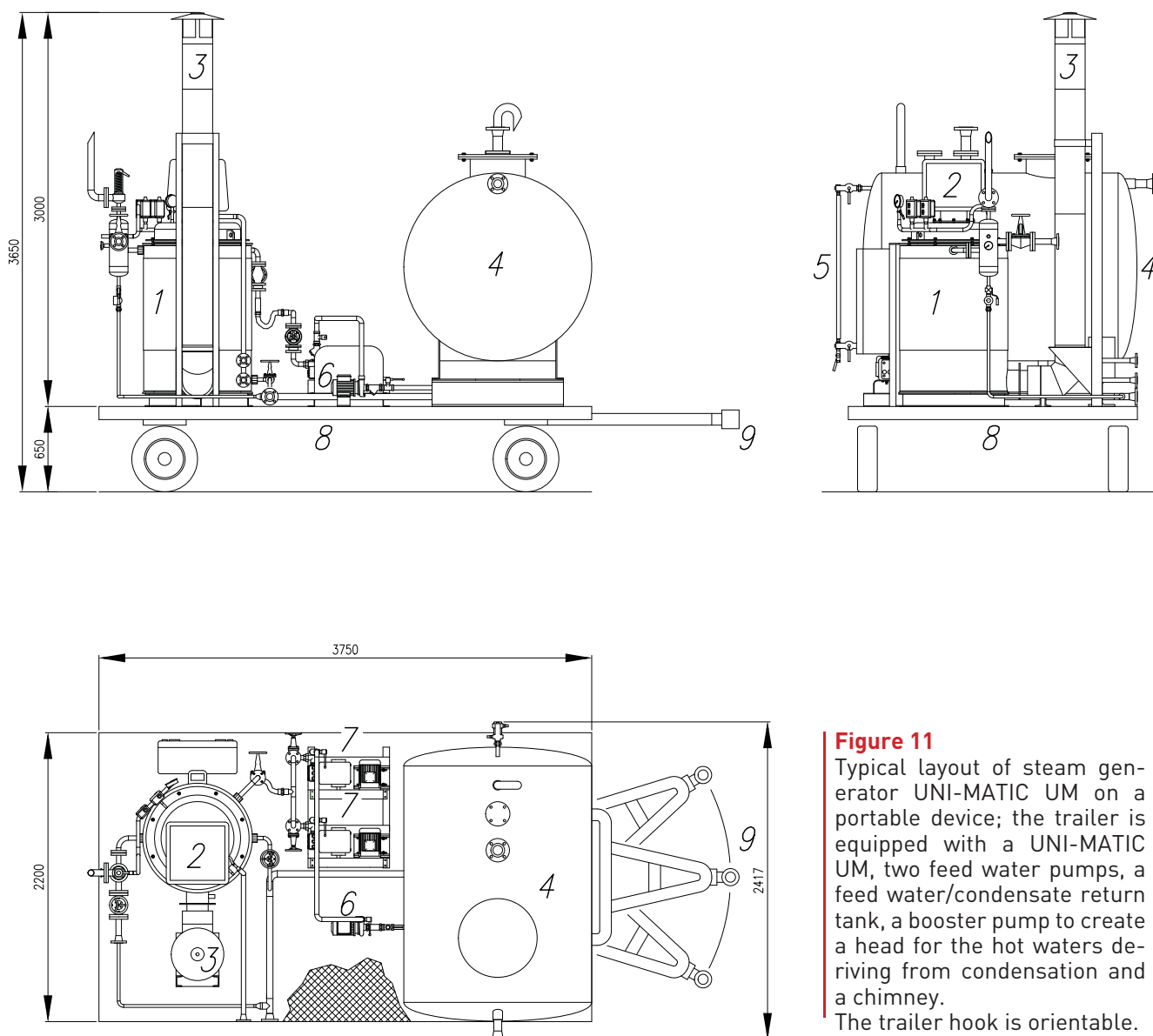


Figure 11
 Typical layout of steam generator UNI-MATIC UM on a portable device; the trailer is equipped with a UNI-MATIC UM, two feed water pumps, a feed water/condensate return tank, a booster pump to create a head for the hot waters deriving from condensation and a chimney.
 The trailer hook is orientable.

1	Steam Generator UM	6	Booster Pump
2	Burner	7	Feed Water Pump
3	Steam Generator Chimney	8	Trailer
4	Feed Water/Condensate Tank	9	Trailer Hook
5	Tank Level Indicator		

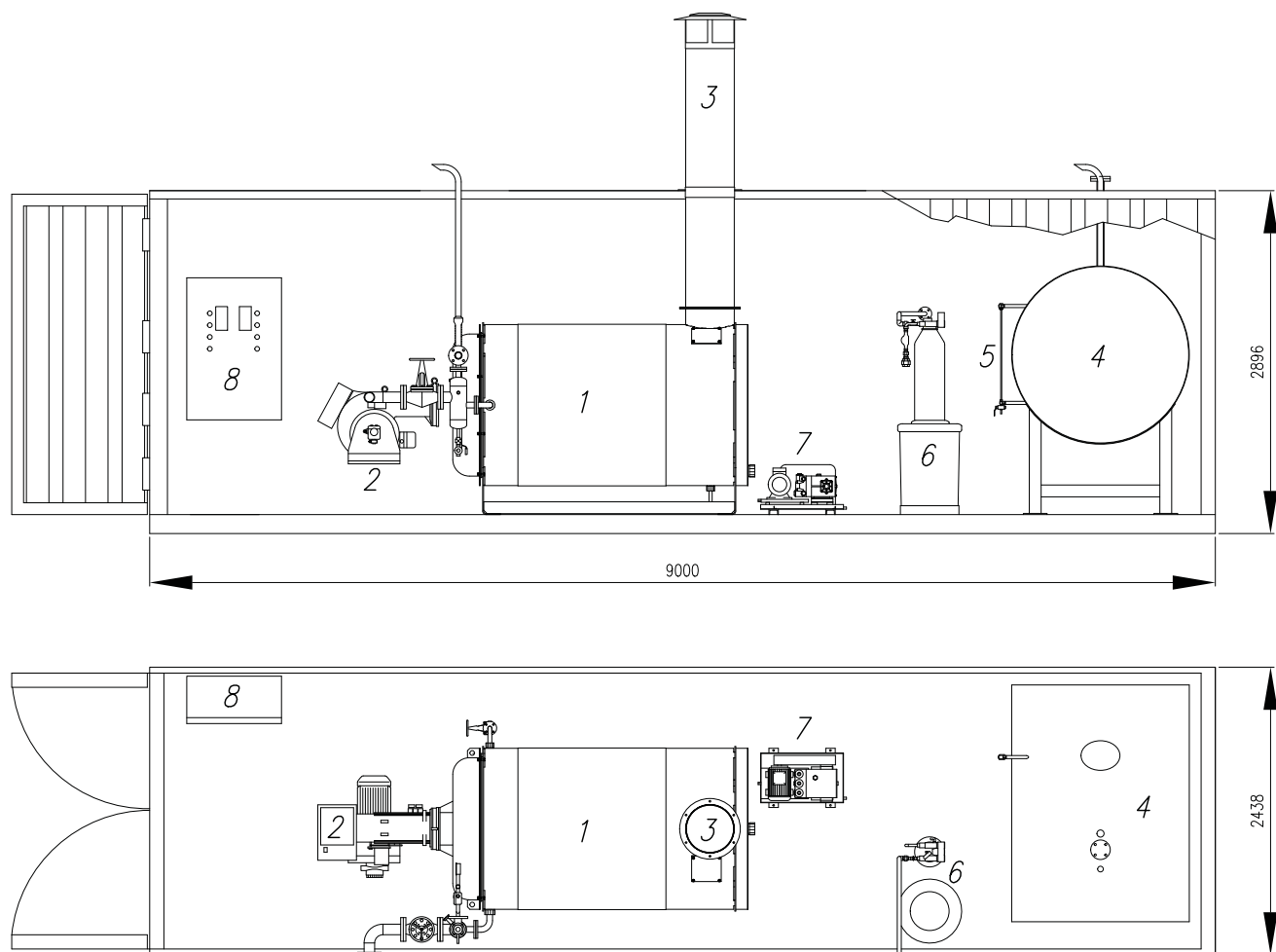
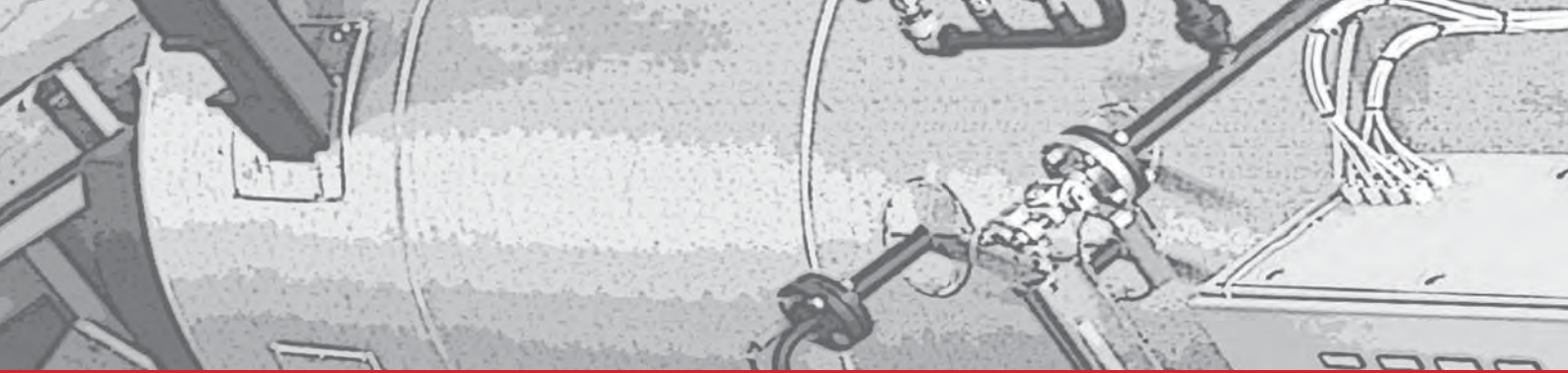


Figure 12

Layout of a UNI-MATIC UM in a container; the container is equipped with a UM steam generator, an electrical cabinet mounted on the container's wall, one feed water pump, a feed water/condensate return tank, a chimney and a water softening system.

1	Steam Generator UM	5	Tank Level Indicator
2	Burner	6	Water Softening System
3	Steam Generator Chimney	7	Feed Water Pump
4	Feed Water/Condensate Tank	8	Electrical Cabinet



6. GENERATOR LAYOUT

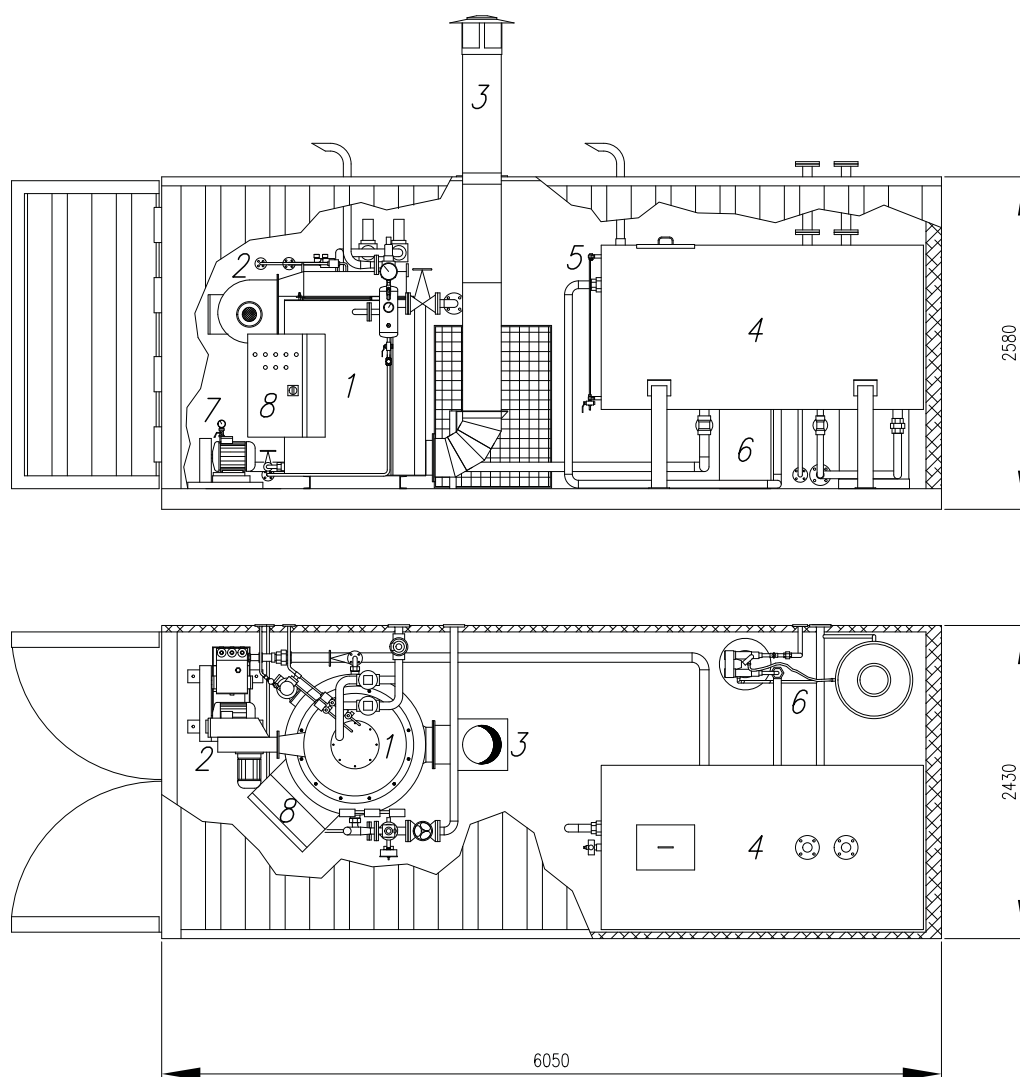


Figure 13

Layout of a steam generator UNI-MATIC UM in a container; the container is equipped with a UM, an electrical cabinet mounted on the generator, one feed water pump, a feed water/condensate return tank, a chimney and a water softening system.

1	Steam Generator UM	5	Tank Level Indicator
2	Burner	6	Water Softening System
3	Steam Generator Chimney	7	Feed Water Pump
4	Feed Water/Condensate Tank	8	Electrical Cabinet



Table 6

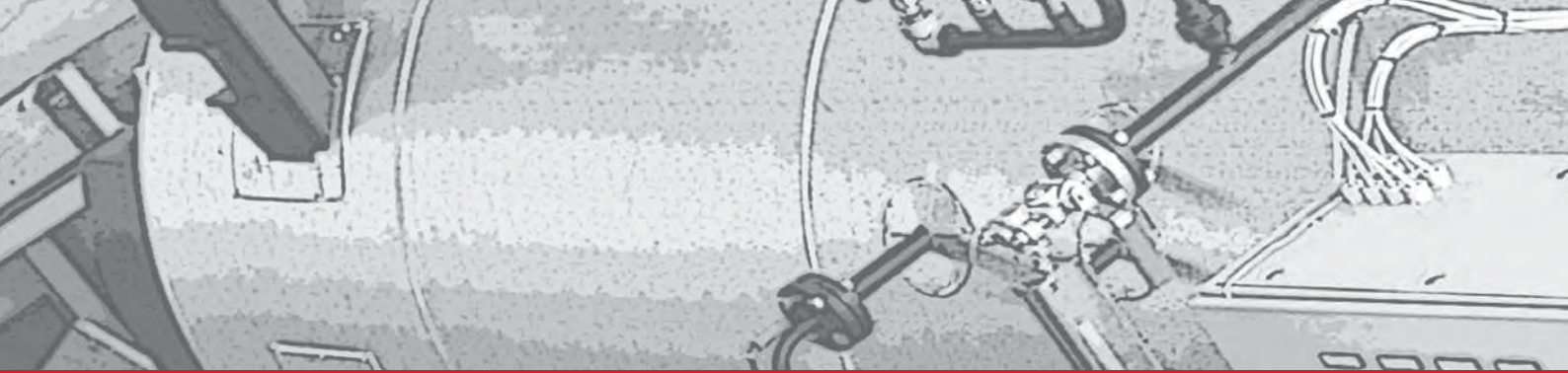
UNI-MATIC range model matching with Riello burners for the three main fuels on the market, for further details and other fuels available please ask.

	Steam generator UNI-MATIC models					
	UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
Steam capacity (kg/h)	300	500	1000	1500	2000	3000
Riello burners - natural gas or LPG - 1 or 2 stages regulation						
Riello type	RS 34/1 tc	RS 44/1 MZ tc	RS 100 tc	RS 130 tc	RS 190 tc	GAS 9/2 tc
Regulation type	1 stage	1 stage	2 stages	2 stages	2 stages	2 stages
Riello burners natural gas or LPG modulating regulation						
Riello type	-	-	RS 100/M tc	RS 130/M tc	RS 190/M tc	GAS 9 P/M tc
Minimum gas pressure at train (mbar)	50	50	50	50	60	100

Riello burners – diesel oil – 1 or 2 stages regulation						
Riello type	RL 34/1 tc	RS 38 tc	RL 100 tc	RL 130 tc	RL 190 tc	PRESS 300 P/G tc
Regulation type	1 stage	1 stage	2 stages	2 stages	2 stages	2 stages
Riello burners – diesel oil – modulating regulation						
Riello type	-	-	RL 100/M tc	RL 130/M tc	RL 190/M tc	PRESS 300 P/G tc

Riello burners – heavy fuel oil *- 1 or 2 stages regulation						
Riello type	P45/N ECO	P60/N ECO	P100/N ECO	P140 T/N ECO	P200 T/N ECO	P300 T/N ECO
Regulation type	1 stage	1 stage	2 stages	2 stages	2 stages	2 stages
Riello burners – heavy fuel oil *- modulating regulation						
Riello type	-	-	P140 P/N	P140 P/N	P200 P/N	P300 P/N

* = heavy fuel oil max viscosity considered is 7°E at 50°C, please ask for higher viscosities.



7. INSTALLATION

GENERAL COMMENTS

The Generator must be installed on a rigid, levelled base, preferably on a concrete slab, in a room which ensures adequate access to all the equipment and for the personnel.

The boiler room must comply with the prevention standards in force and must be dry, clean and well ventilated.

Good ventilation is essential to supply enough air for combustion and a temperature which is suitable for the regular operation of the electrical equipment, in any case not higher than 35-40°C.

The boiler room must have at least two constantly open air inlets, one of which as close to the fan as possible.

The boiler room must be high enough for the coil to be taken out.

! INSTALLATION OUTSIDE IS ABSOLUTELY FORBIDDEN, EVEN UNDER A ROOF UNLESS THE GENERATOR HAS BEEN SPECIALLY MADE FOR THIS PURPOSE

Connections to be made

Make the following connections to start the generator:

- Chimney pipe to drain the fumes from the boiler outlet to the outside.
- Steam piping at the distribution system.
- Water piping at the water/condensation collection tank.
- Humidity separator (if fitted) drainage piping.
- Safety valve drainage piping.
- Boiler drainage piping.
- Fuel piping to the burner.
- Electricity to the panel.

! DURING INSTALLATION ALWAYS MAKE THE HYDRAULIC CONNECTIONS FIRST AND THEN THE ELECTRICAL CONNECTIONS.



CHIMNEY

The section of the chimney pipe must be not less than that of the boiler outlet connection and must follow the shortest and most direct path to the outside and be as vertical as possible.

For the height follow the regulations in force.

If the fume exhaust pipe is connected to the flue it must be suitably pitched with adequate inclination to direct the fumes upwards.

The fume exhaust pipe must not be connected to a flue which is already connected to another boiler.

The flue must be perfectly gas-tight.

In any case constrictions or local losses of load which could disturb operation must be avoided.

WATER SUPPLY

The generator must be supplied with water with hardness less than 0.1°F made up of the condensation recovery and the make-up water softened by a purifier (cation resin) or demineralised. The water supply must always come from the supply tank; a direct connection to the mains water or to the purifier is not allowed.

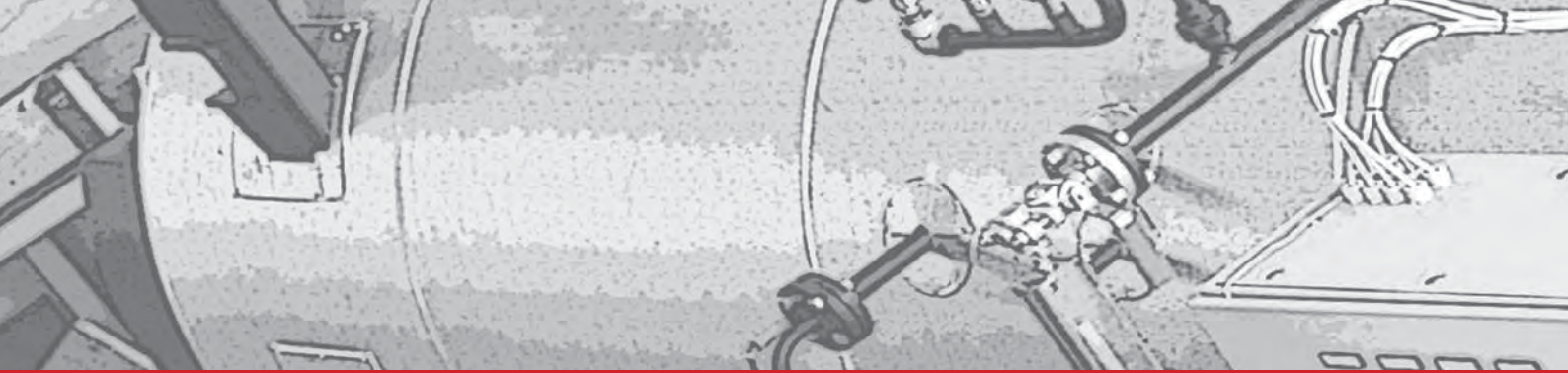
The suction piping must be as straight as possible and its diameter must be larger than that of the connection on the pump (see connection diagram).

The supply water must be at a temperature of at least 70°C as lower temperatures cause deterioration in the generator coils.

If the water temperature is lower than the value indicated above the supply water must be heated. The tank capacity must be adequate for the boiler capacity and normally at least the same as the consumption of an hour operation at maximum load.

The tank must be fitted with a drainage tube with cock direct to the sewers for regular drainage and to empty the tank for cleaning.

Water pump must not suck from the bottom of the tank but slightly higher to avoid the entry of impurities.



7. INSTALLATION

The tank must be raised up and have sufficient head for correct pump operation and to avoid phenomena of cavitation owing to insufficient supply - refer to the table given below.
See chapter 3, table 3 for water pressure/suction head details.

GENERATOR INSTRUMENT HEADER

The generator is fitted with an instrument header on which the following equipment is mounted:

- The safety valve of the generator
- The steam on-off valve
- The distribution manifold of the safety and control devices
- The steam thermometer
- The steam thermometer with the related gauge test tap
- Condensation discharge pipe

The instrument header is also a humidity separator. In this regard kindly refer to the relevant paragraph.

During normal functioning of the generator the steam produced passes through the manifold. The manifold is thus very hot. Do not go near the manifold for any reason.
THERE IS A DANGER OF BEING BURNT.

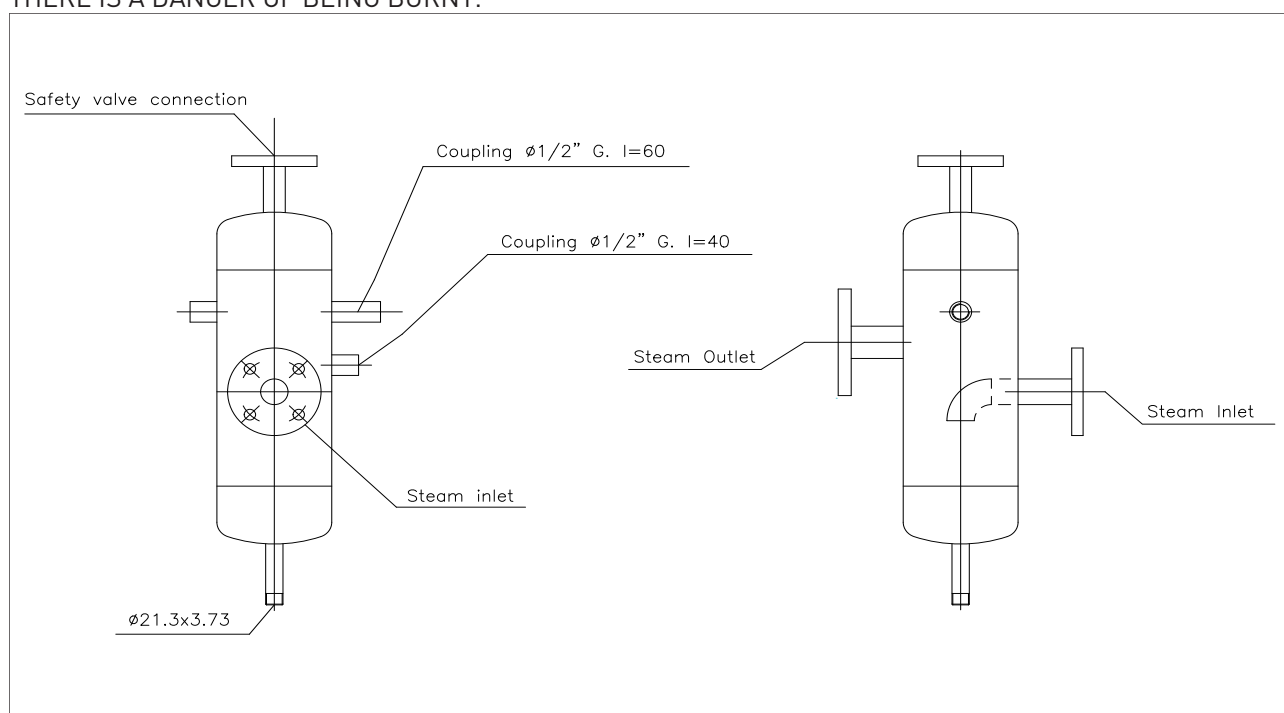


Figure 14
Generator instrument header



HUMIDITY SEPARATOR (if fitted) DRAINAGE PIPING

The continuous purge of the humidity separator condensation drainage is recommended. It is connected to the water tank so that it can be recovered by pre-heating the supply water (compatible with the maximum operating temperature allowed for the pump).

In this case to avoid an excessive concentration of salts drain the tank regularly.

BOILER DRAINAGE PIPING

The boiler drainage valve must be connected directly to the hot sump with independent piping for the drainage under pressure of the coil.

The boiler drainage valve must be operated at least once a day to remove slime and deposits.

For generators in the horizontal version, the drainage can be performed by means of the valve on the steam outlet collector. To make the outflow of water easier compressed air can be blown into the coil inlet.

ELECTRICAL CONNECTION

The generator is delivered complete with control panel and electrical system.

For the connection lead the three-phase line to the control panel and connect it to the terminals of the main switch, checking the direction of rotation of the motors.

If the electrical board of the generator does not have a voltage transformer use the Neutral wire to supply power to the electrical control and command equipment.

The connections must be made by specialised personnel.

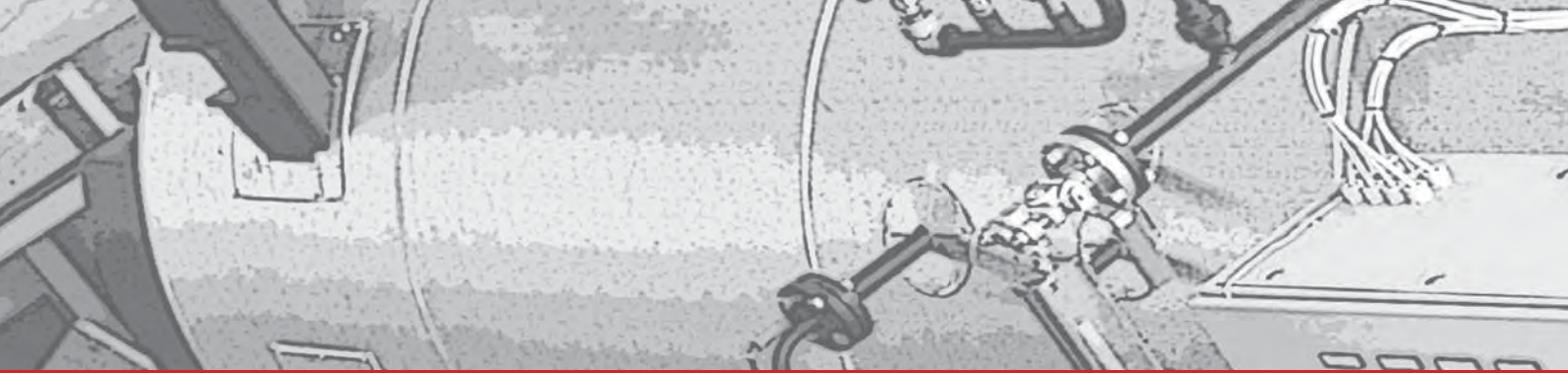
Before making the connections make sure that the properties of the electricity available (voltage and frequency) correspond to those on the generator rating plate.

Variations of voltage greater than 10% interfere with the good operation of the safety device.
The line main switch must be installed at the outside of the boiler room.

STEAM INLET CONNECTION

The steam connection is supplied with a flange (see reference table). In the designing stage the manufacturer did not make provision for any load to be placed on the steam outlet pipe.

Accordingly, any type of mechanical strain due to the weight of the steam delivery pipes must be avoided. If this is not possible an expansion joint and/or suitably sized supports must be provided.



7. INSTALLATION

DRAINAGE SAFETY VALVE

Must connect to the atmosphere the drainage conveyed of the safety valve with piping of diameter not smaller than that of the valve outlet.

To make the connection follow the indications in the drawing shown below.

Stresses on the valve owing to the weight of the drainage piping or to thermal expansion must be avoided. For piping less than 3 metres long the connection can be made as indicated in Figure 15.1; for piping more than 3 metres long follow the indications of Figure 15.2.

The terminal of the drainage piping must be placed in a protected and difficult to reach position so that the steam can exit freely without causing damage to people or things and its end must be so directed that rain does not fall into it.

On the valve body there is a connection for drainage which must be connected to the drainage to avoid the stagnation of condensation inside the valve and consequent damage to the seal surface.

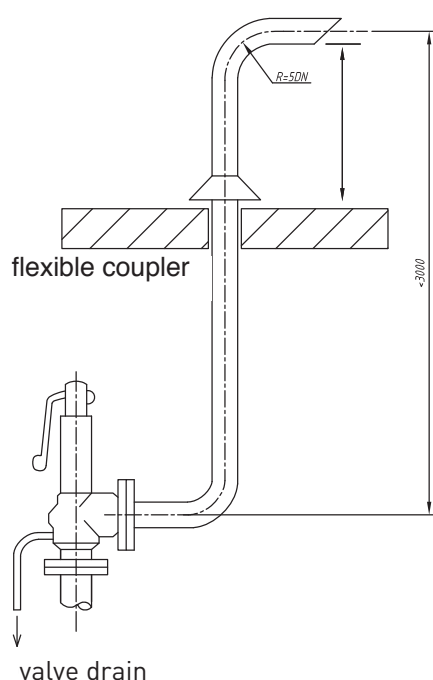


Figure 15.1

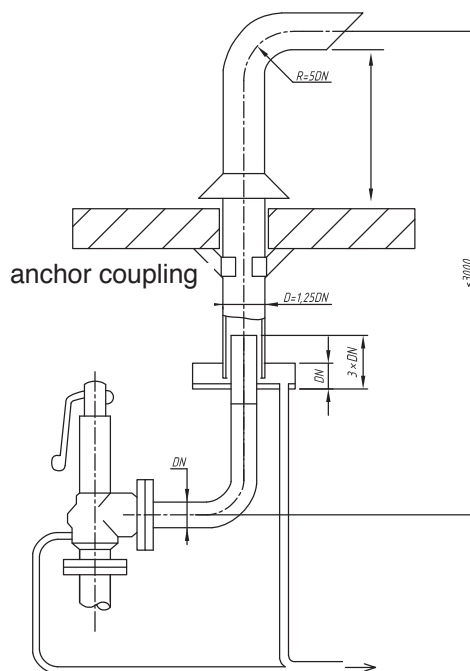


Figure 15.2

INSTALLATION IN CONTAINER

CANNON BONO offers the possibility to install the UNI-MATIC UM into a container equipment, please ask our commercial department for details.



8. MAINTENANCE

GENERAL COMMENTS

Generator operation is completely automatic and requires nothing in particular. The operations to be performed regularly are indicated in the section below. Carrying out the programme of checks and inspections proposed here means extending the system's lifetime and preventing possible faults and malfunctioning.

WARNING: before performing any maintenance operation, switch the unit off by means of the switch upstream of the line, and the main switch on the control panel. Put the sign:

“ MAINTENANCE IN PROGRESS or STOPPED FOR MAINTENANCE”.

on the switches

Daily operations

- Check the regulator ignition cycle.
- Check the boiler supply water hardness.
- Check purifier cycle. If necessary regenerate.
- Check water supply pump delivery pressure.
- Check whether the self-cleaner naphtha/gas filter is clean (turn upper filter handwheel).
- Check smoke thermostat safety lock.
- Check steam thermostat safety lock.
- Discharge the generator under pressure (only for vertical generators).
- Check supply pump belt tension.

Weekly operations

- Clean nozzle and ignition electrodes.
- Check tank fuel level.
- Check naphtha pre-heater temperature.
- Check operation of supply water tank float level regulator.
- Check water supply pump oil level.

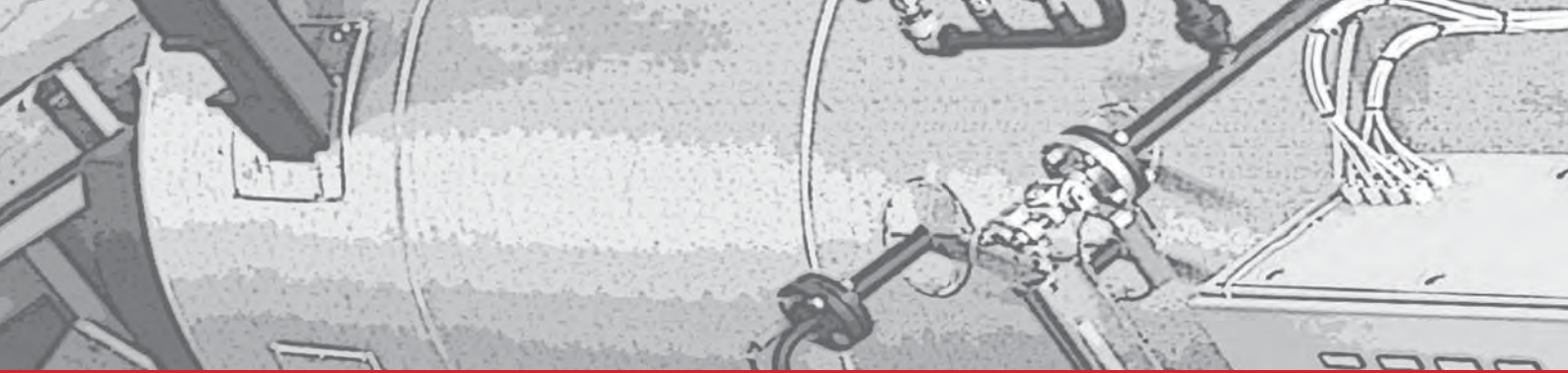
Monthly operations

- Clean water supply pump suction filter.
- Clean burner outflows.
- Clean photocell and protective glass.
- Drain slime out of the water supply tank.

To protect the generator during a short shut-down period proceed as follows:
Discharge the coil under pressure.

Close the on-off valve water supply and the steam intake valve. Keep the relief valves of the coil and humidity separator (for vertical generators) open, wait for the generator temperature to drop to about 50°C and then close the relief valves.

To protect the generator, with seasonal working with long shut-down periods, follow the precise information given in the instruction sheet enclosed.



8. MAINTENANCE

Three-monthly operations

- Check generator smoke side and if necessary clean with compressed air (see instructions enclosed).
- Disassemble and clean naphtha/gas oil in suction filter.
- Disassemble and clean naphtha pre-heater filter.
- Disassemble and clean condensation discharger filter.
- Disassemble and clean water supply filter.
- Check safety valve.

Yearly operations

- Clean smoke side with compressed air and extracting soot.
- Clean fan impeller.
- Change water supply pump oil.
- Check refractors.

WASHING SMOKE SIDE

Washing the smoke side of the generator is very exceptional and may be necessary to free the boiler from clogging of soot and dirt.

Generator in vertical version

- Stop the generator and discharge it.
- Disassemble the burner.
- Detach the chimney pipe union and hermetically close the generator connection with blank flange and rubber gasket.
- Open the lower cleaning door and extract the internal threaded plug.
- Place a sheet channel under the cover for the discharge of the washing solution.
- In a separate container prepare a 10% water and caustic soda solution (9 parts water and 1 part caustic soda). Pour the solution inside the generator through the burner hole and fill up to 5 cm. from the edge of the cover inside.
- Wait 24 hours then drain completely through the lower plug; then fill and rinse the generator with clean water. Wait some time for the inside of the generator to dry then reassemble the components.
- Lubricate the thread of the internal plug with graphitised grease and screw it up tightening moderately.
- Close the door, detach the blank chimney closing flange and reassemble the union section.
- Assemble the burner and make the connections correctly.
- Start the generator with the due precautions to eliminate the humidity absorbed by the refractors.
- The operation should be performed as follows:
- Light the burner and leave it lit for about 1 minute; then switch it off and wait 3-4 minutes.
- Repeat the operation 3 or 4 times.

Generator in horizontal version

- Stop the generator and discharge it.
- Disassemble the burner.
- Detach the chimney pipe union.
- Remove the generator cover.
- Place a sheet channel under the cover for the discharge of the washing solution.



- In a separate container prepare a solution of 10% water and caustic soda (9 parts water and 1 part caustic soda). Wash the inside of the generator with the solution and rinse.
- Lubricate the thread of the cover tie rods with graphitised grease.
- Close the cover and reassemble the union section of the chimney.
- Assemble the burner and make the connections correctly.
- Start the generator with the due precautions to eliminate the humidity absorbed by the refractors.
- The operation should be performed as follows:
- Light the burner and leave it lit for about 1 minute; then switch it off and wait 3-4 minutes.
- Repeat the operation 3 or 4 times.

Generator in vertical version

To extract the coil from the generator proceed as follows:

- Remove the fuel piping and the electrical connections to the burner and disassemble the front cover.
- Disassemble the water and steam connection piping and discharge.
- Unscrew the ring nuts and extract the smoke sealing gaskets.
- Unscrew the connecting stub pipes using a pipe wrench.

The coil thus freed can be hooked to the eye bolts and taken out of the generator.

The operation can be performed by putting a suitably sized and possibly movable lifting device in position above the boiler.

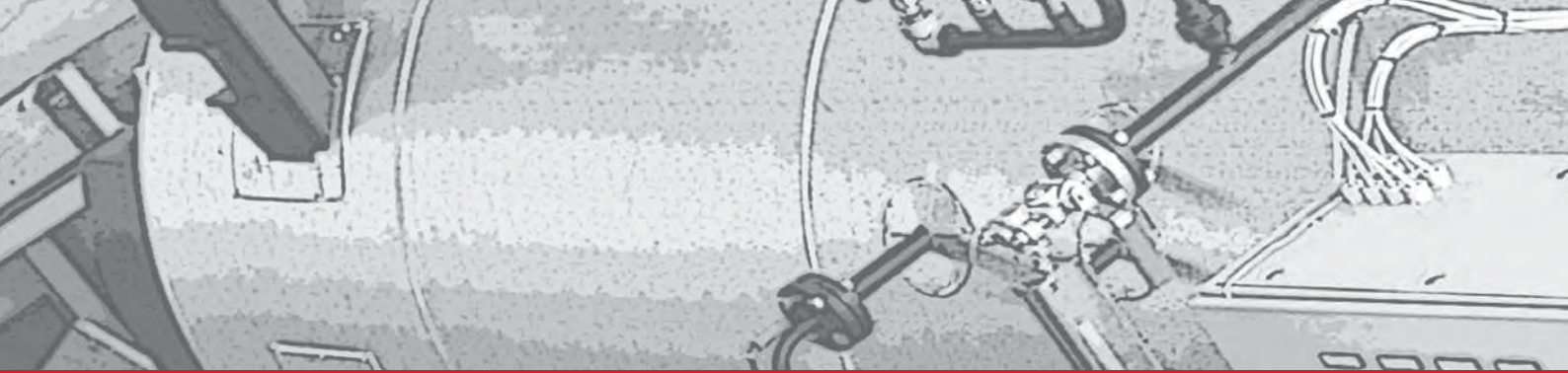
In the case of horizontal generators the coil can be hooked to the eye bolts and taken out of the generator on a suitably strong fork lift truck.

Assembly:

- Hook the coil, lower it into the generator making sure that the connections coincide with the sleeves and check the centring of the coil with respect to the plating inside.
- Replace the front cover sealing gaskets.
- Assemble the stub pipes packing the conical threads with a little teflon tape and tighten completely.
- Put new smoke sealing gaskets in the housings leaving them protruding by the sleeves about 5–10 mm. for later adjustments.
- Lubricate the threading with graphitised grease and tighten the ring nuts.
- Lubricate the stud bolts and reassemble the upper cover.
- Connect the water, steam and discharge piping and make the connections to the burner again.
- Start the generator and check the seals, adjust if necessary.

INSTRUCTIONS FOR CHEMICAL DESCALING

1. With coil empty: wash the inside with just water by means of the supply pump. (If this operation is made possible by the general state of the coil, it should last for a few minutes).
2. Immediately afterwards stop the pump and drain.
3. Remove the meshes of the filters before the condensation discharge (in the version with steam separator) and the water suction pump.
4. Prepare the descaling acid solution in a suitable container (water + commercial hydrochloric acid (HCl 33%) + inhibitor "Lithsolvent"), according to the table specified.
5. Descale the coil putting the acid solution in from the top (steam intake pipe) and recovering it in the collection container draining the solution itself from the supply connection.
The operation of putting in and recovering the descaling solution should be performed with a small pump which allows the continuous circulation from coil to the tank in closed cycle.
The pump delivery is proportional to the boiler capacity:
E.g.: for a UM 30- about 300 lt/h; for UM50- about 500 lt/h etc.
For the unions the PVC hoses available on the market can be used.



8. MAINTENANCE

The acid solution specified in the table is sufficient to remove a thickness of about 2 mm. of scale along the whole coil.

- 6) The closed-cycle operation should last for at least 2-3 hours and in any case until the formation of foam is seen in the container.
N.B. If there is considerable scaling, the operation should be repeated completely, renewing the solution once the time mentioned above has elapsed
- 7) When the operation is finished empty the coil and the container completely.
Collect the solution and neutralise it before draining.
Wash the coil and the container with clean water under pressure, then drain again.
- 8) In the normal container prepare a neutralised alkaline solution with water and sodium bicarbonate (Solvay Soda) base in the proportion specified in the table.
- 9) Circulate the solution in the coil for about 30' then drain.
This operation would be better performed hot (60–70 °C), lighting the burner from time to time.
- 10) Cool, drain and wash carefully to remove the operation residues from: valves, dischargers, etc. Reassemble the previously removed filter meshes, replace the piping and start the boiler.

Table 7 Chemical descaling standard data

UNI-MATIC UM model	Tank capac. (minimum). L	Water content L	Acid content L	Cont. Inhib. "Lithsolvent" L	Content "solvay soda" kg
UM 30	100	80	11	0.50	3
UM 50	150	120	16	0.75	4
UM 100	200	160	22	1	6
UM150, UM 200	300	200	30	1.5	10
UM 300	500	300	40	2	15

Important: in order to operate in security we recommend to ask to our assistance contacting **Bono Energia S.p.a. (+39 02 55302848)**.

DOWNTIME

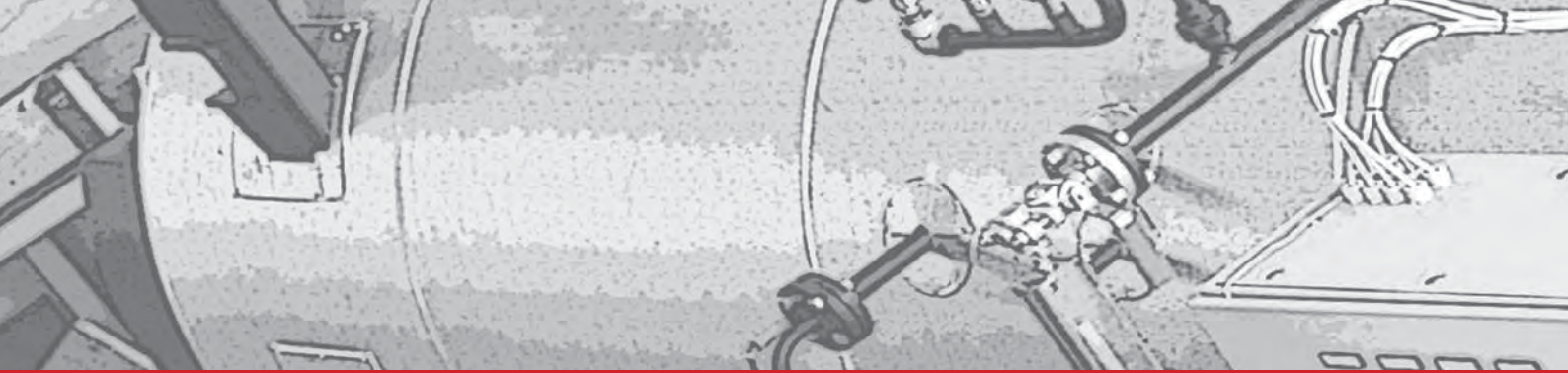
When the generator is placed out of operation for a short time there are no particular precautions; in the case of long downtime the generator should be set up to avoid deterioration to the coil and the equipment.

- Clean the smoke side of the generator carefully by washing with water and caustic soda.
- Immediately afterwards start the generator again for a short time to remove the humidity completely.
- Discharge the coil under pressure and then leave the generator to cool.
- In a separate container prepare an alkaline water solution with 50% sodium bicarbonate "Solvay Soda" (see tab. 7)
- Fill the coil completely and fill the water supply circuit up to the on-off valve on the pump suction, with the alkaline solution described above.
- Close all the generator valves.
- Put a blank on-off flange between the generator and the chimney.
- Lubricate the valve closing screws and all the generator bolts and stud bolts.
- Protect the control panel and all the equipment against dust and external humidity.

N.B. To protect the coil avoid the dangers of frost.

9. SCOPE OF SUPPLY

EQUIPMENT		UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
BOILER COIL PRESSURE PARTS	Tube bank composed of concentric tangent coils with seamless tubes in carbon steel	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Vertical-cylindrical casing containing the coils in carbon steel plate (horizontal execution upon request) Removable upper cover	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Flanged connection for stack with counterflange included	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
VALVES AND ACCESSORIES	Steam outlet valve	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Safety valve	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Coil drain valve	1 pc. (only for vertical design)	1 pc. (only for vertical design)	1 pc. (only for vertical design)	1 pc. (only for vertical design)	1 pc. (only for vertical design)	1 pc. (only for vertical design)
	Steam pressure gauge complete with cock	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Steam temperature thermometer	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Sight glass for water filling indication	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
INSULATION AND EXTERNAL LAGGING	Insulation of the external casing in mineral wool panels, stainless steel external lagging	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
BASE	Base frame at ground level made of steel sections, saddles for horizontal design	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
FEEDING WATER GROUP	Electro-pump, with protecting casing and accessories	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Motor	1 pc. (single-stage burner only)	1 pc. (single-stage burner only)	1 pc. (two-stages burner)	1 pc. (two-stages burner)	1 pc. (two-stages burner)	1 pc. (mod. burner, speed frequency controlled)
	On-off valve	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Check valve	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Pressure gauge	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Flow meter	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.

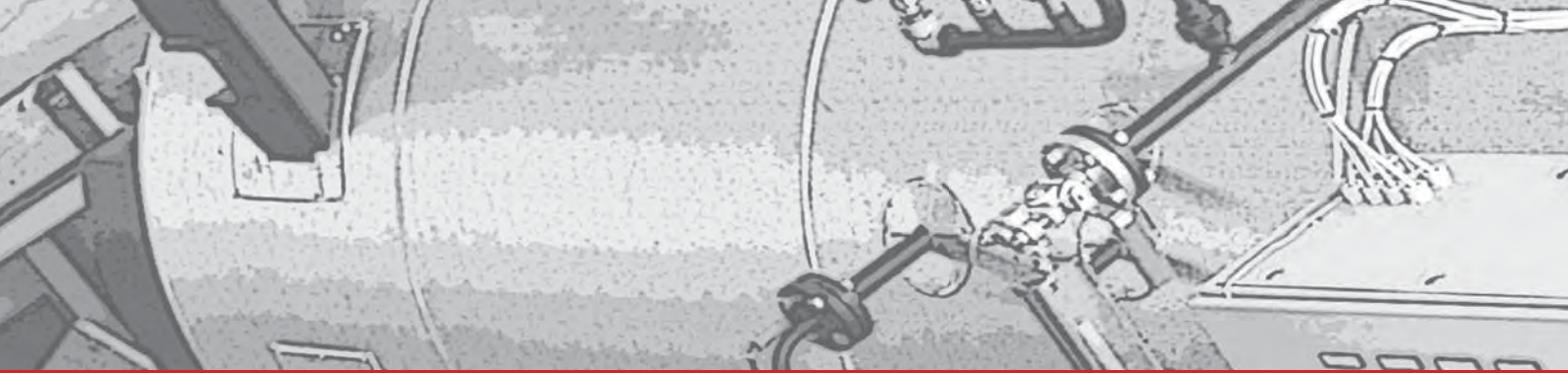


9. SCOPE OF SUPPLY

EQUIPMENT		UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
BURNING SYSTEM	Burner box	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Flame scanner	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Observation port for flame control	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Combustion gun with head	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Fuel atomising nozzle (for fluid fuel version)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Combustion air fan	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Distributor feeding gas multi-nozzles (only for gaseous fuel)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	High efficiency combustion air fan	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Electric type ignition device with high tension and ignition electrodes (only for fluid fuel)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
FUEL PREHEATING STATION	Preheating station with electric armoured resistance (only for heavy fuel oil)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
FEEDING GAS TRAIN	Feeding gas train (only for gas fuel)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Safety solenoid valves	2 pc.	2 pc.	2 pc.	2 pc.	2 pc.	2 pc.
	Regulating solenoid valves	1 pc. (gas, single stage burner)	2 pc. (gas, two stages burner)	2 pc. (gas, two stages burner)	2 pc. (gas, two stages burner)	2 pc. (gas, two stages burner)	2 pc. (gas, two stages burner)

9. SCOPE OF SUPPLY

EQUIPMENT		UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
BURNING CONTROL AND SAFETY EQUIPMENT	Cycle programming panel for burner ignition and flame control (safety automatic device)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Temperature switches for fuel temperature regulation (only heavy fuel oil)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Gas valves seal control device	/	/	/	1 pc.	1 pc.	1 pc.
	Max/min gas pressure switch (only gas fuel)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Shut-down pressure switch for very high steam pressure	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Shut-down temperature switch for high steam temperature	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Shut-down temperature switch for high flues temperature	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Control flow switch for feed water circulation	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
ELECTRIC WIRING	With flexible conduits and tight terminal fittings for high mechanical resistance and water proof sealing	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
ELECTRIC PANEL	Steel cabinet, oven painting, front door, IP54 protection	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Power section, main switch and door locking device, magneto-thermal switches to protect each user, tropicalized power contactors	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Control auxiliary section, ignition and flame control panel, alarms and shut-down logic, alarm horn contacts, auxiliaries protection fuses	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Operators panel, burner START/STOP switch/indicator, feed pump START/STOP switch/indicator, alarms acknowledgement with lamps	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
	Feed water group frequency changer	/	/	1 pc. (modulating regulation)	1 pc. (modulating regulation)	1 pc. (modulating regulation)	1 pc. (modulating regulation)



9. SCOPE OF SUPPLY

OPTIONAL							
EQUIPMENT		UM 30	UM 50	UM 100	UM 150	UM 200	UM 300
AIR PRE-HEATER (FOR HIGH EFFICIENCY)	Tube bank with flue gases running inside and air running outside the tubes	/	/	1 pc.	1 pc.	1 pc.	1 pc.
	Rectangular section shape casing	/	/	1 pc.	1 pc.	1 pc.	1 pc.
	Mineral wool insulation, external covering made of stainless steel	/	/	1 pc.	1 pc.	1 pc.	1 pc.
	Inspection and maintenance upper door	/	/	1 pc.	1 pc.	1 pc.	1 pc.
SECOND FEED WATER PUMP	Reserve water pump, with accessories	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
HIGH TEMPERATURE FEED WATER PUMP	Feed water pump to reach temperature above 95 °C	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
SECOND SAFETY VALVE	Second safety valve	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
HUMIDITY SEPARATOR	Water trap, to separate condensate from steam	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.
MODULATING BURNER REGULATION	Modulating burner regulation, special configuration on request	/	1 pc.	1 pc.	1 pc.	/	/
LADDER FOR BURNER	Ladder for burner maintenance	/	/	/	1 pc. (vertical version)	1 pc. (vertical version)	1 pc. (vertical version)
FLUID FUEL FEEDING STATION	Plunger pump, complete with shut-off valve (fluid fuel only)	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.	1 pc.

10. APPENDIX 1. FUEL CONSUMPTION CALCULATION

We assume that we have to calculate natural gas fuel consumption for the production of 2500 kg/h of saturated steam, working pressure is **9 bar**, the steam generator is a UNI-MATIC UM 300, without air preheater. Feeding water temperature is 70 °C.

In accordance with heat balance equation $Q = M \text{ steam} * (hg - he) / 3600$, where:

Q = heat needed to achieve saturated steam production with the above indicated characteristics (watt);

M steam = steam production, t/h;

hg = enthalpy of saturated steam at the above indicated temperature and pressure;

he = enthalpy of feeding water at the above indicated water temperature;

Values regarding enthalpy are taken from Appendix 2.

As calorific power of natural gas is **8500 kcal/Nm³**, we determine hg - enthalpy of saturated steam under 9 bar gauge pressure and he - enthalpy under 70 °C feed water temperature.

$Q = (2500/3600) * (663,9 - 69,1) = 413 \text{ kcal/s}$ or 1731 kW,

According to Table 1 heat power of UNI-MATIC UM 300 steam generator is 2100 kW, which is 100% boiler's steam production load.

Actual load of the boiler = $(1731/2100) * 100\% = 82\%$,

In accordance with actual modifications of the steam generator (without air preheater) and graphics regarding coefficient of performance (COP) of the boiler UNI-MATIC UM crossed with the load, under different working pressures (Figure 16), we determine that COP (under 9 bar, 82% actual load) is 89,4%.

Determined the COP of the boiler, we consider $Q_p = (413/89,4\%) * 100 = 462 \text{ kcal/s}$. Therefore we calculate natural gas fuel consumption with the relation $462/8500 = 0,054 \text{ Nm}^3/\text{s}$ or **196 Nm³/h**.

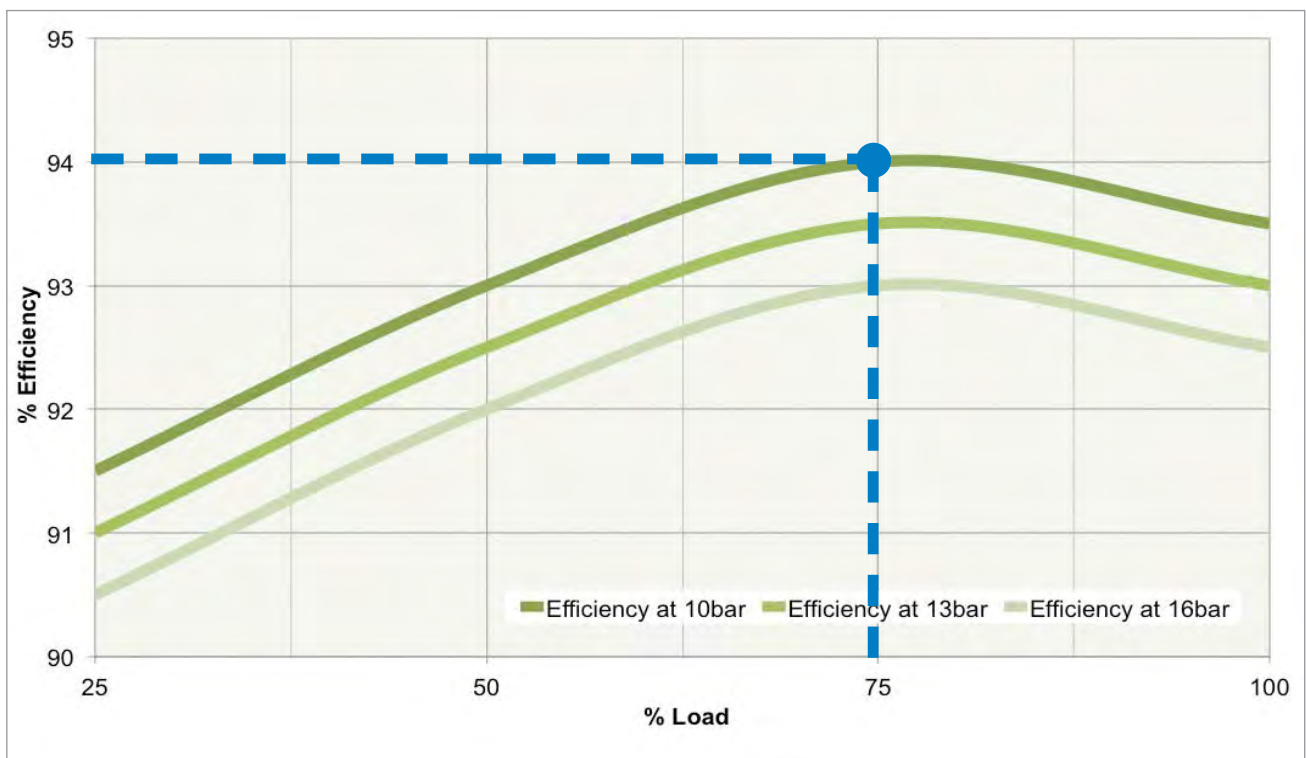


Figure 16
Generic boiler efficiency chart with determined working point

11. APPENDIX 2. THERMODYNAMIC CHARACTERISTICS OF SATURATED STEAM

Pm		Pa		T		V	he		r		hg	
bar	kg/cm ²	bar	kg/cm ²	K	°C	m ³ /kg	kJ/kg	kcal/kg	kJ/kg	kcal/kg	kJ/kg	kcal/kg
		0,050	0,051	306,05	32,9	28,191	137,7	32,9	2425	679,2	2562,7	612,1
		0,100	0,102	318,95	45,8	14,674	191,8	45,8	2394,4	571,9	2586,2	617,7
		0,150	0,153	327,15	54,0	10,023	225,9	54,0	2374,8	567,2	2600,7	621,2
		0,200	0,204	333,15	60,0	7,65	251,5	60,1	2359,7	563,6	2611,2	623,7
		0,250	0,255	338,15	65,0	6,204	272	65,0	2347,5	560,7	2619,5	625,7
		0,300	0,306	342,25	69,1	5,229	289,3	69,1	2337,5	558,3	2626,8	627,4
		0,350	0,357	345,85	72,7	4,526	304,3	72,7	2328,7	556,2	2633	628,9
		0,400	0,408	349,05	75,9	3,994	317,6	75,9	2320,7	554,3	2638,3	630,2
		0,450	0,459	351,85	78,7	3,577	329,6	78,8	2313,6	552,6	2643,2	631,4
		0,500	0,51	354,45	81,3	3,240	340,5	81,4	2306,9	551,0	2647,4	632,4
		0,6	0,612	359,05	85,9	2,732	359,9	86,0	2295,2	548,2	2655,1	634,2
		0,7	0,714	363,05	89,9	2,365	376,7	90,0	2284,3	545,6	2661,0	635,6
		0,8	0,816	366,65	93,5	2,087	391,7	93,6	2275,5	543,5	2667,2	637,1
		0,9	0,918	369,85	96,7	1,869	405,2	96,8	2267,2	541,5	2672,4	638,3
		1,0	1,020	372,75	99,6	1,694	417,5	99,8	2259,2	539,6	2676,7	639,4
0	0	1,013	1,033	373,15	100,0	1,673	419,1	100,1	2258,4	539,4	2677,5	639,5
0,05	0,051	1,063	1,084	374,55	101,4	1,601	425,0	101,5	2254,2	538,4	2679,1	639,9
0,10	0,102	1,113	1,135	375,75	102,6	1,533	430,4	102,8	2251,2	537,7	2681,6	640,5
0,15	0,153	1,163	1,186	378,25	105,1	1,471	435,8	104,1	2247,9	536,9	2683,7	641,0
0,20	0,204	1,213	1,237	379,35	106,2	1,414	440,9	105,3	2245,0	536,2	2685,8	641,5
0,30	0,306	1,313	1,339	380,55	107,4	1,312	450,5	107,6	2238,7	534,7	2689,2	642,3
0,40	0,408	1,413	1,441	382,65	109,5	1,225	459,7	109,8	2232,8	533,3	2692,5	643,1
0,50	0,510	1,513	1,543	384,75	111,6	1,149	468,5	111,9	2227,0	531,9	2695,5	643,8
0,60	0,612	1,613	1,645	386,65	113,5	1,038	476,5	113,8	2221,5	530,6	2698,0	644,4
0,70	0,714	1,713	1,747	388,55	115,4	1,024	484,4	115,7	2216,9	529,5	2701,3	645,2
0,80	0,816	1,813	1,849	390,25	117,1	0,971	491,9	117,5	2211,9	528,3	2703,8	645,8
0,90	0,918	1,913	1,951	391,95	118,8	0,923	499,1	119,2	2206,9	527,1	2705,9	646,3
1,00	1,020	2,013	2,053	393,55	120,4	0,881	505,8	120,8	2202,3	526,0	2708,0	646,8
1,10	1,122	2,113	2,155	395,05	121,9	0,841	512,5	122,4	2198,5	525,1	2711,0	647,5
1,20	1,224	2,213	2,257	396,55	123,4	0,806	519,2	124,0	2194,3	524,1	2713,5	648,1
1,30	1,326	2,313	2,359	398,05	124,9	0,773	525,0	125,4	2190,1	523,1	2715,1	648,5
1,40	1,428	2,413	2,461	399,45	126,3	0,743	530,9	126,8	2186,3	522,2	2717,2	649,0
1,50	1,530	2,513	2,563	400,75	127,6	0,714	536,3	128,1	2181,7	521,1	2718,1	649,2
1,60	1,632	2,613	2,664	402,05	128,9	0,689	542,2	129,5	2178,8	520,4	2721	649,9
1,70	1,733	2,713	2,766	403,25	130,1	0,665	547,2	130,7	2175	519,5	2722,3	650,2
1,80	1,835	2,813	2,868	404,55	131,4	0,643	552,7	132,0	2171,3	518,6	2723,9	650,6
1,90	1,937	2,913	2,970	405,65	132,5	0,622	557,7	133,2	2167,9	517,8	2725,6	651,0
2,00	2,039	3,013	3,072	406,85	133,7	0,603	562,7	134,4	2164,6	517	2727,3	851,4
2,20	2,243	3,213	3,278	409,05	135,9	0,568	571,9	136,6	2158,3	515,5	2730,2	652,1
2,40	2,447	3,413	3,480	411,15	138,0	0,536	581,1	138,8	2152	514,0	2733,1	652,8
2,60	2,651	3,613	3,684	413,15	140,0	0,509	589,5	140,8	2146,2	512,6	2735,7	653,4
2,80	2,855	3,813	3,888	415,05	141,9	0,483	597,9	142,8	2140,3	511,2	2738,2	654,0



Pm		Pa		T		V	he		r		hg	
bar	kg/cm ²	bar	kg/cm ²	K	°C	m ³ /kg	kJ/kg	kcal/kg	kJ/kg	kcal/kg	kJ/kg	kcal/kg
3,00	3,059	4,013	4,092	416,85	143,7	0,461	605,8	144,7	2134,8	509,9	2740,7	654,6
3,20	3,263	4,213	4,296	418,55	145,4	0,44	612,9	146,4	2129,4	508,6	2742,4	655,0
3,40	3,467	4,413	4,500	420,35	147,2	0,422	620,5	148,2	2124,4	507,4	2744,9	655,6
3,60	3,671	4,613	4,704	421,95	148,8	0,405	627,6	149,9	2118,9	506,1	2746,5	656,0
3,80	3,875	4,813	4,908	423,55	150,4	0,389	634,3	151,5	2114,3	505,0	2748,6	656,5
4,00	4,079	5,013	5,112	425,15	152,0	0,374	641,0	153,1	2109,3	503,8	2750,3	656,9
4,20	4,283	5,213	5,316	426,55	153,4	0,361	647,3	154,6	2104,7	502,7	2752,0	657,3
4,40	4,487	5,413	5,520	427,95	154,8	0,348	653,6	156,1	2100,1	501,6	2753,7	657,7
4,60	4,691	5,613	5,724	429,35	156,2	0,336	659,8	157,6	2095,9	500,6	2755,8	658,2
4,80	4,895	5,813	5,928	430,75	157,6	0,325	665,7	159,0	2091,3	499,5	2757,0	658,5
5,00	5,099	6,013	6,131	432,05	158,9	0,315	671,1	160,3	2087,1	498,5	2758,3	658,8
5,50	5,608	6,513	6,641	435,25	162,1	0,292	685,0	163,6	2077,1	496,1	2762,0	659,7
6,00	6,118	7,013	7,151	438,15	165,0	0,272	697,9	166,7	2067,4	493,8	2765,4	660,5
6,50	6,628	7,513	7,661	440,95	167,8	0,255	710,1	169,6	2058,2	491,6	2768,3	661,2
7,00	7,138	8,013	8,171	443,65	170,5	0,24	721,8	172,4	2049,0	489,4	2770,8	661,8
7,50	7,648	8,513	8,681	446,15	173,0	0,227	733,1	175,1	2040,6	487,4	2773,8	662,5
8,00	8,158	9,013	9,191	448,55	175,4	0,215	743,6	177,6	2032,3	485,4	2775,8	663,0
8,50	8,667	9,513	9,700	450,85	177,7	0,204	753,6	180,0	2024,3	483,5	2777,9	663,5
9,00	9,177	10,013	10,210	453,15	180,0	0,194	763,3	182,3	2016,4	481,6	2779,6	663,9
9,50	9,687	10,513	10,720	455,25	182,1	0,185	772,9	184,6	2008,8	479,8	2781,7	664,4
10,00	10,197	11,013	11,23	457,25	184,1	0,177	782,1	186,8	2001,3	478,0	2783,4	664,8
11,00	11,217	12,013	12,250	481,15	188,0	0,163	799,3	190,9	1987,1	474,6	2786,3	665,5
12,00	12,236	13,013	13,269	464,85	191,7	0,151	815,6	194,8	1973,7	471,4	2789,2	666,2

Denomination

Pm - gauge pressure
Pa - absolute pressure
T - temperature
V - specific volume
he - specific enthalpy of water
r - specific enthalpy of evaporation of steam
hg - specific enthalpy of saturated steam

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cannon
BONO ENERGIA

Bono Energia S.p.A

Via Resistenza 12 - 20068 Peschiera Borromeo (Mi) - Italy

Phone +39 0255302848 - Fax +39 025471955

www.bono.it

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