EVALED®

PC technology | **F** series | **12**

More information on this product.

VEOLIA

technical report

Heat pump vacuum evaporator with forced circulation and external shell and tube heat exchanger

CO_2 footprint

1 Technical characteristics

Nominal production capacity of distillate with water:	12000 [l/24h]
Available versions: *(selection dependent on corrosion resistance)*	**PC F 12 AA#** (austenitic stainless steel) **PC F 12 FF#** (superduplex stainless steel) **PC F 12 HH#** (nickel alloys) **PC F 12 FA#** (austenitic and superduplex stainless steel)
Electrical equipment:	PC F 12 --3 (400 [V] 50 [Hz] 3P) PC F 12 --4 (460 [V] 60 [Hz] 3P)
Construction:	pre-assembled, two modules on a stainless steel frame
Condensation heat exchanger:	U tube bundle
Heating exchanger:	external shell and tube with forced circulation
Evaporation conditions:	absolute pressure 6-8 kPa temperature 35-45 [°C]
Distillate temperature:	37-47 [°C]
Concentrate temperature:	35-45 [°C]
Drop separation:	perforated grill demister with packing elements
Feed filter:	bag filter 800 µm
Heating/cooling technology:	heat pump
Circulation pump:	centrifugal with fluxed mechanical seal
Heat pump compressor:	semi-hermetic screw type
Refrigerant:	R 134a (no impact on the ozone layer) Fluorinated greenhouse gas: 150 kg, equal to 215 t CO_2 equivalent
Vacuum system:	ejector and liquid ring pump
Operating control:	automatic, continuous 24/24h 7/7d through PLC Siemens S7-1200; status information and consent to equipment operation remotable through digital signals
Operator panel:	Proface GP4000 touch screen
International Protection Rating:	IP 54
Noise:	maximum value ~83 [dB(A)] measured at 1 mt from the surface of the machinery and at 1,6 mt from the floor
Main reference legislation: *(CE marking)*	Machinery Directive (2006/42/EC) Electromagnetic compatibility (2014/30/UE) Electrical safety (EN 60204-1) Pressure Equipment Directive (PED) (2014/68/UE)

2 Nominal performance

The data reported in the following table (values tolerance ± 10%) refer to the performances achieved during the FAT (Factory Acceptance Test) with clean machine fed with tap water under atmospheric pressure.

Version	**UM**	**PC F 12**
Maximum production of distillate with water	[l/24h]	12700
Absorbed power	[kW]	71
Specific electrical consumption per litre of distillate	[Wh/l]	135
Heat generated by thermal dissipation	[kW]	65
Maximum air flow of finned pack	[Nm^3/h]	30600

3 Functional description

The PC F 12 machine is an evaporator for the treatment of water-based liquids. It uses the combined effect of vacuum and heat pump technology to achieve the boiling of liquids at low temperatures (35-45°C). The various components are identified in figure 1.

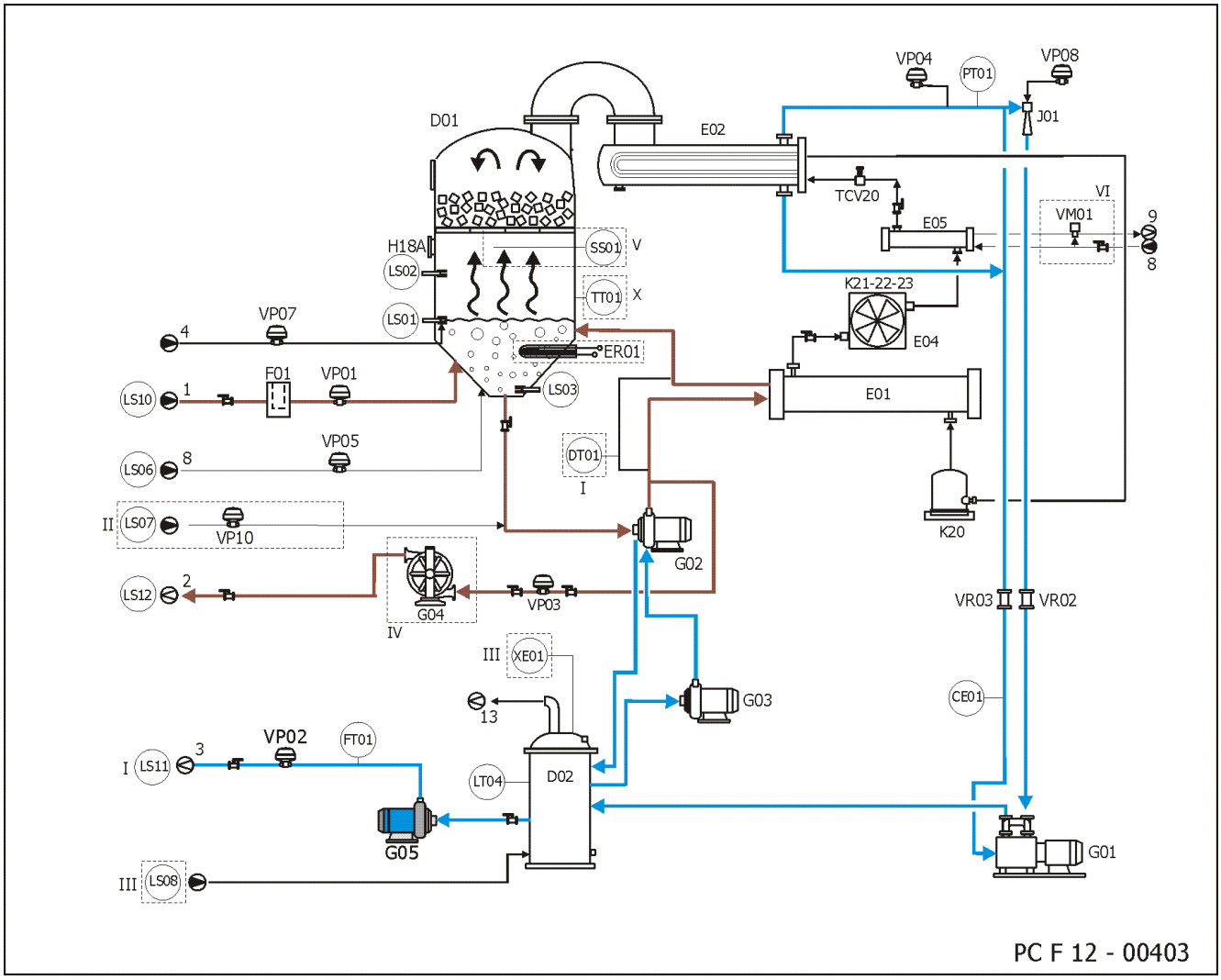


Figure 1

The circles with alphanumeric characters indicate the main sensors on the machine. The Roman numerals and dashed rectangles indicate the optional systems. The numbers next to the inlets and outlets indicate the various connections to the process lines.

3.1 Process liquid circuit

The liquid to be treated is sucked into the evaporation chamber **D01** as a result of the vacuum created inside it by the vacuum system, without using a feed pump. The feed is controlled by the level switch **LS01**, which controls the pneumatic valve **VP01**. The in-line filter **F01** removes any coarse material. The pump **G02** draws the liquid from the bottom of the evaporation chamber and pumps it through the heat exchanger **E01;** this heat exchanger supplies the heat necessary for evaporation. Once heated, the liquid is returned to the evaporation chamber **D01**. As a result of the vacuum in the chamber, a portion of the heated liquid immediately evaporates (flash evaporation). The generated water vapour rises through a separator in order to remove the liquid droplets. The vapour is then condensed against the heat exchanger **E02**.

The vacuum system extracts the distillate together with any incondensable gases and sends them to the tank **D02**. The distillate is discharged from tank **D02** through the opening of valve **VP02** and the activation of pump **G05**. Incondensable gases are vented through the collector (output 13 Figure 1) from the distillate storage tank **D02**. The concentrate is discharged automatically according to the equipment operating time through the opening of the pneumatic valve **VP03**.

Internal washing of the **LS01** level sensor and sight glass in the evaporation chamber is carried out automatically.

3.2 Vacuum system

The vacuum system consists of a liquid ring pump **G01** coupled with the ejector **J01**. The pump liquid ring is fed with the distillate produced by the machine itself. The ejector uses the ambient air as the driving fluid. The efficiency of the vacuum system depends on the temperature of the driving fluid. The opening of solenoid valve **EV04** breaks the vacuum inside the evaporation chamber.

3.3 Heat pump circuit

The heat necessary to evaporate the liquid and the cooling necessary to condense the steam are both supplied by the heat pump circuit. The refrigerant, in the gaseous phase, is heated by the compressor **K20**. The liquid then passes through the heat exchanger **E01** and releases part of its heat to the liquid to be evaporated. In this way, the refrigerant cools and starts to condense. The finned heat exchanger **E04** completes the condensation of the refrigerant, and any excess heat is released into the environment. The refrigerant, in the liquid phase, is sent to the lamination valves **TCV20** and **TCV21**, which cause expansion and cooling. The refrigerant joins the exchanger **E02** in order to condense the water vapour produced by the boiling of the liquid in the boiler.
The cycle is completed with the suction of the refrigerant, in the vapour phase, by the compressor.

3.4 Auxiliary liquids

An antifoam agent supplied through the pneumatic valve **VP05**.
Water for the internal washing of the evaporation chamber level sensor **LS01**.
An additive supplied through the opening of valve **VP10** if the optional system **OM AD F** is present.
Water for auxiliary cooling through the exchanger **E05** if the optional system **OC TP R** is present and for the cooling of the distillate during the start-up if the ambient temperature is too high (**VP12**) .
pH adjusting agent to adjust the pH of the distillate if the optional system **OC pH D** is present.
Bactericide for the distillate, if the accessory system **AM BT D** is present.

4 Options and accessories

(*1)	Code	Description	Standard/Opt
[-]	OM AF F	Antifoam agent dosing device	S
[-]	OC FM D	Distillate Flow Device	S
[-]	[-]	Provision for level control on external process liquid tanks	S
I	OC DN C	Concentrate density control and measuring device(*2)	O
II	OM AD F	Additive dosing device (*2)	O
III	OC pH D	Distillate pH adjustment device (100 litres tank)	O
IV	OT DP C	Concentrate transfer device	O
V	OC AF F	Automatic foam in boiler control device	O
VI	OC TP R	Auxiliary cooling device	O
VIII	OC CN D	Distillate conductivity control device	S
[-]	OW TW	Automatic washing of the level switch in the evaporation chamber	S
[-]	OC TP C	Heating system in boiler	O
[-]	OW CH (PC F)	Automatic chemical washing system for series PC F evaporators *(*2)*	O
[-]	OC PB	Profibus interface device *(*2)*	O
[-]	OC EN	Ethernet interface device *(*2)*	O
[-]	OI AQ	Interface device for Aquavista digital platform *(*2) (*3)*. Ethernet option “OC EN” required	O
[-]	AM BT D	Bactericide dosing device	O
[-]	OT CP D	Distillate transfer device (40 l/min – 2 bar)	S
[-]	AT SP D	Distillate pressurization device (tank not included)	O
[-]	AC pH F	Feed pH adjustment device	O

**1) See the diagram in figure 1. *2) To be considered when ordering. *3) Can be combined with remote control contract EVA-Link. Refer to the specific Aquavista documentation.*

As regards the automatic chemical washing system **OW CH (PC F)**, the interface device for Aquavista digital platform **OI AQ** and accessories refer to the specific technical report.

5 Construction materials

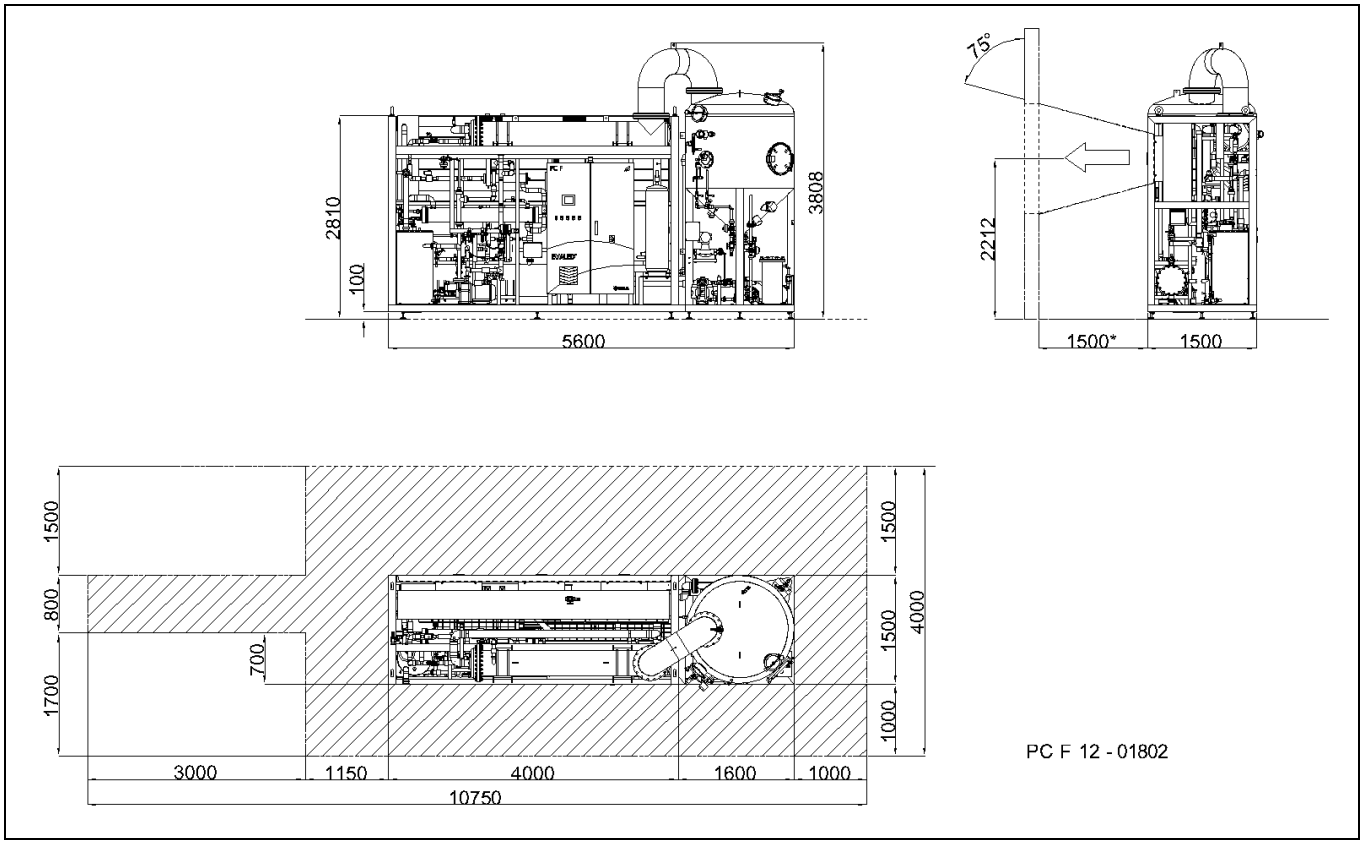
The main materials that come into contact with the process liquids are listed in the following tables.

Key:

SS 304/L	austenitic stainless steel AISI 304 (EN 1.4301) / AISI 304L (EN 1.4307)
SS 316/L	austenitic stainless steel AISI 316 (EN 1.4401) / AISI 316L (EN 1.4404)
SDSS	super duplex stainless steel UNS S32750 / UNS S32760 (EN 1.4410 / EN 1.4501)
IRON/CS	cast iron / carbon steel
PP	polypropylene
Cu	copper
Al	aluminium
C22 / C276	nickel alloy UNS N06022 / UNS N10276
FPM	fluoropolymer
EPDM	ethylene propylene diene monomer
PTFE	polytetrafluoroethylene
CSP	painted carbon steel
Ti	G2 Titanium

Component	**ID**	**PC F NN AA#**	**PC F NN FA#**	**PC F NN FF#**	**PC F NN HH#**
Lower wall of evaporation chamber	**D01**	SS 316/L	SS 316/L	SDSS	C22
Dome of evaporation chamber	**D01**	SS 316/L	SS 316/L	SS 316/L	SS 316/L
Distillate collection tank	**D02**	SS 316/L	SS 316/L	SS 316/L	SS 316/L
Shell and tube heat exchanger (pipes-shell)	**E01**	SS 316/L	SDSS	SDSS	C22
Heat exchanger	**E02**	SS 316/L	SS 316/L	SS 316/L	SS 316/L
Finned heat exchanger	**E04**	Cu/Al	Cu/Al	Cu/Al	Cu/Al
Shell and tube exchanger	**E05**	Cu –IRON/ CS	Cu –IRON/ CS	Cu –IRON/ CS	Cu –IRON/ CS
Vacuum pump	**G01**	SS 316/L	SS 316/L	SS 316/L	SS 316/L
Circulation pump	**G02**	SS 316/L	SS 316/L	SDSS	C276
Concentrate discharge pump (option)	**G04**	PP	PP	PP	PP
Boiler resistor (option)	**ER01**	SS 316/L	SS 316/L	Ti	Ti
Liquid ejector	**J01**	PP	PP	PP	PP
Evaporation chamber level sensors (blades)	**LS**	SS 316/L	SS 316/L	SS 316/L	C22
Structure and frame	**-**	SS 304/L	SS 304/L	SS 304/L	SS 304/L
Piping and line parts	**-**	SS 316/L + PP	SS 316/L + PP	SS 316/L + PP	C22 + PP
Heat pump piping	**-**	Cu	Cu	Cu	Cu
Gaskets	**-**	FPM+PTFE +EPDM	FPM+PTFE +EPDM	FPM+PTFE +EPDM	FPM+PTFE +EPDM
Electric board		CSP	CSP	CSP	CSP

6 Dimensions and clearance zones



* Minimum distance from the wall in the absence of a suitable opening (990 x 3250 mm) or adequate ducting.

Figure 2

A clearance height of ~2000 mm is required above the machine for maintenance operations.

7 Dimensions, weight, packaging, storage and handling

Type	Module	Dimensions [mm]	Weight [kg]
Standard packaging (pallet + nylon)	*exchanger module*	4100 x 1500 x 2810	3300
	boiling chamber	3170 x 1500 x 1500	680
	joint	1400 x 1900 x 700	100
Wooden crate packaging (also with protection bag)	*exchanger module*	4380 x 1700 x 3090	4000
	boiling chamber and joint	3860 x 1700 x 2020	1300
Empty without packaging/under normal conditions with water		see Figure 2	4050/5000

If required, the equipment must be stored packaged and protected from the weather. In any case, the temperature of the storage area must be between **+5** and **+35**°C and the non-condensing relative humidity must be between 20% and 80%.

The evaporator can be moved by pallet truck or forklift truck with forks of a suitable length or by a self-propelled crane or gantry crane using a harness and sling to balance the load.

The machinery contains refrigerant gas (R134a - UN2857 - class 2.2) and can be transported by land with partial exemption according to ADR legislation.

8 Environmental conditions, ventilation and auxiliary cooling

The finned heat exchanger of the heat pump system produces warm air which should be discharged through an appropriate ventilation system to ensure the necessary air circulation. This system could be a simple direct opening to the outside or suitable conveying or forced ventilation systems. If there is no suitable opening in the wall, it is necessary to leave a minimum distance in front of the ventilator as shown in Figure 2.

Temp.	Working conditions
10÷40 [°C]	normal conditions
0÷10 [°C]	start-up allowed with specific precautions. It's recommended using the optional heating system in boiler **OC TP C**
40÷45 [°C]	it is compulsory to use the optional auxiliary cooling system **OC TP R**
>45 [°C]	contact VWT Italia

The machine is designed to be installed at a maximum altitude of 1000 metres a.s.l. (for installations at higher altitude contact VWT Italia).
The nominal performances stated in this document are guaranteed for a liquid feed temperature lower than 55°C.

The cooling water used for the optional auxiliary cooling device **OC TP R** should be compatible with the E05 exchanger materials. Any use of the distillate is not allowed. The cooling water specific properties are listed in the following table.

Cooling Water	PC F 12
Refrigeration units [kW]	44
Output water temperature [°C]	45
Maximum tap water flow rate required (input temperature 15°C) [m^3/h]	2,1
Maximum tower water flow rate required (input temperature 28°C) [m^3/h]	3,8
Pressure drop [kPa]	120
Maximum input water pressure [kPa]	300

If a cold water heat exchanger is installed instead of the finned heat exchanger E04, the coolant water flow rates have to be approximately three times the amount listed in the table above.

9 Installation requirements

The machine is designed to be installed in safe areas with non aggressive atmosphere, indoors on a horizontal surface that can support the weights listed in section **7**. There must be clearance areas around the machine to enable users and maintenance staff to work unobstructed and to allow the passage of cooling air from the ventilator as specified in section **6**. The features of the hydraulic connections are listed below:

(*1)	Description	Type	Dext [mm]	Available outlet pressure [barg]	Required inlet pressure [barg]
1	Liquid to be treated inlet	Hose adapter	32	-	-0,6 <P< 1
2	Concentrate discharge	Hose adapter	32	~0,3	-
2	Concentrate discharge with pump (option IV)	Hose adapter	32	~3	-
3	Distillate discharge	Hose adapter	25	~2	-

**1) Ref. Figure 1*

The machine is supplied with a collector for the conveyance of non-condensable gases (see output 13 in figure 1) that must be advisably canalized, if necessary, in respect of the local regulations.

The following utilities are required to operate the machine, with the specified characteristics:

	Setup	Required pressure	Consumption	Connection	Features
Compressed air	PC F 12 –3/4	6 [barg]	1 [Nm^3/h]	PE tube (Dext 12 mm)	Water- and oil-free
Compressed air	PC F 12 –3/4 with IV option	6 [barg]	20 [Nm^3/h]	PE tube (Dext 12 mm)	Water- and oil-free
Tap water	PC F 12 –3/4	1,5-3 [barg]	2 [m^3/h] (intermittent flow)	PP tube (Dext 32 mm)	For washing of components in D01

	Setup	Frequency	Voltage	Nominal current / Installed power	Power supply
Electric energy	PC F 12 --3	50 (±2%) [Hz]	400 (±4%) [V]	198 [A] / 114 [kW]	3-PHASE + EARTH
Electric energy	PC F 12 --4	60 (±2%) [Hz]	460 (±4%) [V]	180 [A] / 109 [kW]	3-PHASE + EARTH

Electric cabinets are designed for triphase power feed networks type TN-C, TN-S (without neutral) or TT.
Short circuit current rating (Icc) ≤ 10kA.

The power connection to the electricity network must be made according to the characteristics reported in the wiring diagrams.
An adequate electrical protection system must be put in place upstream of the machine by a qualified engineer, according to good practice.

10 Documentation

The machine is supplied with standard documentation, realized according to standard Veolia formatting, symbols and tagging of components and that includes all options available for the machine. Different requests must be considered when ordering.

Standard documentation package includes:

- Installation, use and maintenance manual;
- Process diagram (P&ID);
- General assembly drawing with tie-points list;
- Wiring diagram;
- Spare parts list;
- FAT test report;
- CE declaration of conformity.
- Manuals of the main components installed on the machine (pumps, frequency inverter, instruments,…).

Physical quantities used in manual and HMI are expressed in SI units (International System) and derived units.
Standard documentation package is provided in hard copy (electronic version on request - pdf file).

11 Environmental Impact Reduction: CO_2 emissions

Below are the results of our Carbon Footprint study and a comparison with an extreme case of pollution:

$kgCO_{2eq}/m^3$ treated liquid waste	81,54
Percentage of emissions avoided with respect to incineration of the liquid waste	-93,5%

The first value represents an average between the various industrial uses considering machine usage of 24h/d, 330 d/y, for 10 years, road transport of the machinery 1000 km from the manufacturer's production site and road

transport of the chemical products for a distance of 100 km from the customer's site. The data for comparison with incineration was weighted for machine efficiency, i.e. the ratio between the initial liquid waste to be treated and the residual concentrate to be disposed of.

12 Chemical products

Chemical products are required during the normal operation of the machine. In order to obtain the best performances together with minimum consumptions, the manufacturer recommends using "Hydrex" chemical products.

"Hydrex" is the VEOLIA brand that meets the chemical products requirements of the wastewater treatment and process water production.

Notes

- For details concerning machine safety and installation, refer to the use and maintenance manual.

- The data in this document are indicative. VWT Italia reserves the right to change any data without prior notice. The front-page photograph is not representative of all versions or all models.