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Budapest Újpest Szt. István sq. - Thermal energy supply with sewage heat utilization

Operation and maintenance manual for the operator and the end-user

Thermal energy generation system proposed at the project:

HEAT4COOL

Smart building retrofitting complemented by solar assisted heat pumps integrated within a self-correcting intelligent building energy management system

THERMOWATT

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1 COMPREHENSIVE OPERATION & MAINTENANCE INSTRUCTION MANUAL

1.-The introduction of the installation

Based on preliminary assessments, the decision has been made to use sewage heat recovery to meet the thermal needs of the facilities in a modern and renewable fashion.

2.-The tasks of project realization

The sewage heat utilization technology includes a screening unit, heat exchangers, heat pumps and water pumps ensuring circulation.

Components of the sewage heat utilization system: heat pump engine room, heat exchanger engine room and screening engine room

3.-Sewage availability

The area's sewer network is combined. There is a large main collector below the Gabor Laszlo Street at St. Stephan Square.

Characteristics: DN2800 sized Rocla type steel reinforced concrete pipe
The flow measured by Budapest Sewage Works amounts to min. 500 m^3/h
The flow bottom of the pipe at the access point is 101,37 mBf.
The pipe is operated by the Budapest Sewage Works (Budapest Asztalos Sándor út 4.).

4.-The operation of the technology

Heat utilization concept: thermal energy production by heat pump.
The sewage flows from the main collector into a chamber where it is directed through a 42° tilted DR7220E4M type screening unit to separate the sludge. The screening-out of the sludge is required to avoid the clogging of the heat exchangers and therefore allow for the installation of the simpler shell and tube type heat exchangers. The sludge is vertically lifted and fed back to the main collector with the sewage flow returning from the heat exchangers. The screened sewage is directed to the heat exchangers where it transfers its heat to a technological water. The technological water is then directed to the heat pump which is connected to the building to provide heating and cooling depending on needs.

5.-Technological advantages

- Fast and easy installation
- Compact heat exchanger can be used
- Independent of the size of the sewage pipe
- Easy and efficient control
- Clogging occurs only during operational error
- Low maintenance cost

6.-Additional characteristics of the technology

- Fast commissioning
- Independent from gas and oil

- Cost efficient
- Environment-friendly
- Easy access to heat source

7.-Technology components

- Main collector and connecting pipes
- Screening unit and sludge lifting unit
- Filtered sewage return pipes
- Water pump for the screened sewage
- Heat exchanger
- Heat pump, water pumps ensuring circulation
- Electrical network (strong current, weak current, measuring equipment
- Pipework
- Air compressor for pneumatics

8.- Technical data of main technology components

- Screening unit and sludge lifting unit

Diameter of drum:	700	mm
Useful length:	2200	mm
Diameter of perforation:	4	mm
Nominal flow rate:	250	m3/h
Mounting angle:	42°	
Power unit type:	Nord SK5382	
Engine capacity:	1,1	kW
Weight:	3131	Nm
Full length:	5720	mm
Full weight:	3479	kg

- Screened sewage water pump

Type:	Grundfos	SL1.110.200.245.4. 52M.S.N.61G
Nominal flow rate:	250	m3/h
Lifting capacity:	23,6	m
Electrical power:	23,7	kW
Nominal spinning speed:	1776	1/min
Full weight:	331	kg

- Heat exchanger

Installation:	2 pcs A +2 pcs B	piece
Shell diameter:	610	mm
Useful length:	3000	mm
Tube size A:	35x1,5	mm
Tube size B:	38x1,5	mm
Connecting sewage pipe size:	DN 200	mm
Connecting tech. water pipe size	DN 200	mm
Nominal capacity:	200	kW
Sewage section volume:	488/428	dm3 A/B

Tech. water section volume:	537/597	dm3 A/B
Operating weight:	2 295/2 335	kg A/B

- Heat pump

Type:	Carrier	30XWHP0712 water-water heat pump
Heating capacity:	708,8/859,9	kW heating/cooling
Cooling capacity:	514,4/728,1	kW heating/cooling
Total electrical power:	128,3	kW heating/cooling
Heating efficiency (COP):	3,39	kW/kW
Cooling efficiency (EER):	4,3	kW/kW
Evaporator temperature (in/out):	7-12	°C heating/cooling
Evaporator volume flow:	35	l/s
Evaporator pressure drop:	51,7	kPa
Condenser temperature (in/out):	60-50/33-26	°C heating/cooling
Condenser side volume flow:	29,5	l/s
Condenser side pressure drop:	40,0	kPa

- Water pumps ensuring circulation

  - Technical pump

Type:	Grundfos	NB 100-160/176 A-F2-A-BAQ
Nominal flow rate:	255	m3/h
Nominal lifting capacity:	20,6	m
Electrical capacity:	18,5	kW

  - Condenser pump

Type:	Grundfos	NB 65-200/219 A-F2-A-BAQE
Nominal flow rate:	61,8	m3/h
Nominal lifting capacity:	11,5	m
Electrical capacity:	3,0	kW

  - Evaporator pump

Type:	Grundfos	NB 65-160/177 A-F2-A-BAQE
Nominal flow rate:	125	m3/h
Nominal lifting capacity:	25,3	m
Electrical capacity:	15,0	kW

9.-Launching and restart order of component parts

Launching order:

- Machine gates open, fine screen starts
- Technical pump starts

- Evaporator pump starts
- Condenser pump starts
- Heat pump starts
- All technical components launch at minimum capacity and then their capacity increases; for the pumps with their inverter and for the heat pump with its own internal control

The shutdown happens in the reverse order of the launching.

10.-Technical machinery operational conditions

I. Valve:

The screened sewage water pump can only operate in the event of an open forward valve.

II. Valve:

The screened sewage water pump can only operate in the event of the sewage level reaching the minimally required level in the chamber.

III. Valve:

The heat pump can only be launched if the condenser and evaporator pumps are in operation.

IV. Valve:

The operation of the pumps is only possible in the event of proper pressure in the pipes. Protection is ensured by built-in pressure switches. The supply of water is ensured by a compressor expansion automat, the feedwater is directed through a water softener equipment.

The first rule of maintenance is that maintenance must be done according to the attached manuals of each technical equipment.

11.-The operation and maintenance of screening units

The operation and maintenance of screening units are performed according to the attached manual.

12.- The operation and maintenance of the screened sewage water pumps

The operation and maintenance of the screened sewage water pumps are performed according to the attached manual.

13.- The operation and maintenance of heat exchangers

The operation and maintenance of heat exchangers are performed according to the attached manual.

14.- The operation and maintenance of heat pump

The maintenance and repair of the equipment under guarantee can only be carried out by an accredited company with the consent of the distributor.

The operation and maintenance of the heat pump are performed according to the attached documents: 1. Carrier 30XA/XW heat pump operation and maintenance. 2. Carrier 30XA/XW TouchPilot control operation and maintenance

15.- The operation and maintenance of pumps ensuring circulation

The operation and maintenance of pumps ensuring circulation are performed according to the attached manual.

16.-Attachments

- Annex I ENG 1: Operation and maintenance of screening unit. English version
- Annex I ENG 2: Operation and maintenance of screened sewage water pumps. English version
- Annex I ENG 3: Operation and maintenance of heat exchangers. English version
- Annex I ENG 4.1: Operation and maintenance of heat pump. English version
- Annex I ENG 4.2: Operation of heat pump Touch Pilot Control. English version
- Annex I ENG 5.1: Operation and maintenance of pumps ensuring circulation. Grundfos CUE series. English version
- Annex I ENG 5.2: Operation and maintenance of pumps ensuring circulation. Grundfos NB, NBG series. English version

2 OPERATION OF SCADA CONTROL AND MONITORING SOFTWARE, INSTRUCTIONS FOR THE OPERATOR

The task of the wastewater recovery system created at Újpest St. Stephan Sq. is to satisfy the heat demand (heating and cooling demand) of the selected building at the square. For the heat recovery, the system uses the heat of the available wastewater.

The task is provided by the heat pumps and their associated unites – circulating pumps, gate valves, sewage pumps - located in the underground engine room and in the marketplace. The two engine rooms are connected by optical cables for information flow.

The connection is provided by S1200 type PLC units along with their associated HMI equipment which are situated in the engine rooms.

The PLC units ensure the measurements and interventions necessary for the automatic control.

HMI devices display system signals and provide the ability to change the control parameters.

The remote monitoring of the system is carried out by the dispatcher system at the headquarters of THERMOWATT Ltd.

The structure of the system:

Underground engine room,
- HMI displayer
- S1200 type PLC,
- heat pump,
- technological water circulating pump,
- condenser circulating pump,
- evaporator pump,
- sewage pump with valves,
- wastewater fine screen,
- heat meters and thermometers.

Marketplace engine room,
- HMI displayer,
- S1200 type PLC,
- heat pump,
- condenser circulating pump,
- evaporator pump,
- heat meters and thermometers
- regulating valves

Operation of the underground engine room

The incoming wastewater is received and transmitted by opening or closing the incoming valve, by adjusting the level of the wastewater in the pit with the frequency converter pump and by opening or closing the sliding valve.

Operating the incoming wastewater gate valve: By default, the gate valve is open, it closes at the analog set maximum level of wastewater (it is triggered by switching the operating maximum level switch).

Operating the outlet gate valve: By default, the gate valve is open, it closes at the command of the emergency maximum level switch.

Operating the sewage pump: Based on the signal of the analog level meter the wastewater pump operates at the maximum rotational speed in the upper range, below that in 3 further stages at reduced speed (controlled by the frequency inverter). Below the minimum operating level it stops, it also stops at the signal of the minimum level switch and if the outlet gate valve is closed by the system.

Managing emergency-maximum position with remote control: The outlet gate valve is opened and the sewage pump is started. If the water level continues to rise (analog sensor), the pump gets stopped and the outlet gate valve gets closed. If the water level lowers, the automatic operation can be restored after reaching the maximum operating level.

Operation of the wastewater fine screen (drum filter): The wastewater drum filter is powered by a frequency converter. The filter runs in intermittent operation, in default settings the filter runs for 20 seconds ’forward’ which is followed by 2 minutes of inaction. After every 10th-20th rotation, it initiates one rotation to the other direction (up to 20 seconds). The length of the pause time, the length of the operation time as well as the number of counter-rotation cycles can be changed in the settings.

Operation of the heat pumps: The basic condition of the operation of the heat pumps is to have the necessary fluid flow in the condenser and the evaporator cycles as wel. This can be achieved by the proper combined operation of the condenser, evaporator and the technological water pump. The heat pump’s operating mode can be chosen, whether it is for cooling or heating. It is also possible to limit the heat pump performance. The heat pump can be started or stopped.

Cooling and heating setpoint can be given at a function of the external temperature:

- the setpoint valid below the lower value of the outdoor temperature
- the setpoint valid above the upper value of outdoor temperature
- the setpoint is determined linearly by the value of the outside temperature in the intermediate range

(Parameters:1. lower value of outdoor temperature; 2. valid setpoint; 3. upper value of outdoor temperature; 4. valid setpoint)

Operation of the circulating pumps: The rotational speed of the pumps is determined by the temperature difference of the transported medium:

- the valid value of the rotational speed below the lower value of the temperature difference (%)
- the valid value of the rotational speed above the upper value of the temperature difference (%)
- in the intermediate range, the rotational speed is determined linearly as the function of the external temperature difference (%)

(Parameters:1. lower value of temperature difference; 2. valid rotational speed (%); 3. upper value of temperature difference; 4. valid rotational speed (%))

Operation of the marketplace engine room

The control method of the heat pump and pumps in the engine room of the marketplace is the same as described above.

In the summer (cooling) period of the system it is also a task to participate in the production of the DHW of the building, the procedure is the following: If there is any DHW demand (Control contact status) for the marketplace, the following interventions apply: Nr. M-13.3 and M-13.4 valves close. When the temperature value measured by the T103 sensor reaches 60°C, M-13.1 valve closes, M-13.2 valve opens, P-15 pump at the right rotational speed ensures equilibrium of the heat pump's condenser side while the system continues to function according to the normal requirements of the cooling task.

Description of HMI displays

On the underground engine room's HMI device the total system's operation can be monitored. With the help of the installed Sm@rtClient program the operation can be supervised by the dispatcher center of the THERMOWATT Ltd.

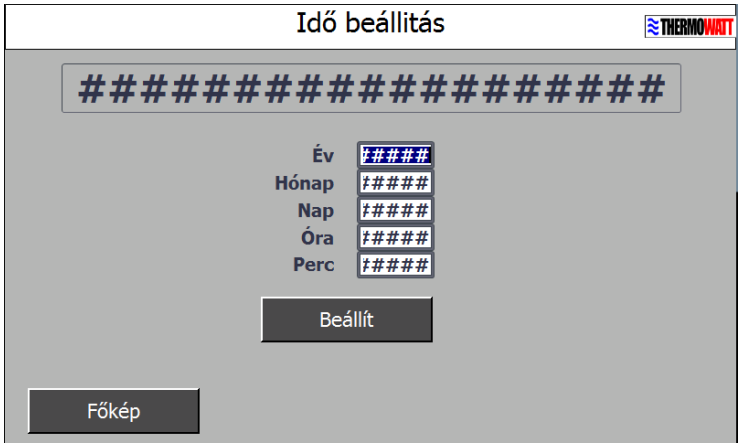
For application of the program on the international market, simple translation makes it easy to select any language display.

Description of the underground engine room's HMI device

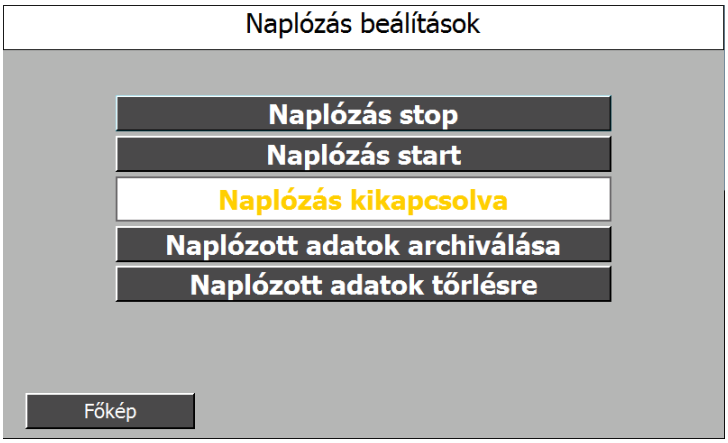
- Images of the device screen at the underground engine room:

From the main screen of the system you can navigate through the menu items using the navigation buttons. Description can be seen below.

General settings:

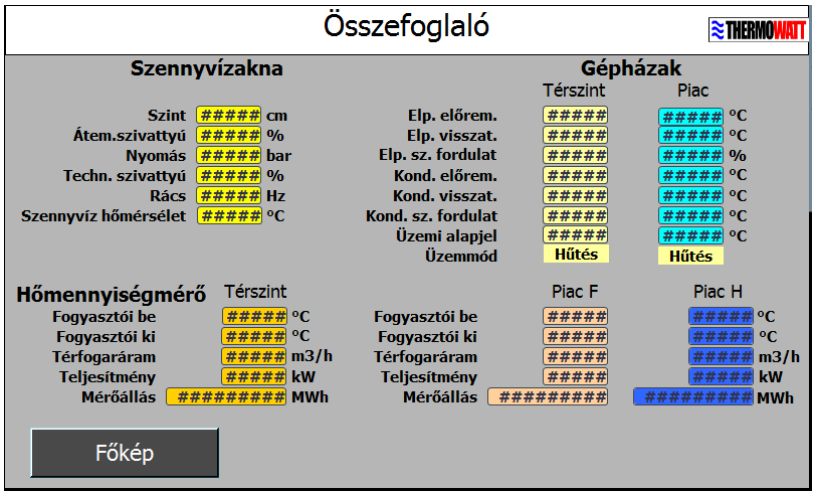


The system clock can be set here. You can accept the value by pressing the 'Set' button.

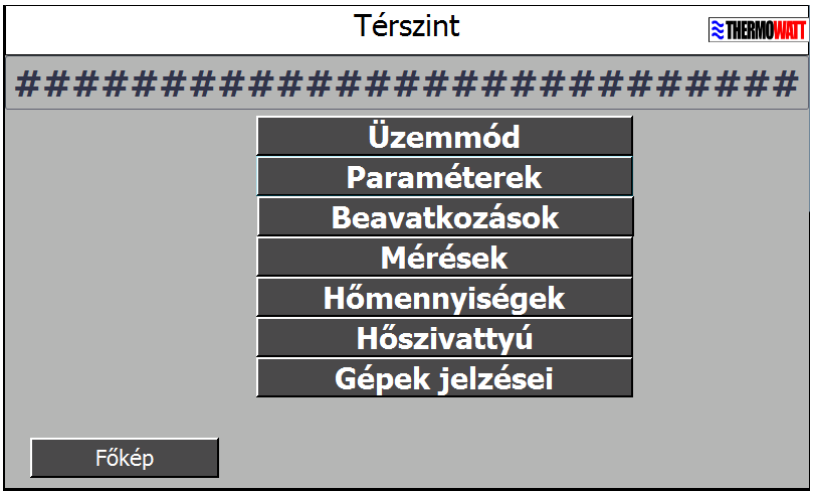


The device stores predefined data that can be read back from the control center. The process of monitoring can be started or stopped using the navigation buttons, the data can be archived

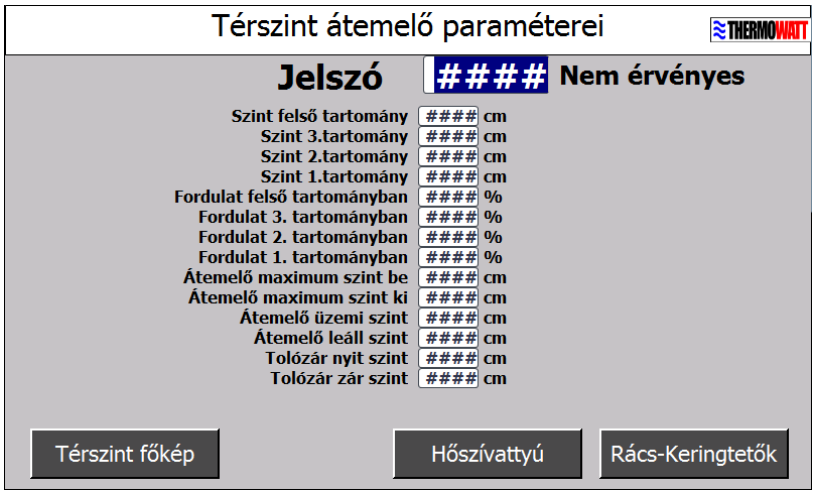
or deleted. The list of monitored parameters can be found in the Nr. 1 Supplementary table, at the end of the chapter.



The ’Summary’ menu of the main page shows the most important data for both engine rooms.

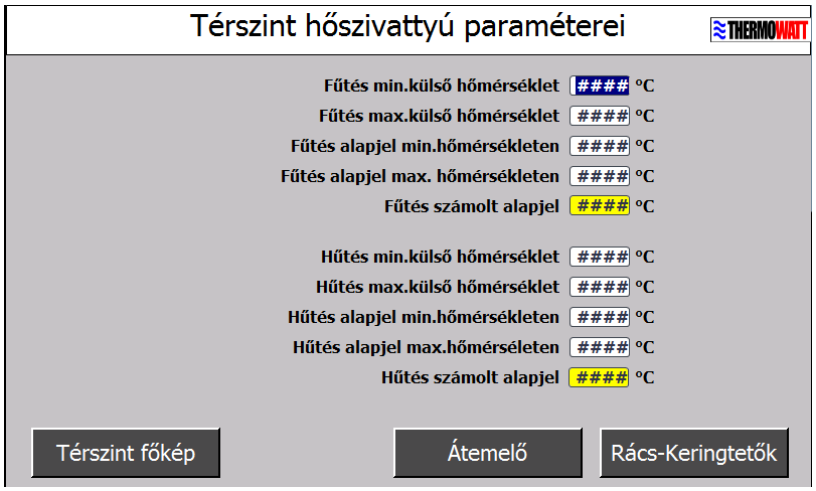


The signals and parameters of the underground engine room can be followed from this screen.

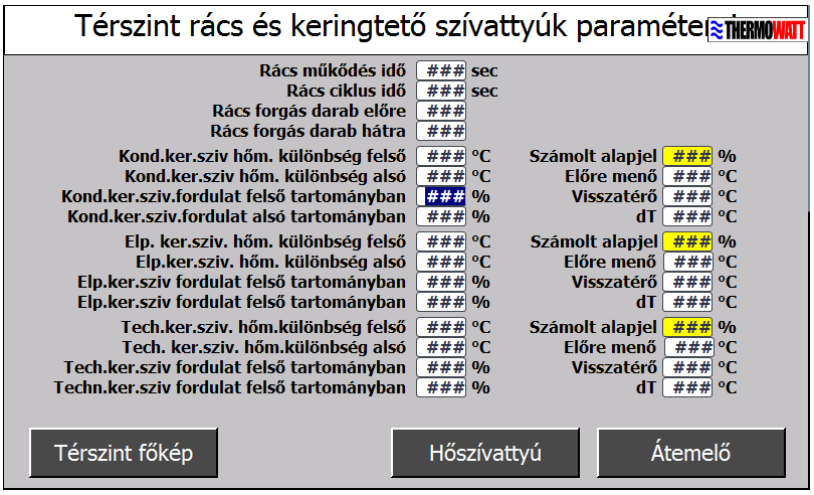


Parameters of the whole system are protected by password to avoid accidental interventions. Password: ####. The password is valid for 10 minutes and then terminates. If the password is valid, ”valid” sign appears on the screen.

The switching and control values of the sewage pump can be set on this screen.

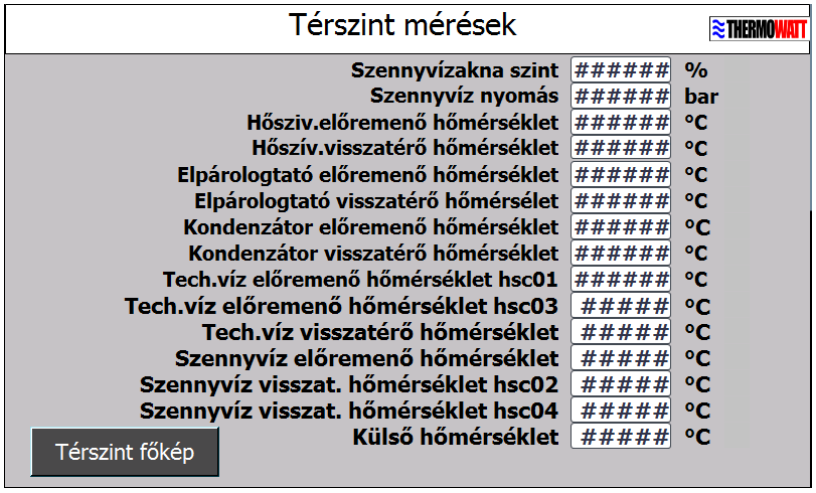


The parameters of the heat pump can be changed here, the calculated setpoint for the control appears in the yellow marked field.

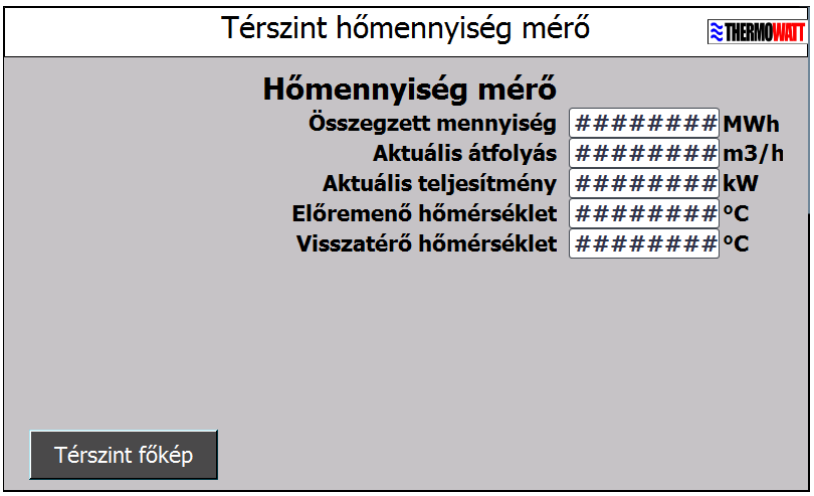


The parameters of the fine screen (drum filter) and the circulating pumps can be changed here, the calculated setpoint for the control appears in the yellow marked field.

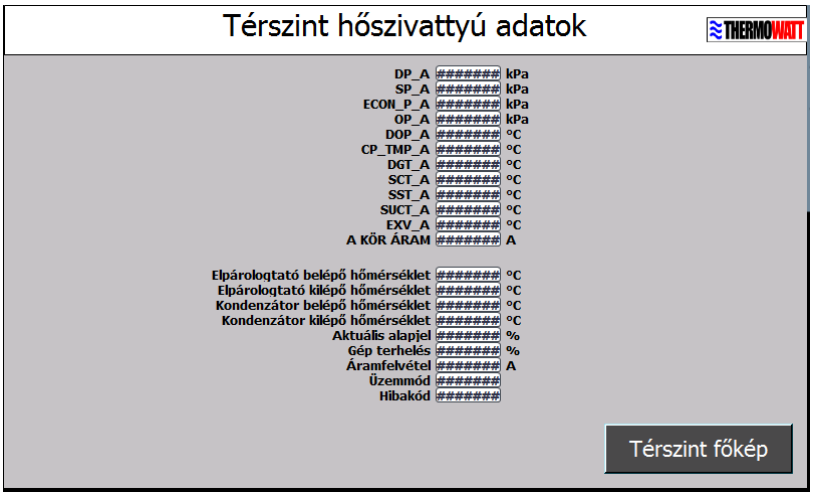
In the case of servicing (repairs), machines can be started and shut down without automatic operation. The rotational speed of the pumps can also be changed.



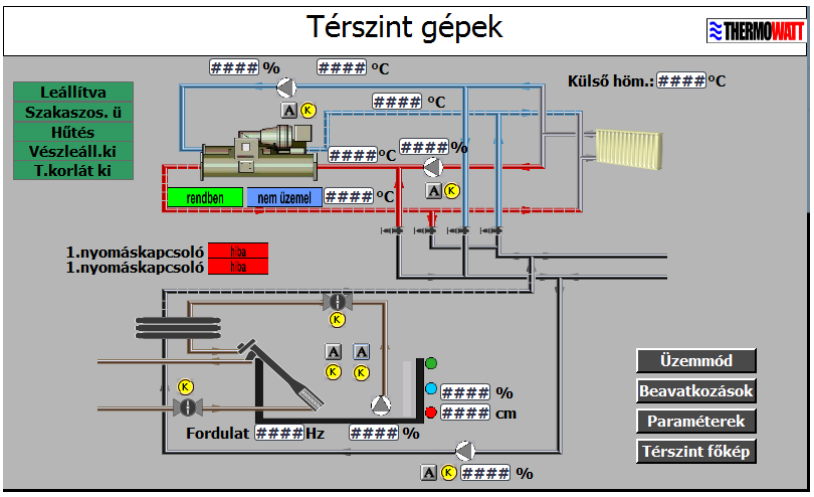
Measurements of the technology system appear here.



The current data for the built-in heat meters are displayed here.

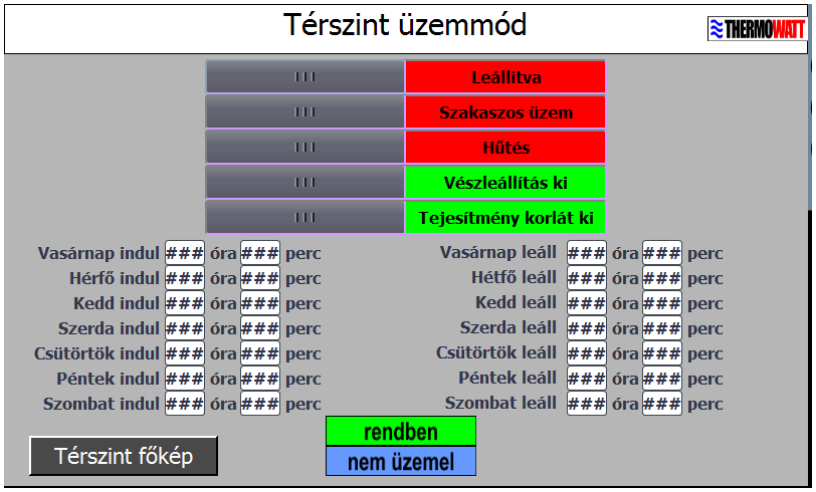


Datas of the heat pump:



An overview of the machines below surface, which can be used to monitor the operating status of the machines and the values of important measurements.

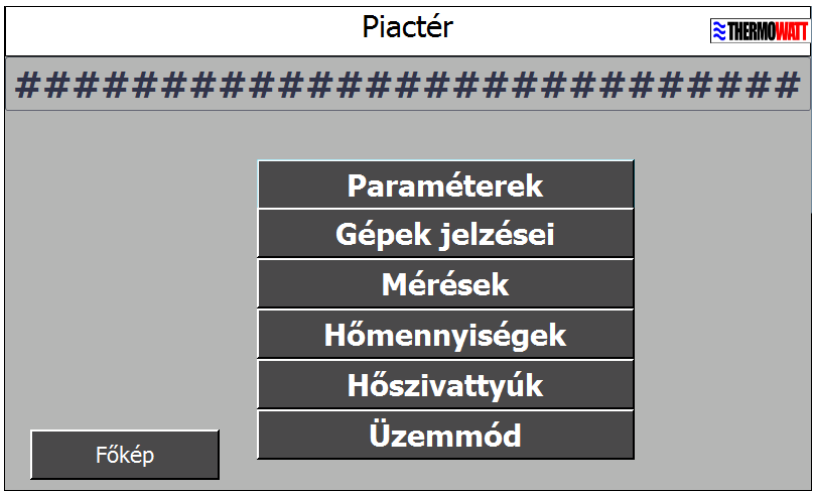
Use the navigation key of the mode selector to move to the 'Surface mode' screen.



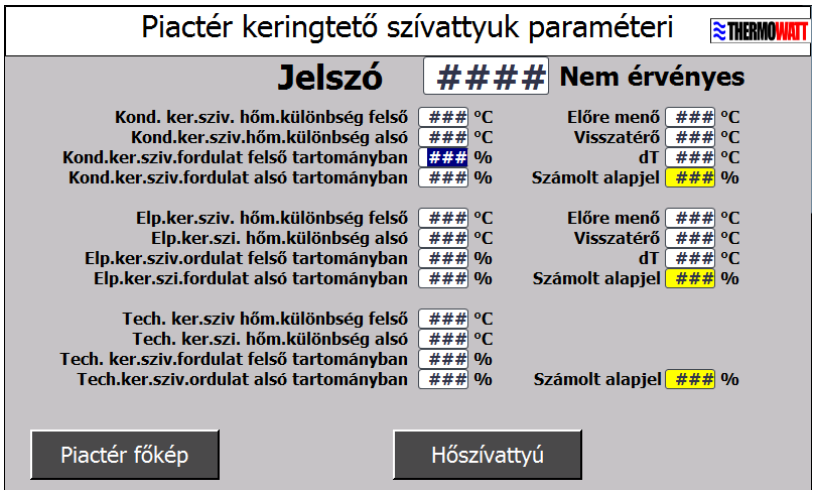
Here you can set the operating modes of the heat pump of the underground engine room.

Enabled/ disabled, continuous operation/ batch operation, heating/ cooling, emergency stop on/ off, power limit on/ power limit off, starting time on/ starting time off (the latter in the case of batch operations per day).

- Images of the device screens at the marketplace engine room::



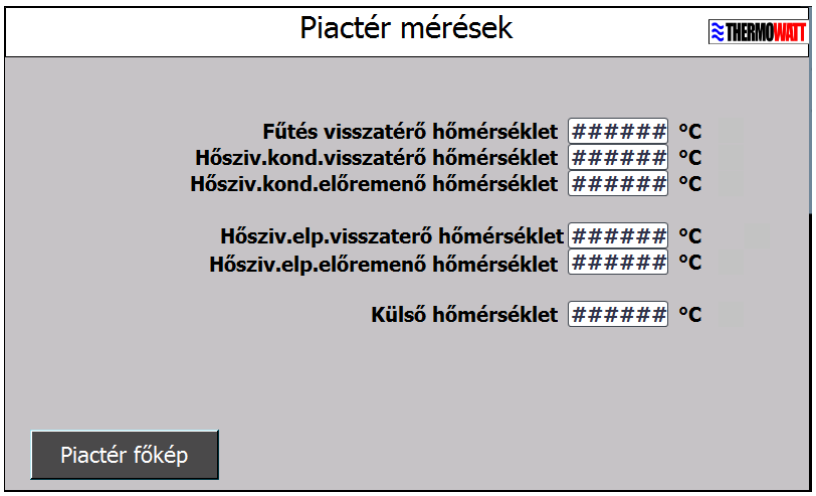
The signals and parameters of the marketplace engine room can be followed from this screen.



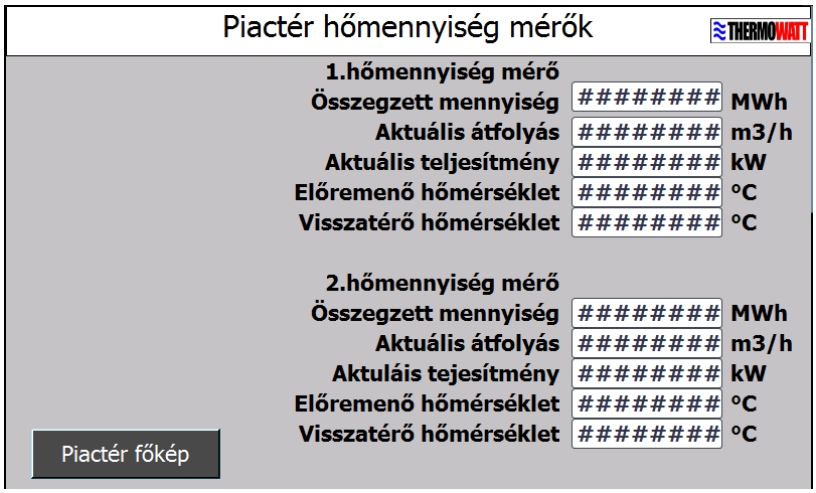
Parameters of the whole system are protected by password to avoid accidental interventions. Password: ####. The password is valid for 10 minutes and then terminates. If the password is valid, ”valid” sign appears on the screen.

The parameters of the circulating pumps can be changed here, the calculated setpoint for the control appears in the yellow marked field.

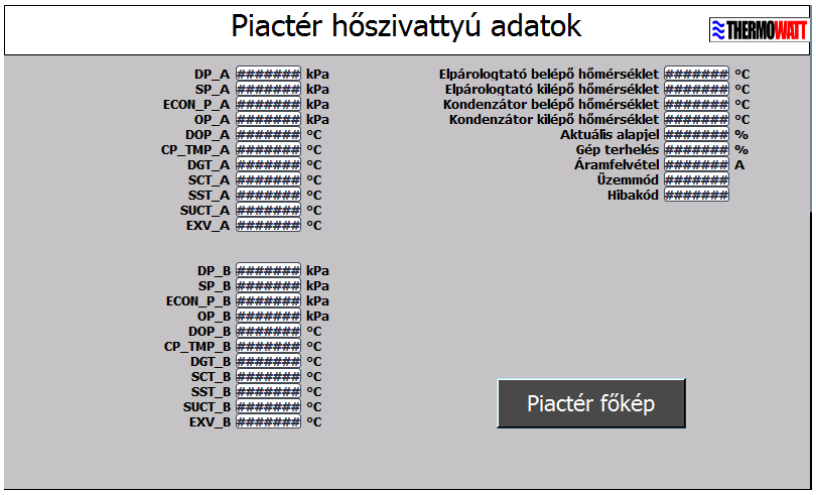
Parameters of the marketplace heat pump and magnet valve.



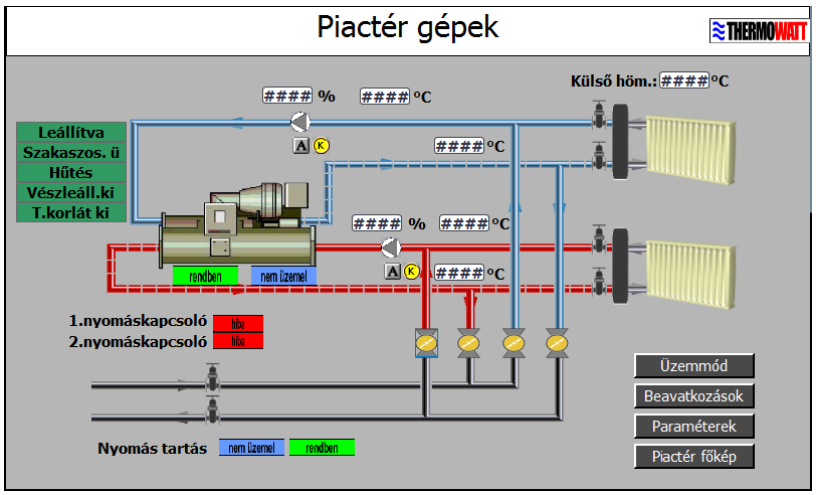
Measurements of the technology system appear here.



The current data for the built-in heat meters are displayed here.



Measured data of the heat pump in the marketplace engine room.



An overview of the machines located in the marketplace engine room, which can be used to monitor the operating status of the machines and the values of important measurements.

Use the navigation key of the mode selector to move to the 'Marketplace mode' screen.

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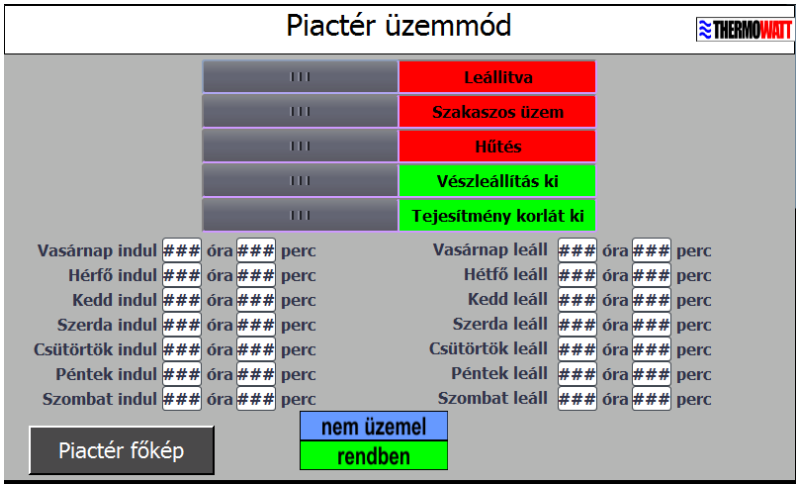


Here you can set the operating modes of the heat pump of the Marketplace.

Enabled/ disabled, continuous operation/ batch operation, heating/ cooling, emergency stop on/ off, power limit on/ power limit off, starting time on/ starting time off (the latter in the case of batch operations per day).

Description of the marketplace engine room's HMI device

A HMI device was also installed in the marketplace engine room. This only performs local display. Except for some important data.

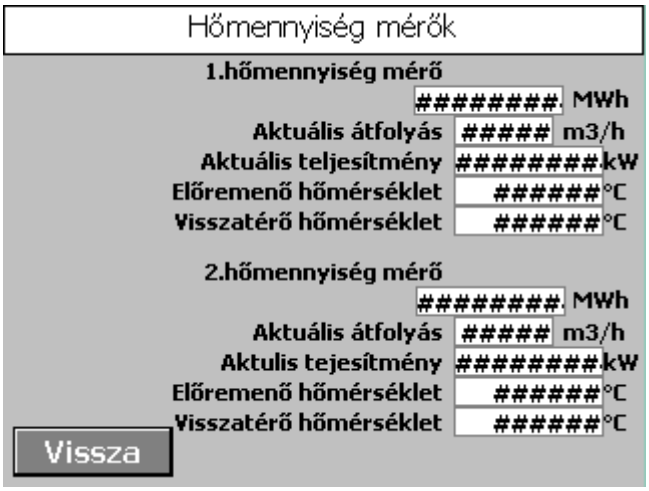
This device has a simplified display. Its handling is similar to the other HMI device placed at the underground engine room, but it does not have remote monitoring.

- Marketplace images

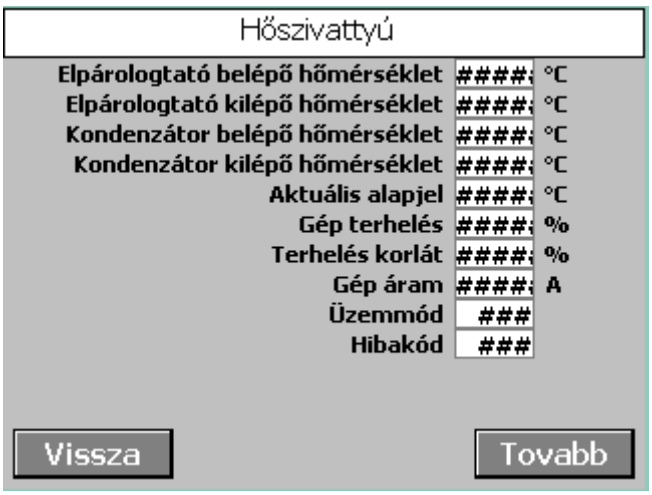
It is used for service (repairs) purpose, just as the other one at the underground engine room.

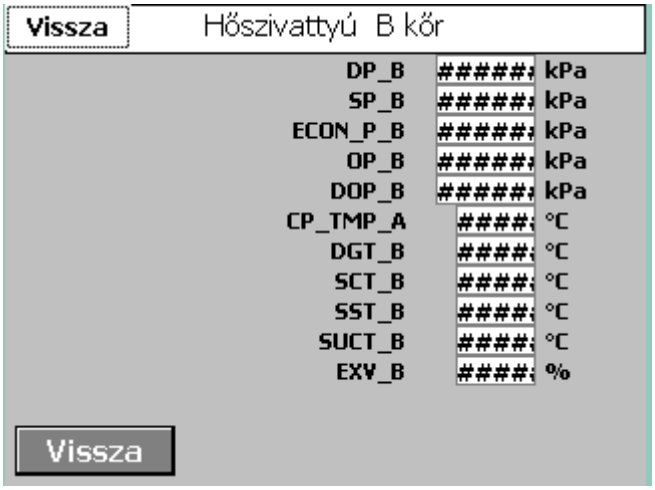
Operating statuses appear in text: operating, stopped, error, manual, automatic, opened/ closed valve.

Values for technological data.



Values of the heat meters.





In case of on-site maintenance, you may need some data from the underground engine room. These can be seen here.

Nr. 1 Supplementary table:

List of monitored parameters

	NAME
1	Pipe-line forward temperature
2	Pipe-line return temperature
3	Pipe-line mass flow
4	Heat quantity 1. (heating)
5	Heat quantity 2. (cooling)
6	Wastewater forward temperature
7	Wastewater return temperature 1.
8	Wastewater return temperature 2.
9	Wastewater forward pressure
10	Primer circle forward temperature
11	Primer circle return temperature
12	Outdoor temperature
13	Electricity consumption, P momentary value
14	Electricity consumption, P total value
15	Electricity consumption, performance factor
16	Electricity consumption, voltage
17	Heat pump 1. performance (%)
18	Heat pump 1. condenser’s forward temperature
19	Heat pump 1. condenser’s return temperature
20	Heat pump 1. evaporator’s forward temperature
21	Heat pump 1. evaporator’s return temperature
22	Heat pump 1. error
23	Heat pump 2. performance (%)
24	Heat pump 2. forward temperature
25	Heat pump 2. return temperature
26	Heat pump 2. evaporator’s forward temperature
27	Heat pump 2. evaporator’s return temperature
28	Heat pump 2. error

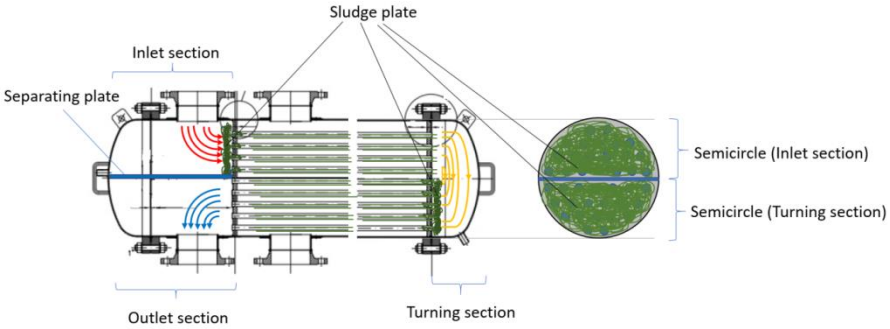
3 SPECIAL OPERATION & MAINTENANCE TASKS

3.1 O&M of HEXs cleaning

CLEANING OF SEWAGE HEAT EXCHANGERS - INTRODUCTION AND BACKGROUND

Cleaning of heat exchangers in the thermal utilisation of sewage is always necessary, as no (economically available) filtration technology exists that would ensure the entry of totally "purified" sewage into the heat exchangers, thereby avoiding contamination.

Illustrating the wastewater flow and fouling of the heat exchangers:



The part of the THERMOWATT technology requiring significant operational and maintenance expenditure and resources is the cleaning (and keeping clean) of the heat exchangers, hence the scientific focus on the analysis of different innovative, alternative cleaning methods in the confines of the Heat4Cool project.

As part of the Heat4Cool research and development project, a new innovated group of HEXs is going to be manufactured and implemented at the Budapest Demo site along with two of the investigated cleaning methods, thus during the supervised experimental operation these methods will ensure the cleaning of the HEXs. Through the multiple testing of the methods their efficiency during real operational circumstances will be evaluated too.

The cleaning methods to be implemented and applied at the Demo system:

1. *Counter-current cleaning (with sewage)*
2. *High pressure cleaning*

A cleaning protocol will be compiled for both cleaning methods that will be taking the one-year-long experimental operational experiences also into consideration.

TIME AND FREQUENCY OF CLEANING

After having decided which cleaning method is to be applied, a related question is with what frequency and in what state of the heat exchanger and/or the system to perform the cleaning. This is primarily defined by limitations appertaining to services, and is advised to be decided upon by economic optimisation.

As limitations, generally two criteria emerge with regularity. On the one hand, cleaning is necessary even if consumer heat demand is not met and the inlet temperatures cannot be

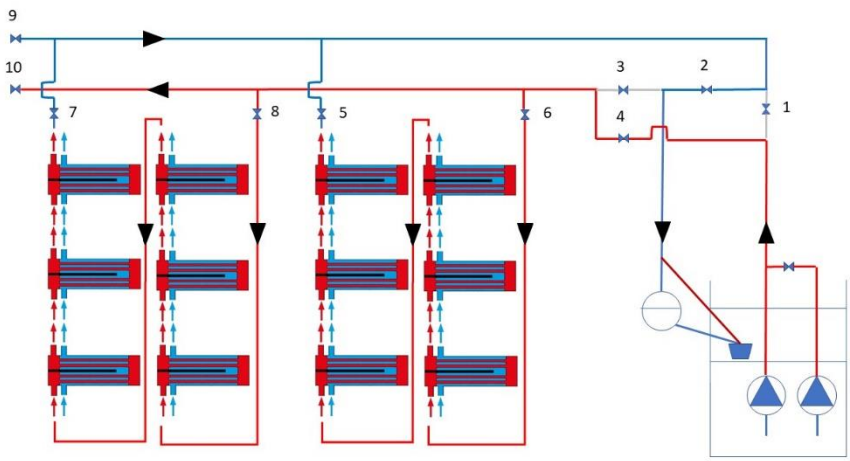
maintained by the system, therefore the quality of service deteriorates. (And if the occurrence f this is expected).

A specific time interval cannot be an appropriate answer to the frequency of cleaning, as the load status of the system and the temperature of the sewage vary. In certain heating or cooling seasons, a more frequent, while during the transitional periods, a less frequent cleaning would be optimal.

The compiled cleaning protocol however will provide great bases to be followed, that could be overwritten in case the recorded operational data supports the necessity of adding an extra cleaning session.

1. OPERATION TASKS OF **COUNTER-CURRENT CLEANING** (WITH SEWAGE)

Illustration of implementation of counter-current cleaning with two wastewater pumps:



Steps of the cleaning process

- stopping the wastewater pump(s)
- disconnecting designated HEX's (using mechanised means of shutting the gate valves) as per it is preset in the cleaning protocol
- changing the position of required valves
- starting the wastewater pump(s)
- after a certain period of time spent with counter-current cleaning stopping the appropriate pump(s) – the exact amount of time is determined in the cleaning protocol
- restoring the required valves and starting normal operation for the preset interval of time
- continuing the cleaning process with the attempted reversing of the direction of the flow multiple times – as it is set forth in the cleaning protocol and additionally as per the volumetric flowrate values calculated from the concurrently recorded $p_{measured}$ values (indicating when sufficianlty approaching the values featuring a clean heat exchanger row)
- registering the parameters corresponding to the final state in the cleaning report and monitoring of data in the SCADA system.

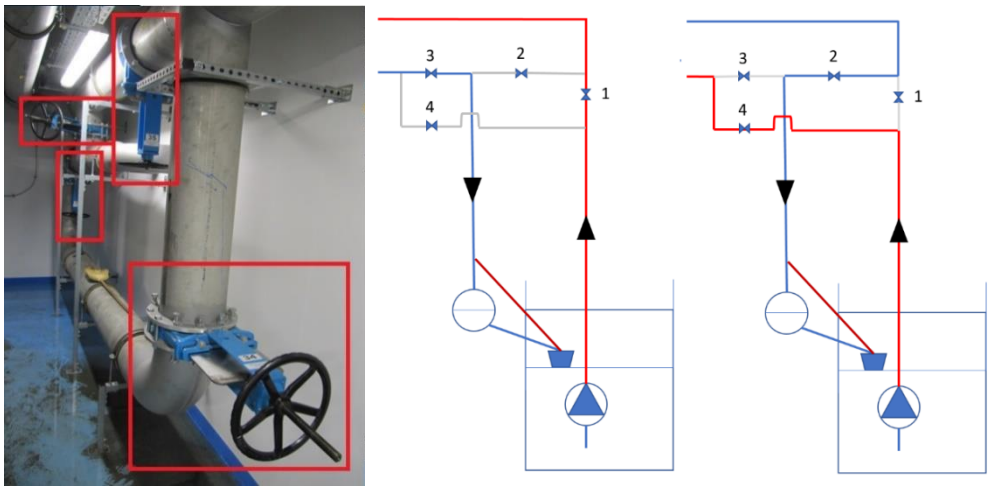
Registering the parameters in the cleaning report

It is necessary to register the following parameters corresponding to the final state in the cleaning report and monitoring of data in the SCADA system:

- speed, calculated from measured volumetric flow value
- length of the period of time for applying the counter-current
- inlet and outlet temperature of wastewater (to calculate Δt_{ww})
- inlet of wastewater and the outlet of clean water temperature (to calculate Δt_{HEX})
- headloss (hydraulic pressure loss in the HEX row, Δp_{loss})
- volumetric flowrate (Q)
- length of the entire period of time spent on the cleaning method (stop-to-start)

Creating the counter-flow

Cross connection to create counter flow:



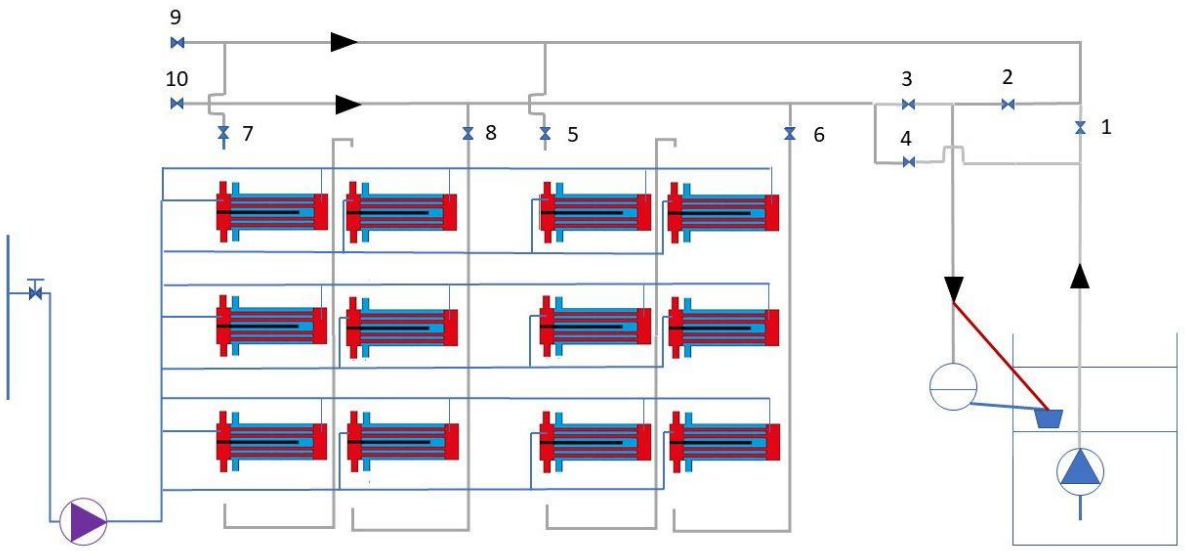
Cleaning personnel

Technical supervisory personnel who oversees the resetting of the system (stopping the pumps, changing the position of the required valves…). The work of the personnel requires basic level technical knowledge, there is only small demand of light physical work (changing the position of the required valves), and working with sewage is not required.

The cleaning process demands only 1 person's 2 hour-work-time, that could be executed with or without personal presence depending on the level of automatisation and status of remote control.

2. OPERATION TASKS OF **HIGH-PRESSURE CLEANING**

Illustration of implementation of high pressure cleaning:

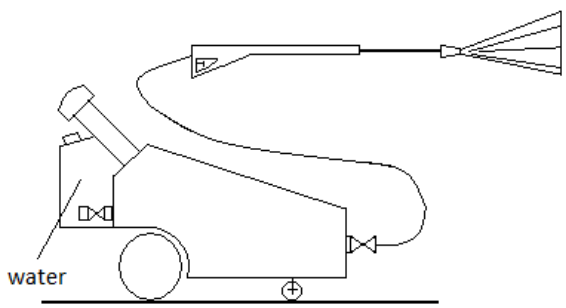


Steps of the cleaning process

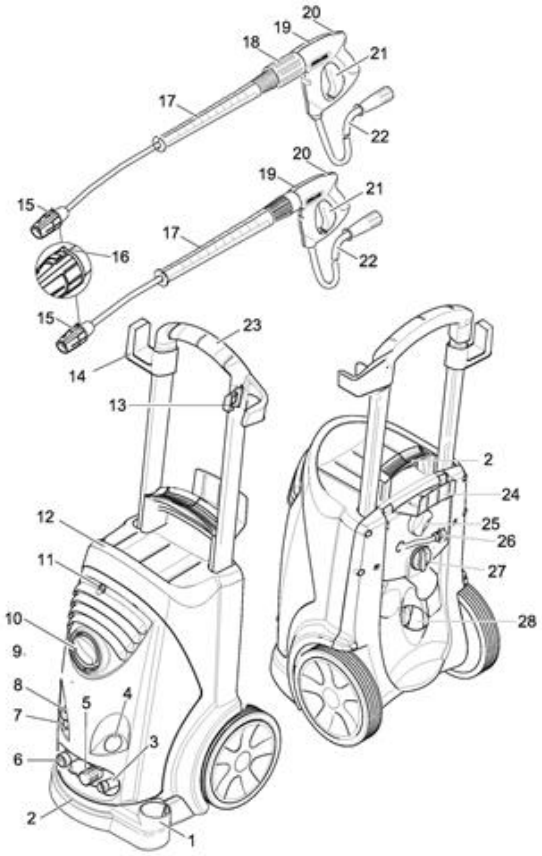
- stopping the wastewater pump(s)
- disconnecting designated HEX's (using mechanised means of shutting the gate valves) as per it is preset in the cleaning protocol
- draining the disconnected HEXs to be cleaned through their draining stub
- connecting the pressure washer to the water supply point
- blowing the cleaning medium with high pressure using the water jet equipment acquired for the cleaning process through the cleaning stub of the HEXs
- the process lasts until the proper cleanness is achieved (determination through visual inspection)
- disposing of the accumulated cleaned-out sludge (emptying the bucket placed in fixed position under the draining stub), tidying up the HEX room
- filling the HEX back up with wastewater, reconnect the separated HEXs into the system circle and start the normal operation
- registering the parameters corresponding to the final state in the cleaning report and monitoring of data in the SCADA system.

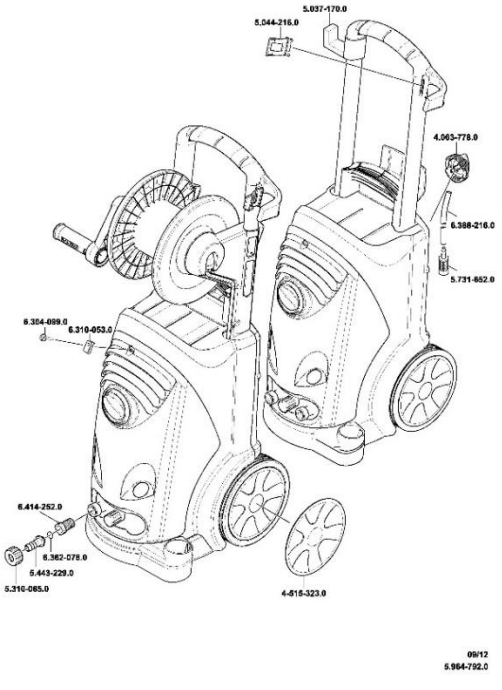
High pressure washer (Water jet)

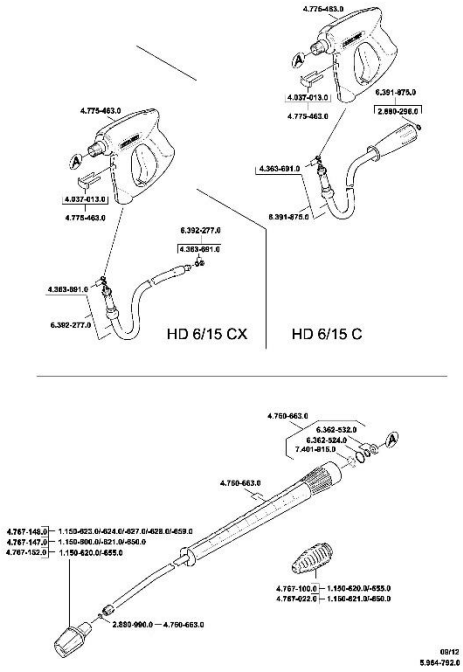
High pressure (water) washing equipment:



Kärcher's electric HIGH PRESSURE WASHER HD 7/18 C using cold water (or equal). Scheme:







Nozzle to be used: high-pressure fan jet (25°).

Registering the parameters in the cleaning report

It is necessary to register the following parameters corresponding to the final state in the cleaning report and monitoring of data in the SCADA system:

- distribution of insufflation
- the pressure
- the length of the insufflation process
- inlet and outlet temperature of wastewater (to calculate Δt_{ww})
- inlet of wastewater and the outlet of clean water temperature (to calculate Δt_{HEX})
- headloss (hydraulic pressure loss, Δp_{loss})
- volumetric flowrate (Q)
- length of the entire period of cleaning method (stop-to-start)
- amount of pure water demand

Cleaning personnel

The person performing the cleaning task will come in contact with sewage thus they need to have the necessary vaccinations according to the regulations, moreover wearing the appropriate protective gear is obligatory (single-use jumpsuit, goggles, gloves, mask).

The work of the personnel does not require special professional knowledge, basic level of technical knowledge is advantageous for the stopping of pumps, changing the position of the required valves, and it consists of moderate physical work. The cleaning process demands appr. 1 person's 2 hour-work-time on site.

3.2 O&M instructions of the sewage shaft

I. Cleaning and maintenance of the sewage pit and its equipment

I.1 General regulations

The cleaning/ maintenance works of the sewage pit have to be liaised by the contractor and the operator. The personal and material conditions of the tasks to be performed are going to be determined via their discussion. The appropriate work conditions of the agreed tasks for their own workers, such as safety, non-hazardous workplace, are granted by the sewage channel cleaning group (including the supplying of personal protective equipment, conducting an appropriate number of qualified personnel with valid medical aptitude test, providing the necessary technical means in proper condition).

The leader of the sent group has to report to the responsible person of the operation as soon as they enter into the sewage heating centre. Before the start of the work, the leader of the maintenance group, and the responsible person of the operation has to determine the tasks that have to be performed together. The operator of the sewage pit is liable for describing the potential dangers during the work (for example dangerous technologies, materials, etc.) as well as the work safety regulations, which must be recorded in writing. The leader of the deployed group has to assess, that with the available number of people and equipment, the technical conditions are appropriate for the work to be performed safely. If the conditions are not fully ensured, then the work cannot be started. In this case the responsible person for the operation has to arrange the necessary conditions. Before the start of the work – if the nature of the job requires – the representative of the operator has to define a so called escape route, which has to be introduced to the workers. Before entering the underground concrete structure, a preliminary airspace test shall be carried out.

On the basis of the measurement values, the operation manager authorizes the work. Interference with any technological process (mechanical, electrical, etc.) that becomes necessary during the work may only be done with the permission of the operator responsible for the operation.

For any other kind of works that is not detailed in this regulation, risk assessment has to be done. The aim of the risk assessment is to determine the necessary provisions and to set up a priority ranking, as well as prevention of the risk, or lowering it to an acceptable level.

II. The mechanical cleaning of the sewage pits

II.1 General descriptions

The cleaning of the pits are done by special-purpose machines. Throughout the work, it is not necessary to go down into the concrete structure. The machine operator during sludge suction, transportation and draining is in constant contact with the shift workers. The operator opens or closes the appropriate valves upon the command of the shift workers and regulates the suction truck's vacuum pump. After filling the tank, the sludge must only be drained at the designated waste disposal facility. The operator needs to pay attention to the hose connections in order to avoid any sludge leakage.

The casing of the drum filter and the screw lifting the screenings are to be washed with a high pressure water jet, using washing guns. Working and staying on the operational level of the concrete structure is only permissible on the areas which are protected by safety barriers. Starting and stopping the machines, equipment can only be carried out by the shift workers. It

is forbidden to clean the sensitive on-line instruments and equipment in the sewage pit directly with high pressure cleaners.

II.2 The cleaning of the sewage pits with special-purpose machines – processes and instructions

Preparation of the special-purpose machine, field-work.

Demarcation and indication of the workplace, if it is located on a public area.

The cleaning of the sewage pit begins with the venting of the underground structure, but before that, protection against falling for workers working nearby has to be ensured.

During the ventilation, the filling of the tank should carried out from a fire hydrant.

Closure of the sluice gates and valves for any inlet and outlet ducts and other conduits that opens into the suction area, followed by pumping the water out of the suction area.

Disconnecting the pumps from the main switch.

A ”Do not switch on” table has to be put on the main switch.

The suction truck approaches the pit, the workers put together the suction hose, they lower it down, and the suction can be started.

Usually the whole amount of the sludge cannot be sucked up from the basin, so after the airspace test and with a filled boarding permit 1 person goes down to the basin, appropriate security provided.

The cleaning worker in the pit is observed and helped by another one from the top.

The leftover sludge in the pit has to be driven to the suction hose by the cleaning person, the suction has to be working throughout the whole process, or until the suction tank gets full (with strict adherence to sedimentation).

A washing head has to be installed on the washing hose on the surface, then lowered into the suction area, the pit, the remaining sludge is washed together, so that the suction hose can fully suck it up.

After the complete cleaning of the bottom, the floating switches of the pumps and the level sensors have to be cleaned also, then as the washing hose is re-assembled on the surface the basin’s walls need to be washed off by water jet operated by a secured worker in the pit in order to get rid off any dirt that has been deposited on them.

During the workflow it is necessary to choose the right pressure of water, also before starting, it is necessary to make sure that the pressure control switch is in the default position.

Checking the functionality of the floating switches.

Reassembling the pump, or any other equipment if it is necessary.

Opening the gate valves (if necessary).

Breakdown of the traffic diversion, powering the station, as needed.

Degassing the pumps, starting the station in manual mode then switching to automatic mode (if necessary).

Documentation of the whole cleaning process in the sewage heat center’s operation log, closure of the sewage pit and the underground structure, retreat to the discharge area or the premise.

II.3 The cleaning of the sewage pits with special-purpose machines – staff needs, protective gear

• 1 person commissioned as site manager (main collector cleaner) /includes working in the pit/

• 2 people special purpose-machine operators (main collector cleaner) /driver/

• 1 person special purpose-machine operator (main collector cleaner) /includes working in the pit/

• Mandatory protective equipment:

- Weatherproof footwear and protective clothes, specified in the MVSZ
- Rubber boots and technical two-piece protective clothing
- Rubber cloth with joined customized rubber boots equipped with anti-pierce protection
- Technical suit
- Protective helmet, headlight
- Chemical oxygen escape mask, and compressed air breathing apparatus in closed conduit section
- Cutting-resistant rubber gloves and canvas gloves
- The workers providing security from the surface have to wear high visibility vest

IV.) Special cleaning and maintenance work

Amongst the equipment defect one of the filter's malfunction, which even if rarely but can happen is clogging.

The technology of the workflow of the clogging removal concur with the high pressure water cleaning and the functioning of the sludge suction special-purpose machine, with additional manual work. The two systems can be operated together according to the order of the cleaning tasks, thus the sequence of the procedures can also be changed.

The workflow requirement is 2 people, of which 1 is the main supervisor, or commissioned supervisor:

• 1 person special-purpose machine operator - driver

• 1 person special-purpose machine operator

• In the case of a special location, the team leader may also request the work of additional 3-5 people (e.g. underpasses, lifting stations, or pool cleaning)

Mandatory protective equipment:

- Weatherproof footwear and protective clothes, specified in the MVSZ
- Protective helmet
- Hearing protection device (ear plugs or earmuffs, the level of required noise reduction must be taken into account when selecting)
- Cutting-resistant rubber gloves and canvas gloves
- High visibility vest

Rubbish which stuck into the machine has to be removed by hand. During the work the manual cleaning is assisted by the so-called high pressure water washer that loosens the deposited hardened sludge/ grease and discharges through the built-in suction hose.

Data sheet:

Name and post of workplace leader:

Mandatory personal, material conditions for workers in the work area: yes / no

Medical state: in order / not Operator privilege: in order / not

Work safety training: done / not

Protective equipment: in order / not

Continuous work control: in order / not

Tools, machines: in order / not

Condition of lifting ropes: in order / not

Description of the subject of the risk assessment (data in meters):

Width:

Length:

Depth:

Presence of hazardous material: yes / no

Anti-fall covers: in order / not

Interior airspace: in order / not

I have instructed the undersigned employees – as the workplace leader – about the risks of the cleaning of the underground concrete structure:

(date, signature)

I acknowledge the above-mentioned risks and dangers, and agree to keep the work instructions:

name/signature name/signature name/signature

name/signature name/signature name/signature