KLAREX Self Cleaning

Heat Exchangers

Koppe van der Meer

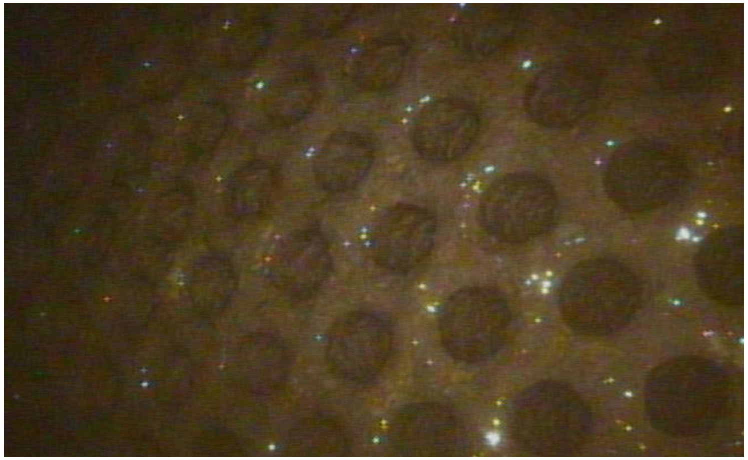
Bronswerk Heat Transfer

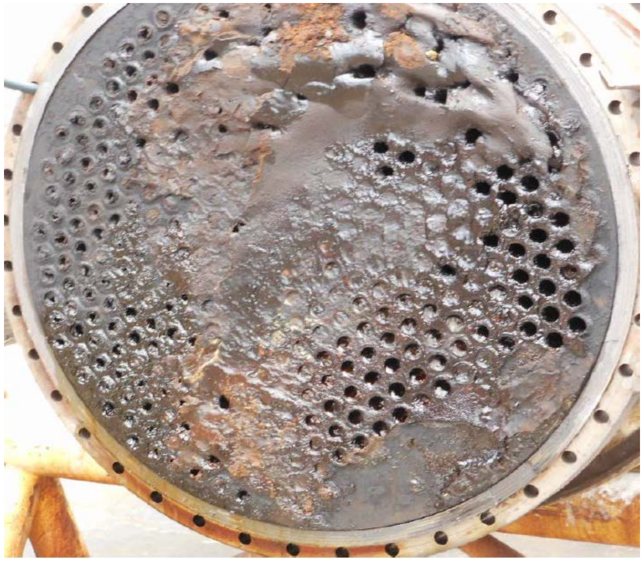
BHT Holding

- BRONSWERK HEAT TRANSFER BV — The Netherlands
- BRONSWERK HEAT TRANSFER SPOL. S R.O. — Czech Republic
- BRONSWERK KLAREX TECHNOLOGY BV — The Netherlands
- BRONSWERK RADIAX TECHNOLOGY BV — The Netherlands

FOULING

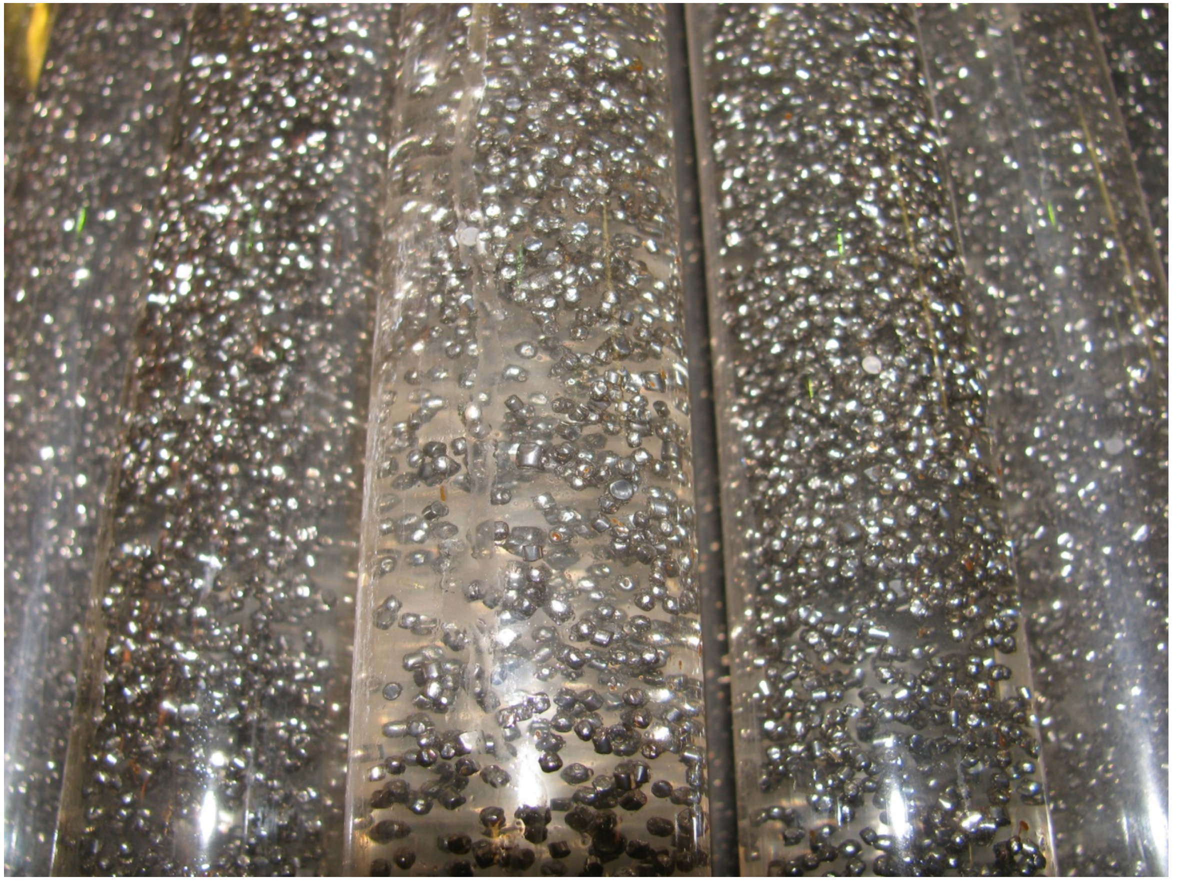
Heat exchangers used for heating or cooling of **fouling liquids**, will reduce in **capacity** due to the heat resistance of layers of fouling solids which form on the heat transferring surfaces.





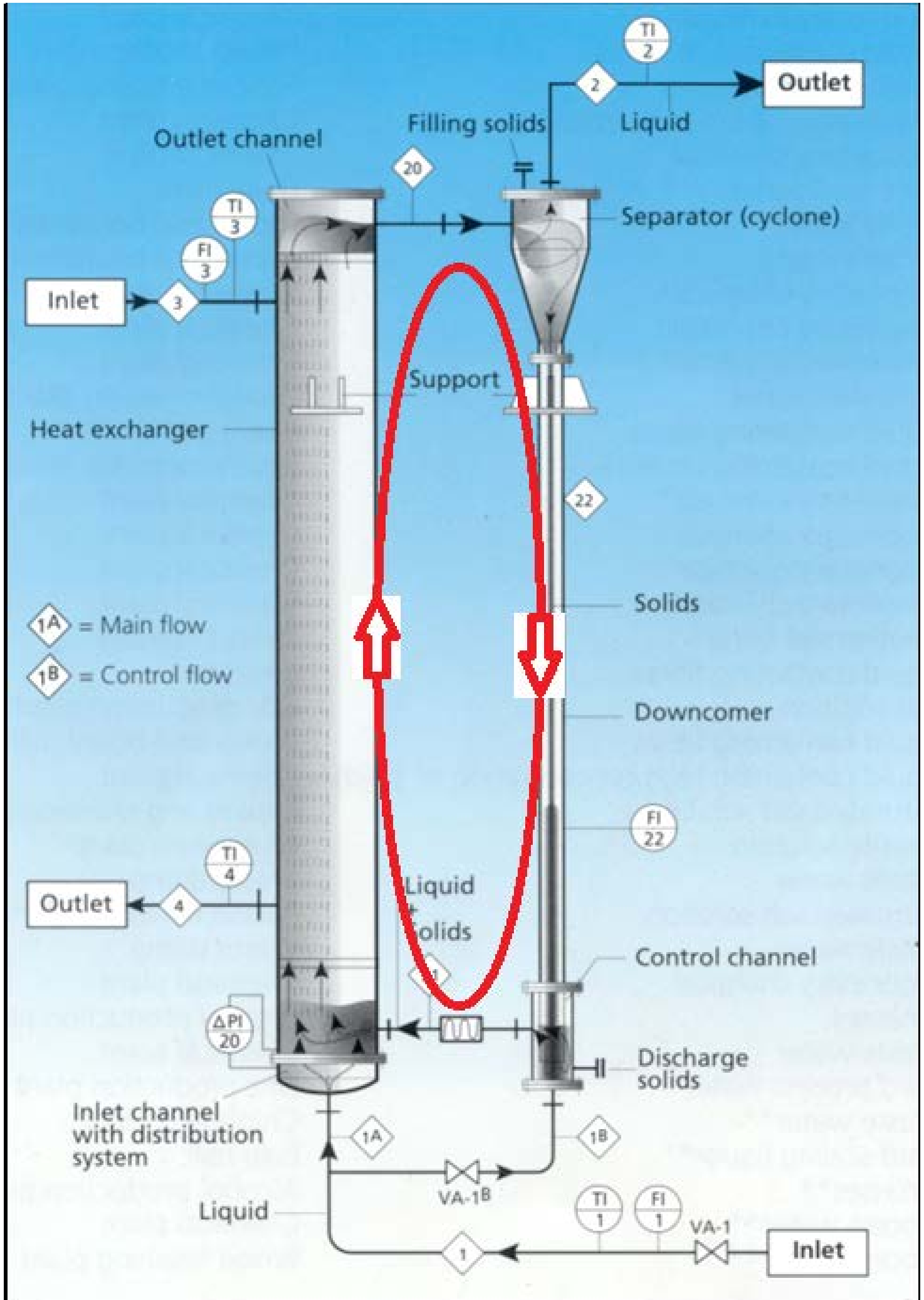
This means that such exchangers will have to be overdimensioned, to have **spare** capacity, and that they will have to be **cleaned** after some time to remove the fouling layer, to regain the original capacity.

To prevend such an operational discontinuity, a Klarex self cleaning heat exchanger can be used, in which a fluidized bed of cleaning particles **prevents** the settling of fouling solids on the wall or which removes these in an early stage.



Klarex heat exchangers

- Vertical shell and tube type
- Fluidized cleaning particles inside the tubes
- External circulation of particles through downcomer tube
- Storage volume for particles in downcomer
- Distribution system for homogeneous particle flow over the parallel tubes



Typical Klarex configuration

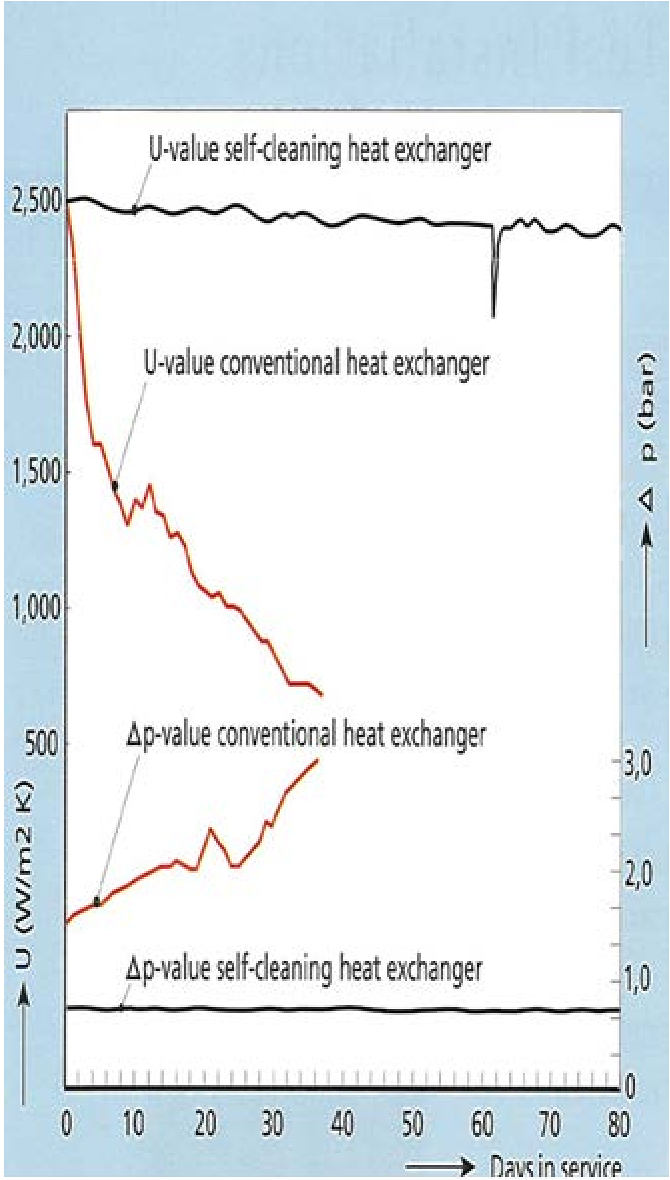
Circulation of cleaning particles

Whirling glass / metal particles change laminar flow pattern into **turbulent** flow

- this prevents settling of fouling solids
- heat transfer enhancement

Light scraping effect along heat transferring surface

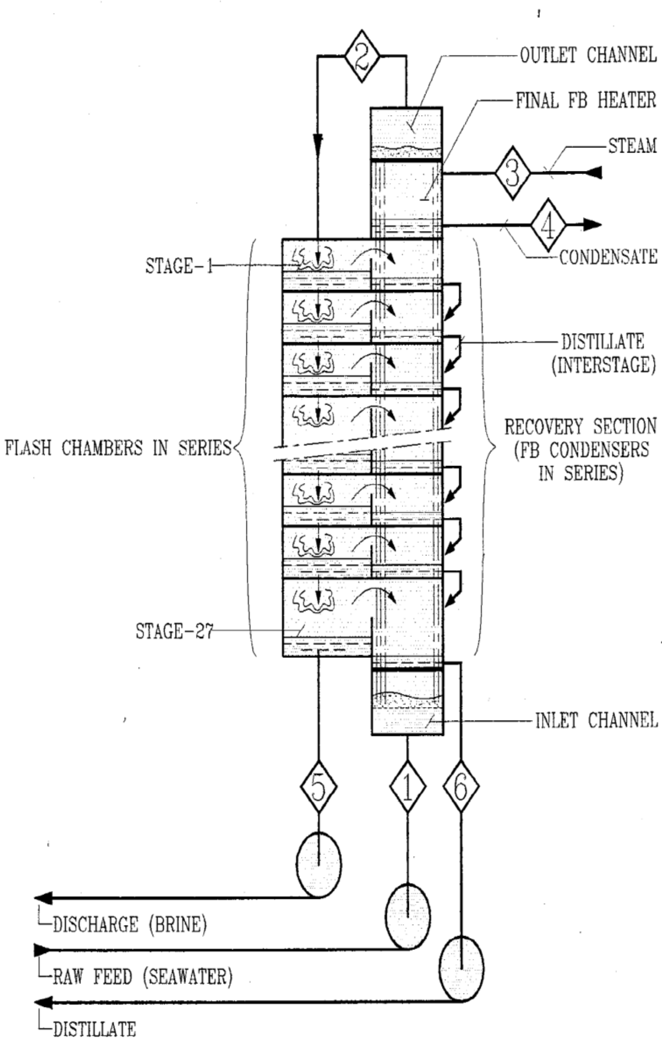
- removing fouling at early stage

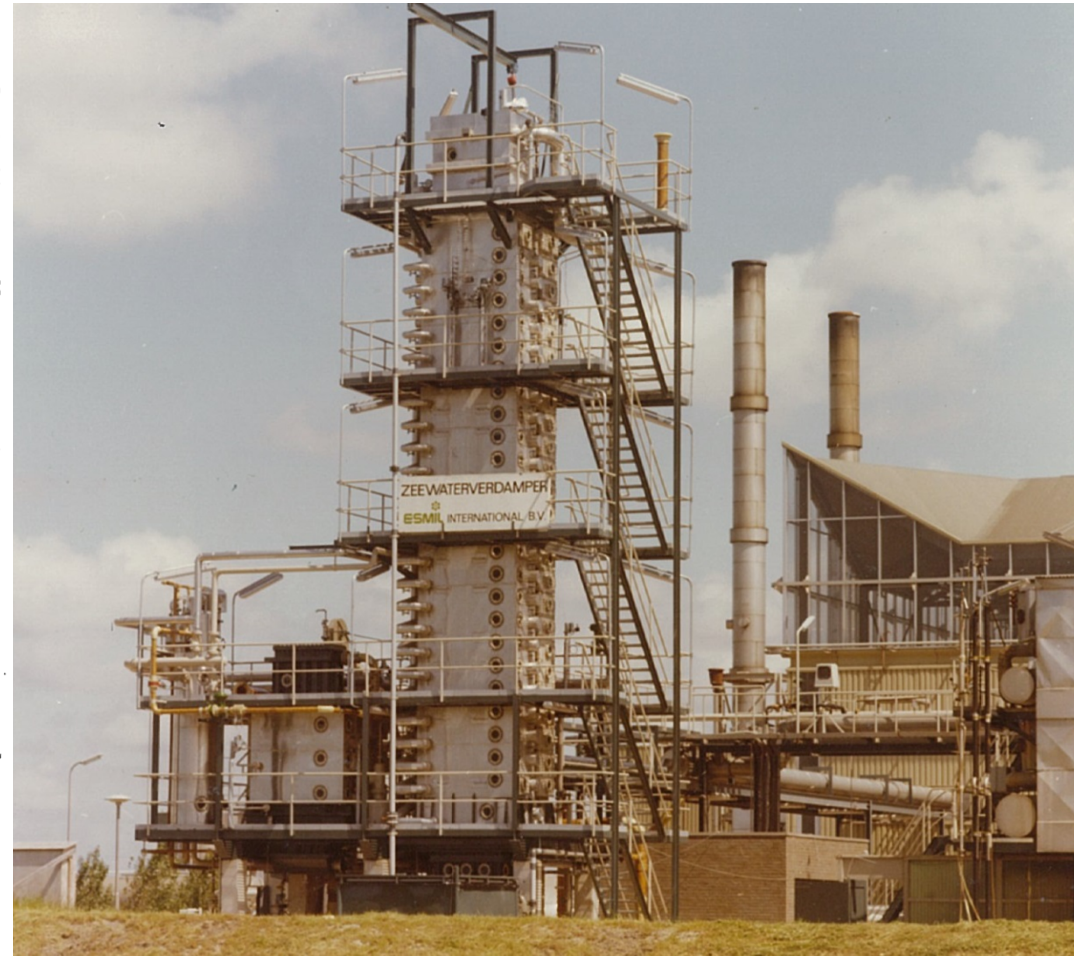


Advantages of Klarex system

- Smaller heat transferring surface required
- Continuous operation possible
- No periodic cleaning costs

Particles are acting as turbulators	+
Continuous removal of fouling	+ / -
Constant heat transfer coefficient	+
Extra pressure drop by particle weight	-
Lower pressure drop by lower velocities / passes	+





First fluid bed heat exchanger used for sea water desalination

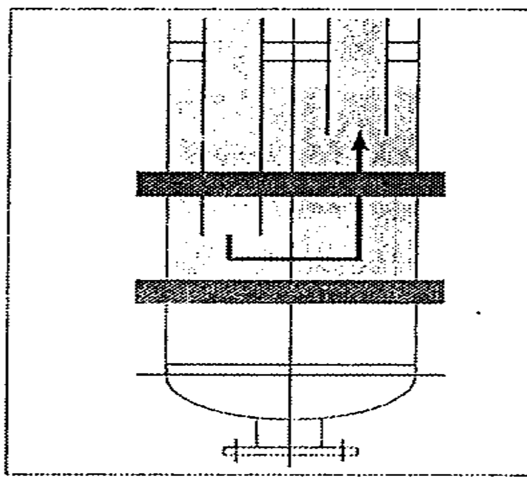
Fluidized bed heat exchanger eliminates reboiler fouling [1)]

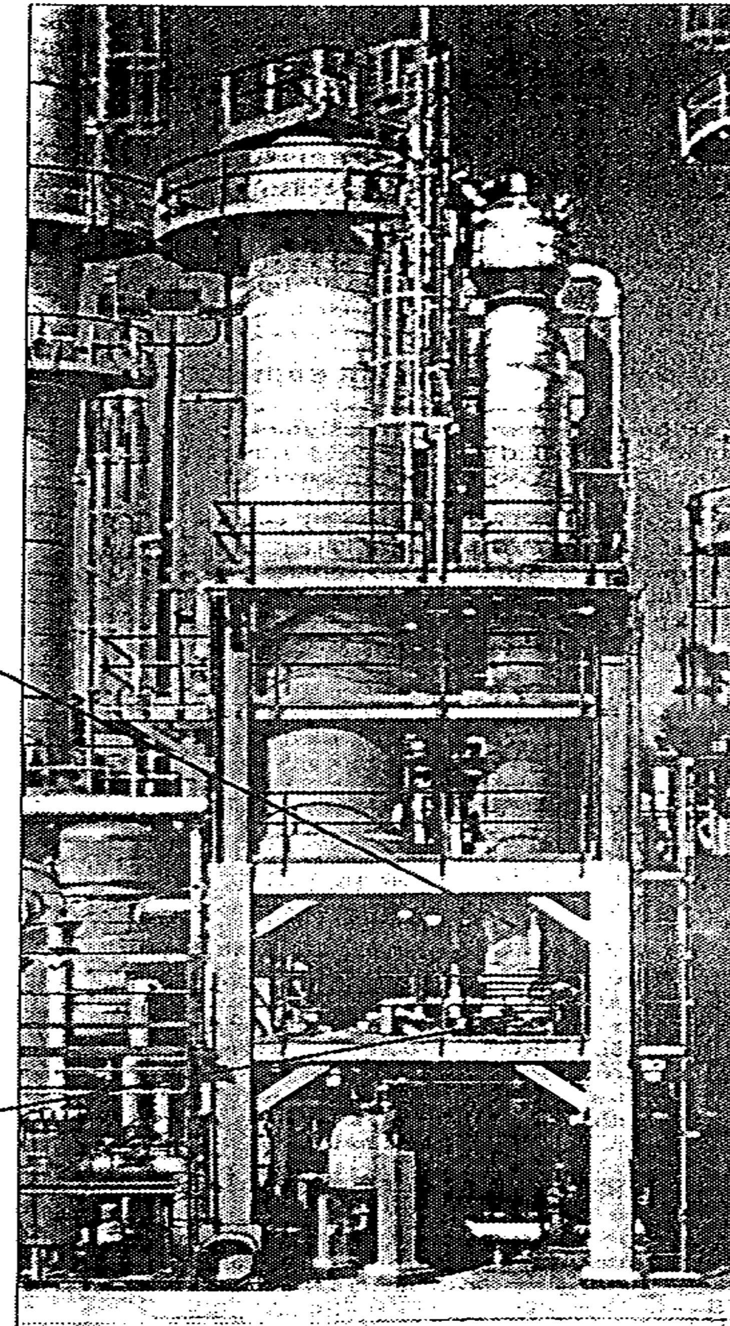
Annual turnaround replaces cleaning every 4 to 5 days

RUSSELL GIBBS
Senior Engineering Associate
Hoechst Celanese Corp.
WILLIAM P. STADIG
Houston Regional Editor

Problem: A steam-heated evaporation system at Hoechst Celanese's Clear Lake, TX, plant recovers a volatile organic from a heavy organic solution laden with foulants. A hard, black scale that was forming in the upper 25% of the tubes was forcing the plant to switch two parallel once-through rising film evaporators with a clean pair every four to five days.

When asked to increase throughput and simplify operations, engineers considered installing a 2100-sq-ft falling film evaporator (FFE) to operate in series with the existing rising film evaporators (RFE). Although the combination system was expected to run approximately 10 weeks between cleanings, a better solution was needed.





Right: A fluidized bed heat exchanger (at right in photo), used as a reboiler for an evaporator system (at left in photo) to recover a volatile organic from heavy ends, has operated over one year without fouling. On-stream time for previous rising film evaporators was only four to five days.
Above: The riser (upflow) and downcomer (downflow) tube arrangement in conjunction with custom-designed distribution plates ensure that beads are evenly distributed within the FBHX for optimum heat exchange performance.

Solution: The engineers had heard of an innovative, fluidized bed heat exchanger (FBHX) technology being used at another Hoechst Celanese plant. The technology eliminates heat transfer

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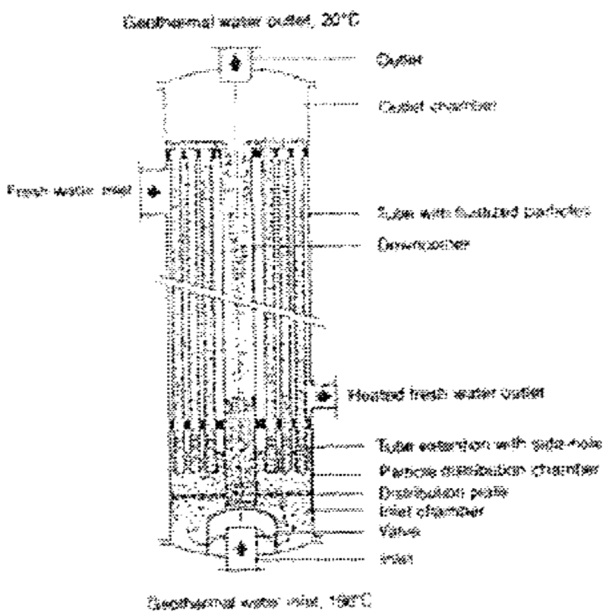
Hitaveita Reykjavikur operated a pilot heating plant at Nesjavellir during 1974-1990. Various types of heat exchanger were tested. Conventional plate heat exchangers are used for the condensation of steam from the separators and to cool the condensate. They are equipped with EPDM-gaskets and made of titanium plates to avoid stress corrosion; as, it is not possible to guarantee problem-free operation if stainless steel plates were used.

Conventional heat exchangers cannot be used for the separated water due to the high content of dissolved solids (TDS 1200 ppm) which would cause severe scaling of silica. A new type of heat exchanger, in the geothermal context, was tested successfully in the pilot plant. These are the so-called "fluidized-bed heat exchangers," or FBHX made by Eskla Heat Exchangers BV in the Netherlands. They are shell-and-tube heat exchangers operating in a vertical position (Figure 1). Stainless steel balls, 1.5 mm in diameter, circulate in the flow stream of the separated water. They impact continuously against the pipe surfaces and remove any scaling that may form. A mechanical device is fitted to the inlet and outlet of the heat exchangers to keep the steel balls evenly distributed in the flow stream. The FBHX heat exchangers make possible the direct utilization of the heat in the water from the separators and contribute to the overall economy of the heating process.



A schematic drawing of a "fluidized-bed heat exchanger" (FBHX).

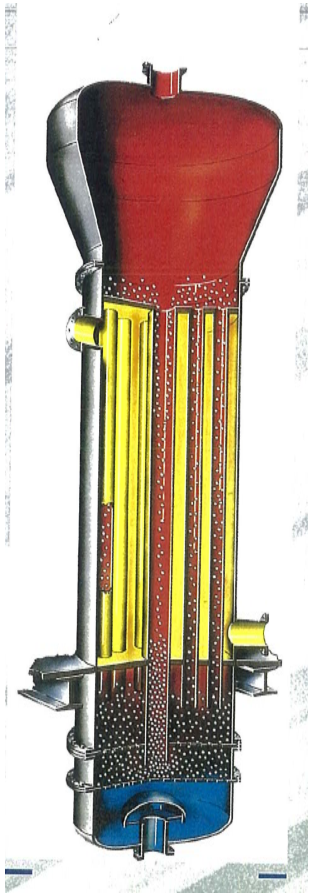
Recently, the FBHX was dismantled as the well enthalpy and dissolved silica content of the fluid has changed. Thus, ordinary shell-and-tube plate heat exchangers now appear satisfactory.

Technical developments of the Klarex type heat exchangers:

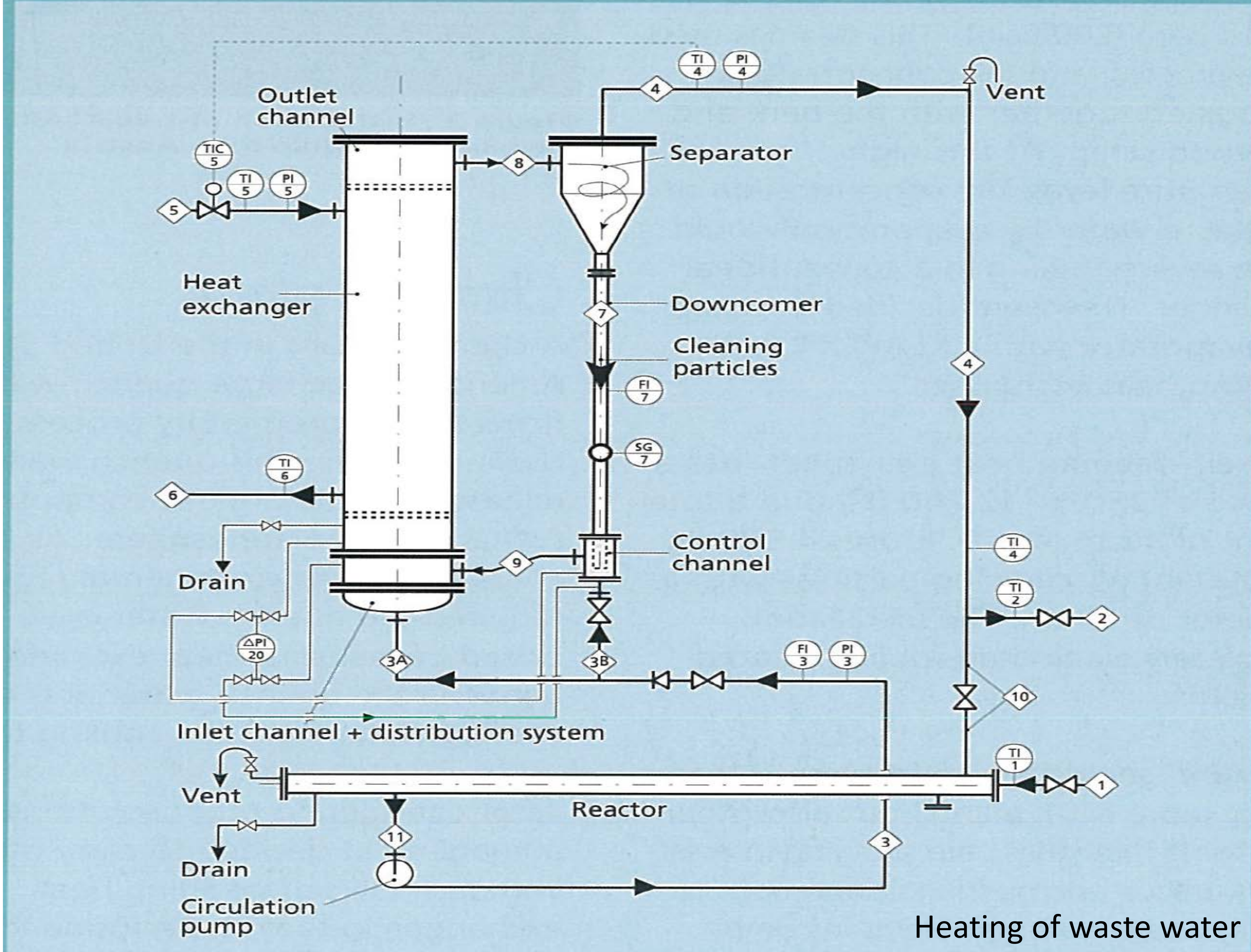
1) Stationary bed of fluidized particles
   - constant flow required

2) Recirculation inside heat exchanger
   - flow variations allowed

3) Recirculation outside heat exchanger
   - control of recirculation velocity
   - control of bed porosity
   - storage of particles

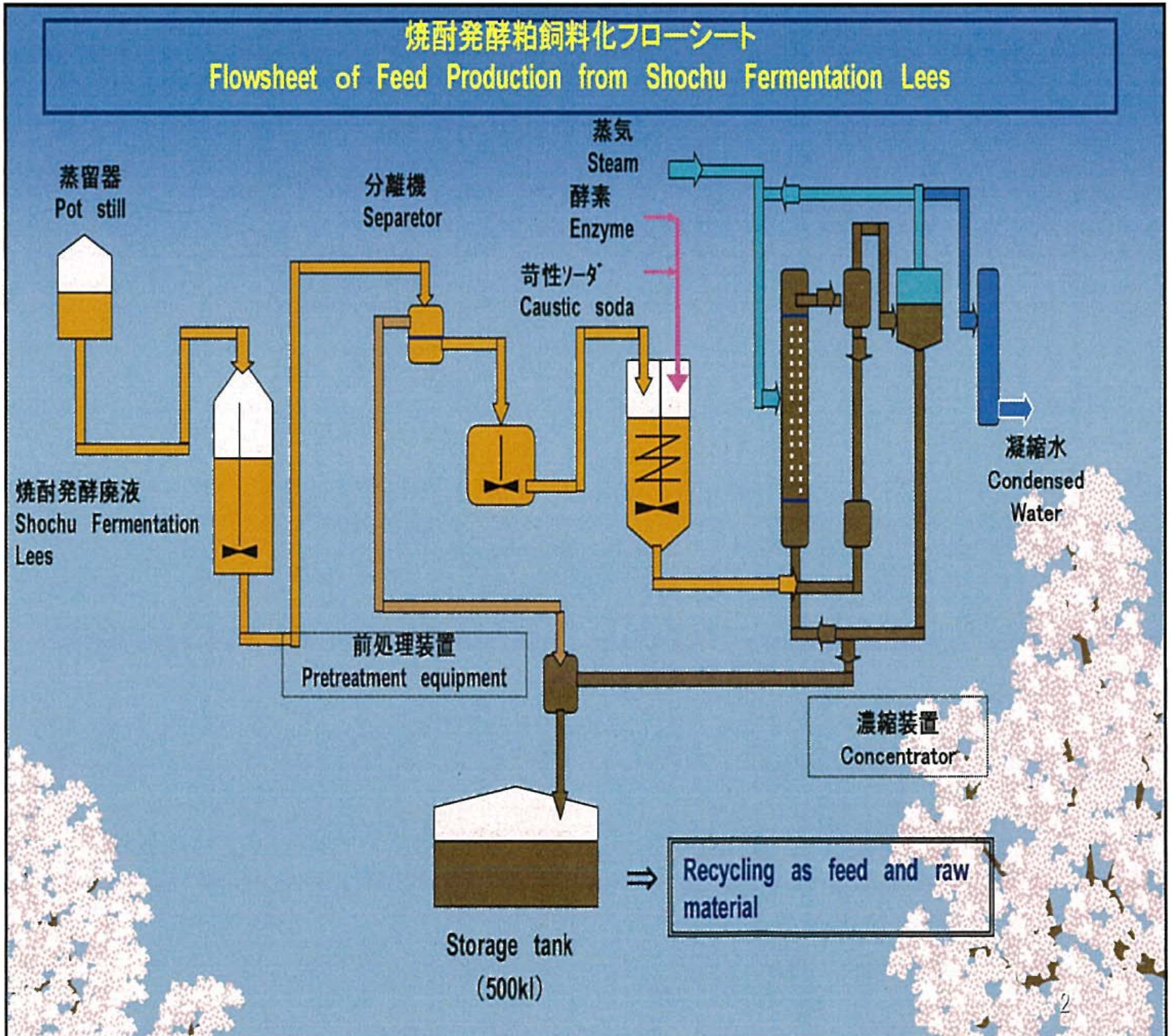


Earlier type with internal recirculation

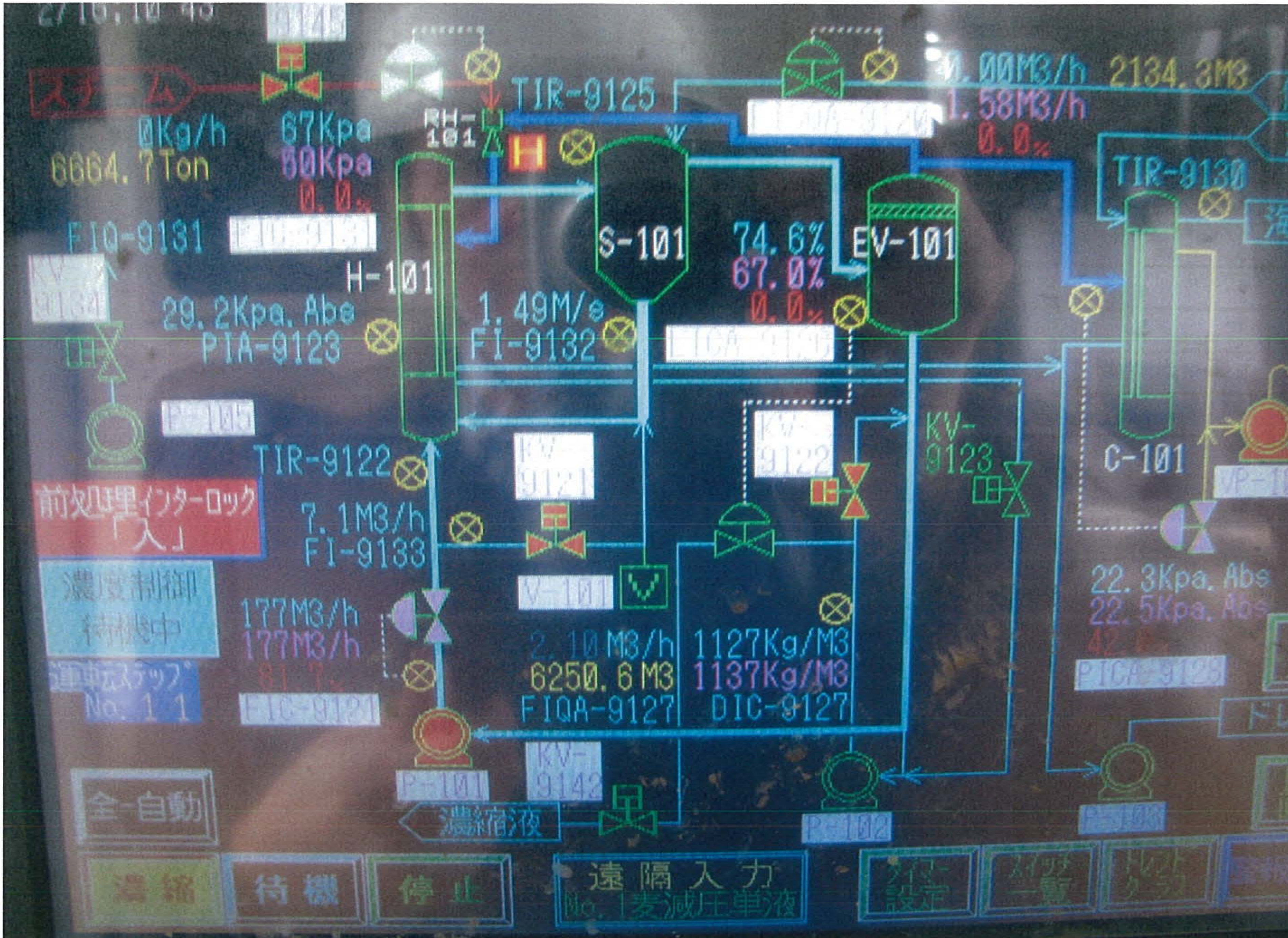


Heating of waste water

Figure 1 : Flow diagram heat exchanger zinc refining plant, the Netherlands.



Evaporation of waste water


TIR-9125
0Kg/h
67Kpa
6664.7Ton
80Kpa
0.0%
FIQ-9131
H-101
S-101
74.6%
67.0%
0.0%
EV-101
2134.3M3
1.58M3/h
0.0%
TIR-9130
29.2Kpa.Abs
PIA-9123
1.49M/s
FI-9132
TIR-9122
KV-9121
KV-9122
KV-9123
C-101
前処理インターロック
「入」
7.1M3/h
FI-9133
V-101
濃度制御
待機中
177M3/h
177M3/h
運転ステップ
No. 1 1
FIC-9121
2.10M3/h
6250.6M3
FIQA-9127
1127Kg/M3
1137Kg/M3
DIC-9127
22.3Kpa.Abs
22.5Kpa.Abs
PICA-9128
P-101
KV-9142
P-102
P-103
全自動
濃縮液
濃縮
待機
停止
遠隔入力
No.1麦減圧単液


No 3 母液ｽﾄｯｸﾀﾝｸ

Self Cleaning Heat Exchanger

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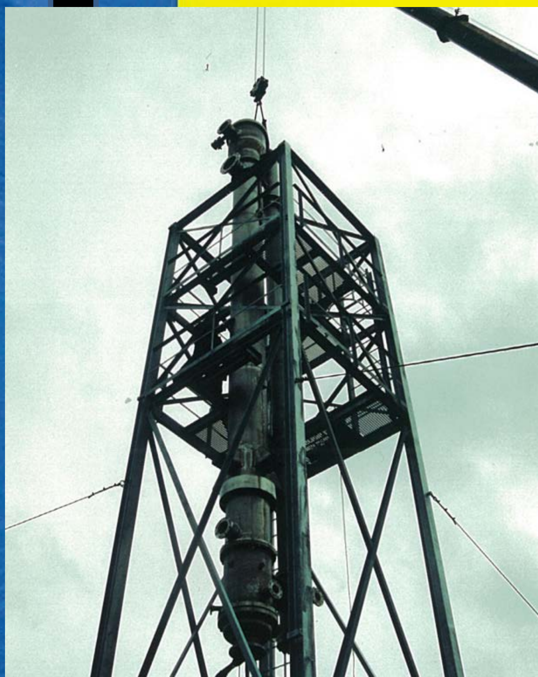

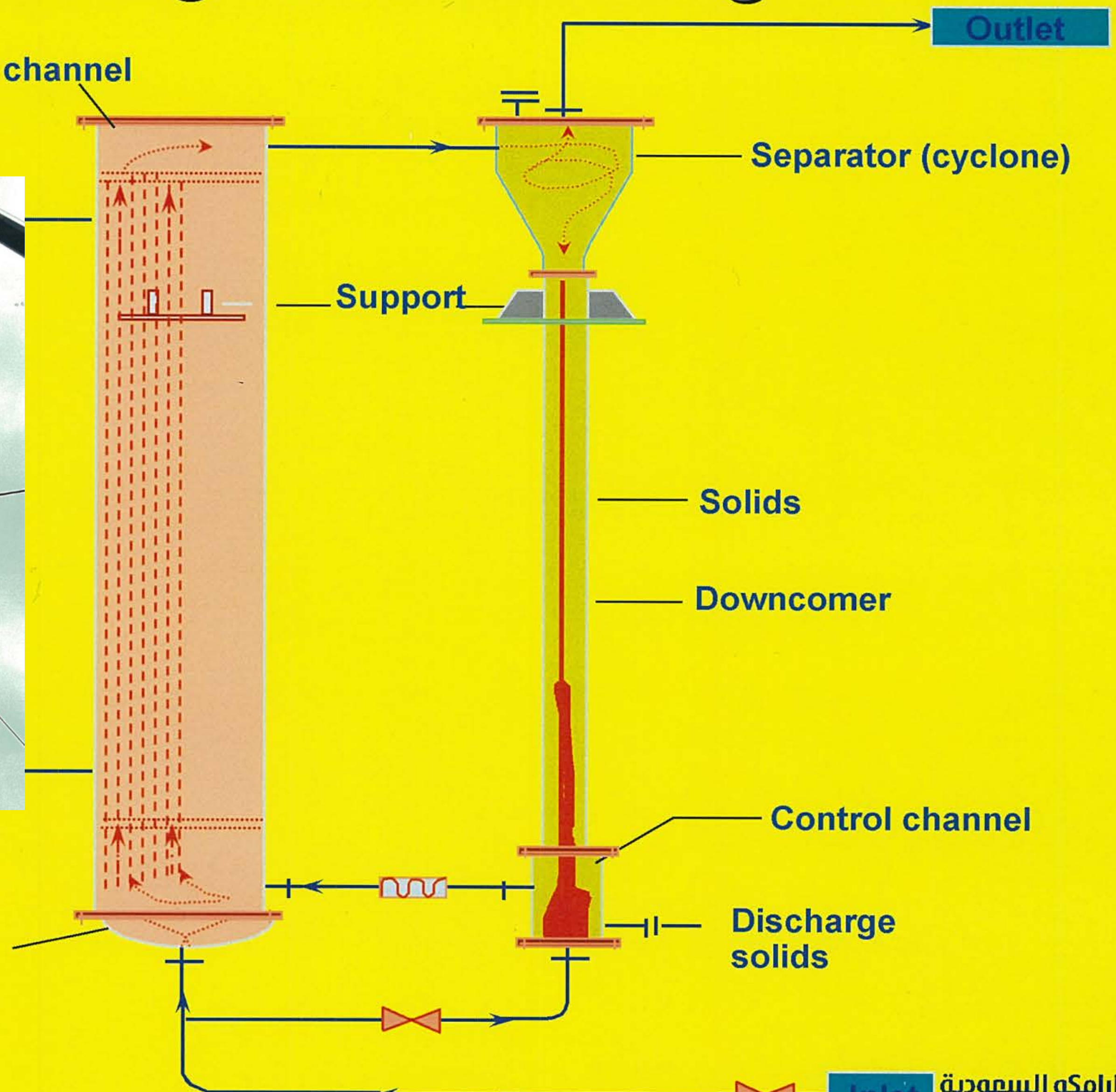

HEA

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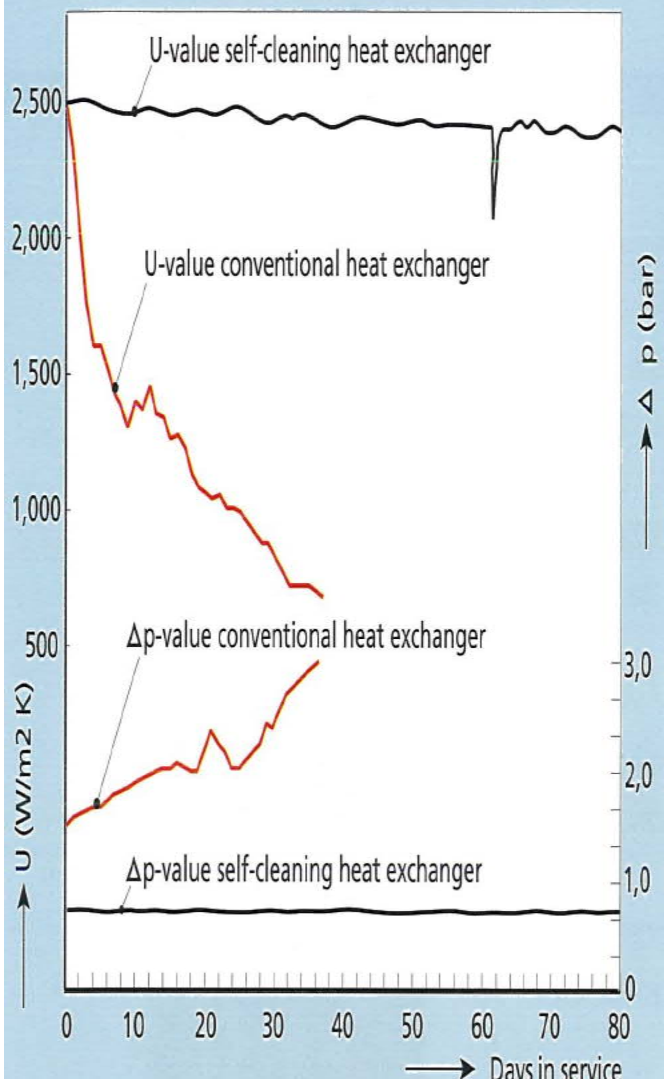
Heating of black liquor

Cooling of quench water

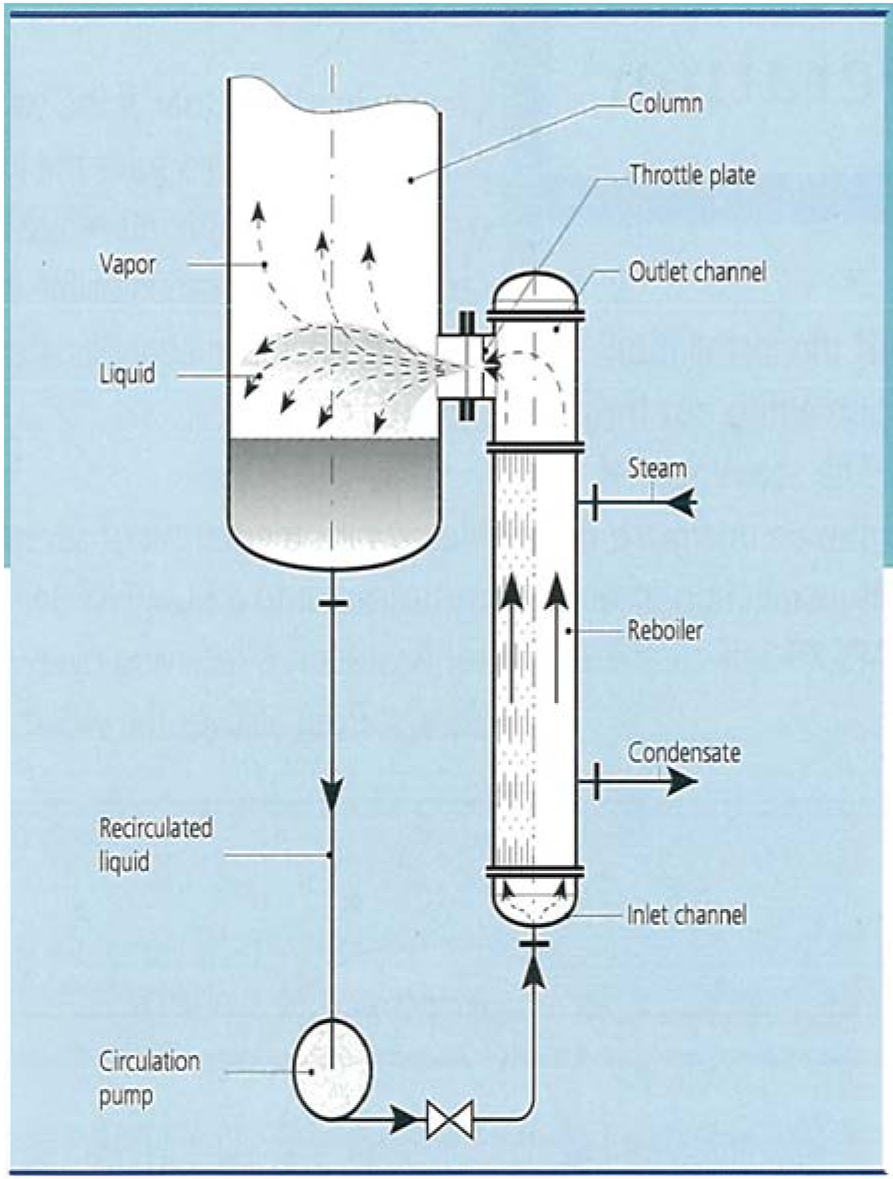


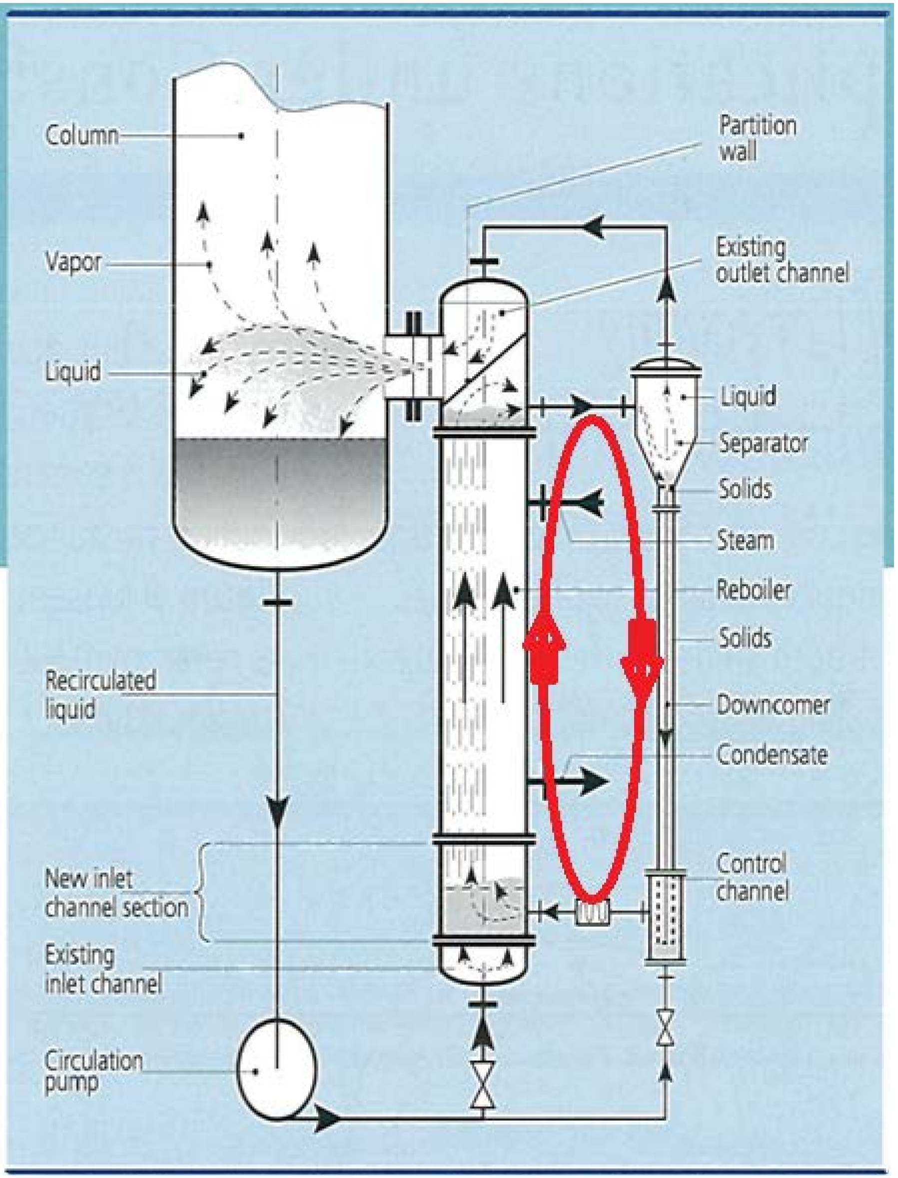
Two of the four self-cleaning heat exchangers were installed in October 1998 and have operated without fouling for more than seven months, as predicted. The other two exchangers were put into operation in April 1999. *Figure 7* shows the four KLAREX® self-cleaning heat exchangers. Similar applications are being considered.

	Self-cleaning heat exchanger	Conventional heat exchanger
Heat transfer surface	4,600 m^2	24,000 m^2
Pumping power	840 kW	2,100 kW
Number of cleanings per year	0	12

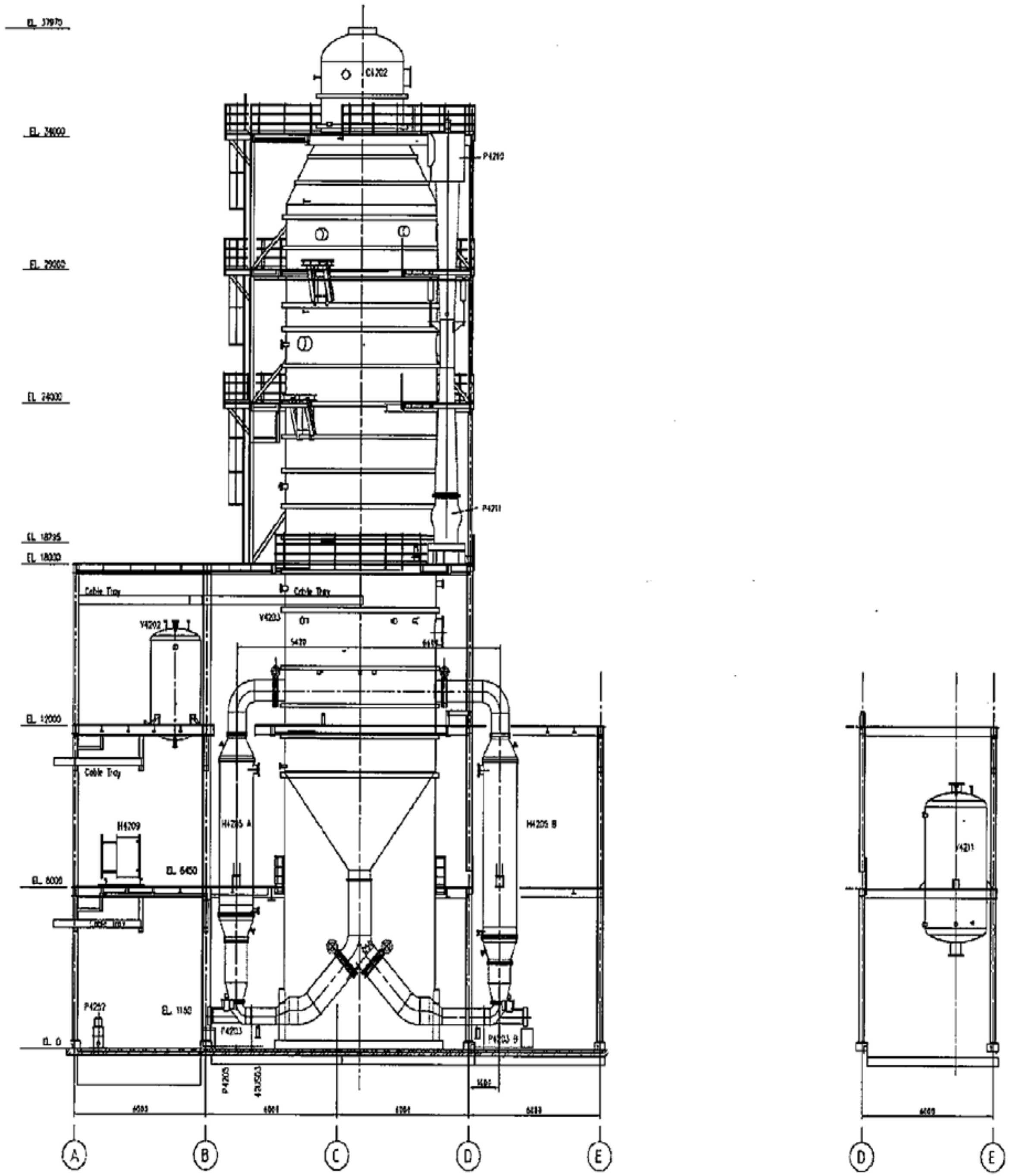
Self-cleaning heat exchangers designed and put into operation by KLAREX® TECHNOLOGY specialists .

Country	Number of units	Fouling liquid	Application	Surface area in m²
the Netherlands	1	Desalination of canal water	MSF distillation plant (evaporator)	25
the Netherlands	1	Seawater desalination	MSF distillation plant (evaporator)	1000
the Netherlands	2	Liquid containing proteins	Anaerobe waste water treatment plant	6
the Netherlands	2	Brackish water	MSF distillation plant (evaporator)	100
Finland	1	Industrial waste water	Anaerobe waste water treatment plant	14
Iceland	2	Geothermal brine	District heating	12
the Netherlands	1	Liquid containing proteins	Anaerobe waste water treatment plant	6
the Netherlands	2	Slaughterhouse waste water	Anaerobe waste water treatment plant	50
the Netherlands	1	Liquid containing fibres	Board mill	55
Norway	1	Liquid containing proteins	Fish meal plant	11
Iceland	2	Geothermal brine	District heating	44
the Netherlands	3	Hard well water	Board mill	50
the Netherlands	3	Liquid containing fibres	Board mill	60
Italy	1	Municipal sewage	District heating	6
United States	1	Proprietary herbicide	Chemical plant	9
Fed.Rep.Germany.	1	Liquid containing proteins	Potato processing plant	26
Sweden	1	Waste water	Food processing plant	2
Fed.Rep.Germany.	1	Waste water from tank cleaning	Chemical plant	3
Fed.Rep.Germany.	1	Proprietary chemical	Chemical plant (reboiler)	300
United States	3	Hard well water	Dairy plant	45
France	1	White water	Paper- and board mill	19
United Kingdom	2	White water	Paper- and board mill	96
Fed.Rep.Germany.	2	Proprietary chemical	Chemical plant (test unit)	12
Austria	1	Proprietary chemical	Chemical plant (test unit)	6
Fed.Rep.Germany.	1	Proprietary chemical	Chemical plant (test unit)	6
the Netherlands	1	Hard well water	Food processing plant	23
France	1	Liquid containing fibres	Board mill	19
France	1	Liquid containing proteins	Food processing plant	187
United States	1	Proprietary chemical	Chemical plant (test unit)	6
United States	1	Proprietary chemical	Chemical plant (test unit)	6
United States	1	Proprietary chemical	Chemical plant (test unit)	6
United States	1	Proprietary chemical	Chemical plant (test unit)	6
Iceland	2	Geothermal brine	District heating	54
Fed.Rep.Germany.	1	Liquid containing fibres	Paper mill	55
Fed.Rep.Germany.	1	Salt solution	Zinc production plant	240
Belgium	1	Liquid containing fibres	Paper- and board mill	24
the Netherlands	1	Liquid containing high concentration of solids	Chemical plant	2
Fed.Rep.Germany.	1	Saturated salt solution	Mining and chemical plant	65
Hungary	1	Bauxite solution	Aluminium plant	6
Fed.Rep.Germany.	1	Waste water	Waste dump	3
Canada	1	Saturated salt solution	Potash mining and chemical plant	430
Fed.Rep.Germany.	2	Waste water	Waste dump (evaporator)	57
United States	1	Proprietary chemical	Chemical plant (reboiler)	73
the Netherlands	1	Vinasses	Alcohol production plant (evaporator)	330
Fed.Rep.Germany.	1	Waste water	Chemical plant	84
the Netherlands	1	Hard process water	Zinc production plant	16
Japan	1	Waste water	Food processing plant (evaporator)	60
Belgium	1	Waste water	Chipboard plant (evaporator)	250
Austria	2	Hard scaling liquor	Pulp mill	250
United States	4	Process water	Chemical plant	4600
the Netherlands	1	Hard well water	Board mill (revamp)	25
Kingdom of Saudi Arabia	1	Crude oil	Refinery (test unit)	2
Australia	2	Laterite nickel slurry	Nickel processing plant (test units)	100
United States	1	Proprietary chemical	Chemical plant (reboiler revamp)	73
Belgium	1	Waste water	Paper mill	50
Canada	3	Produced water	Steam generation oil company (test unit)	50
Australia	1	Copper boil	Nickel processing plant (test units)	2
United States	1	Process liquid	Chemical plant (test units)	2
Italy	1	Process liquid	Chemical plant (test units)	5

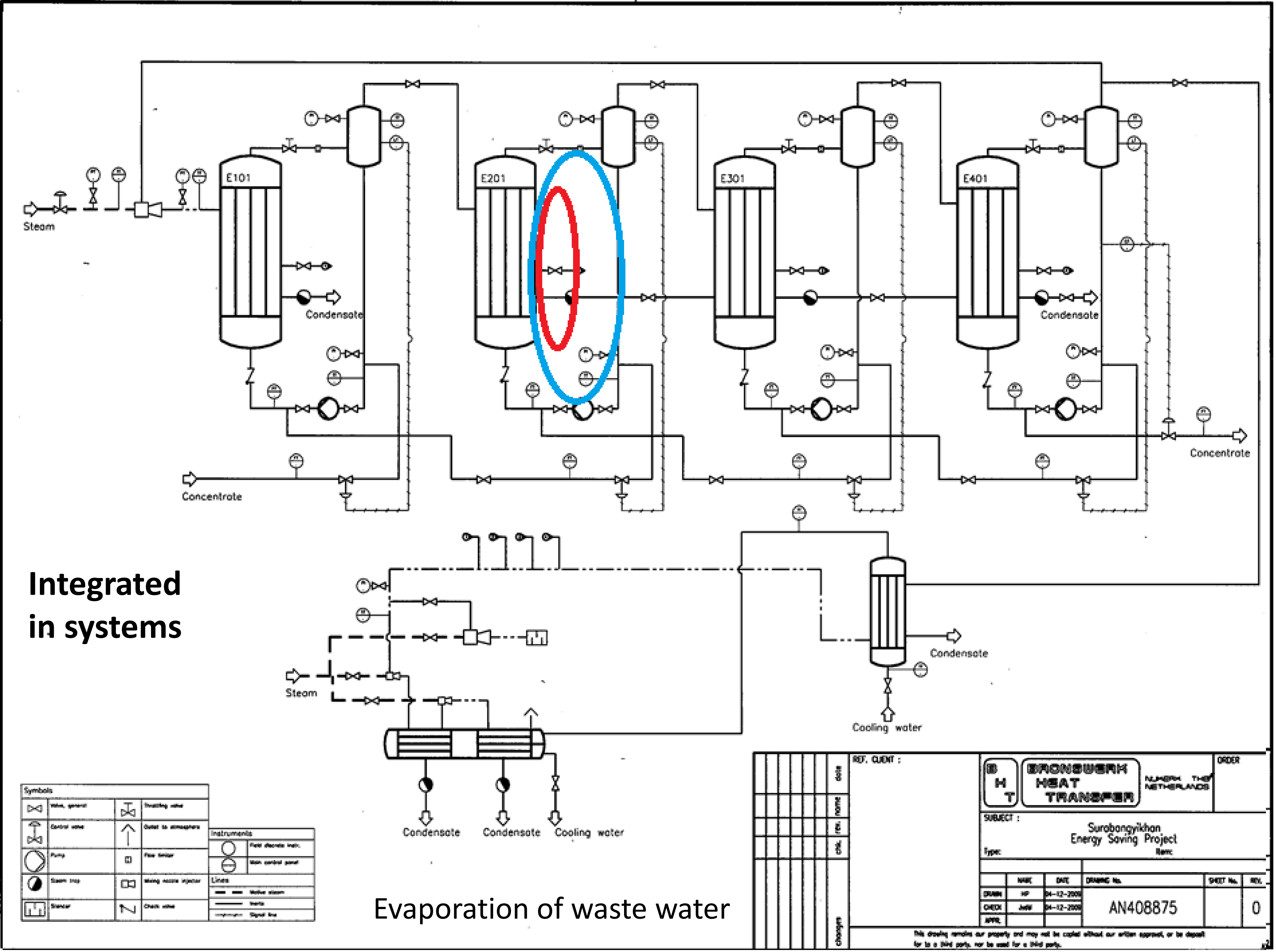




Revamp of reboilers

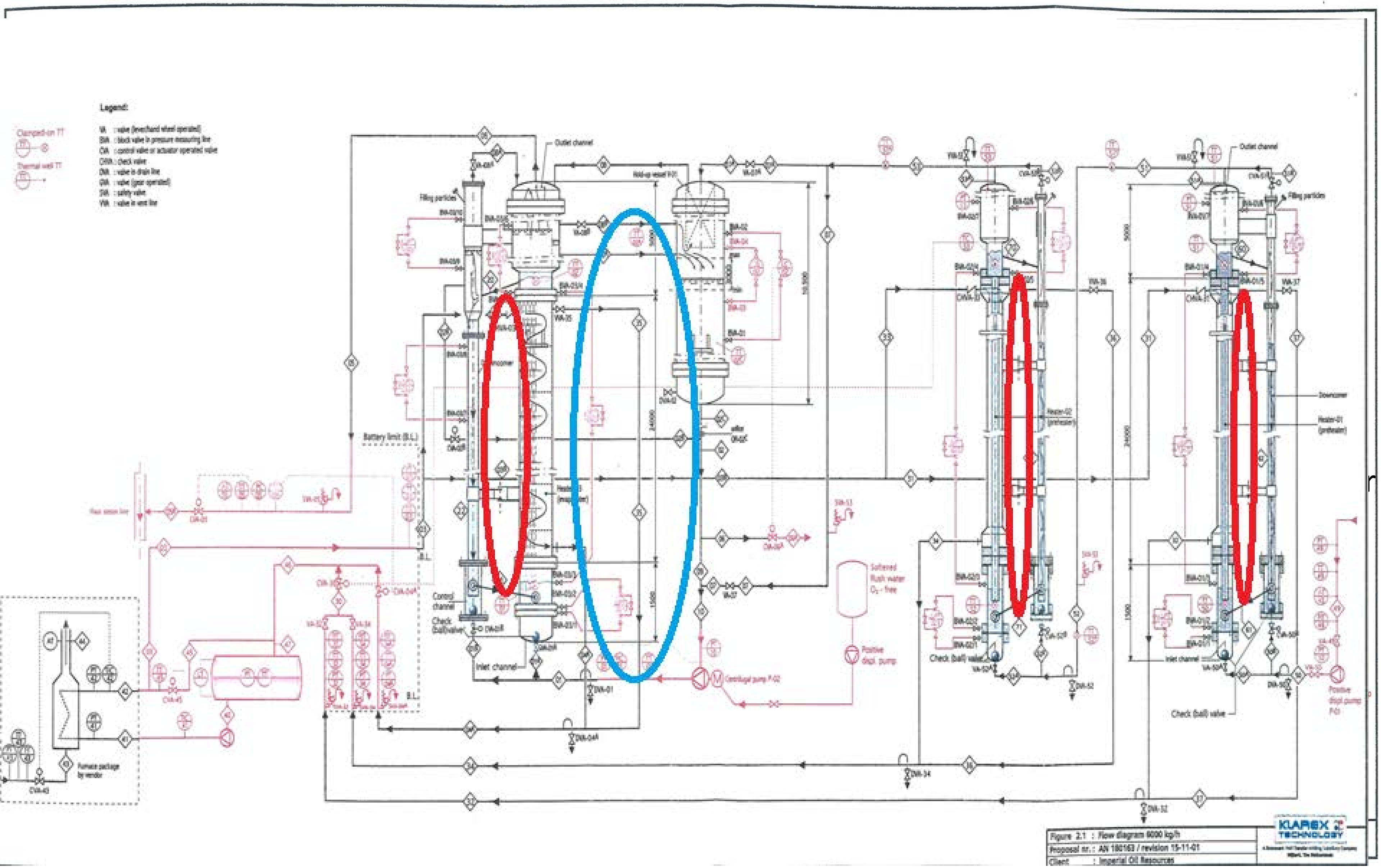


Study for revamping



Integrated in systems

Evaporation of waste water



High pressure Steam production from fouled water

Einde

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