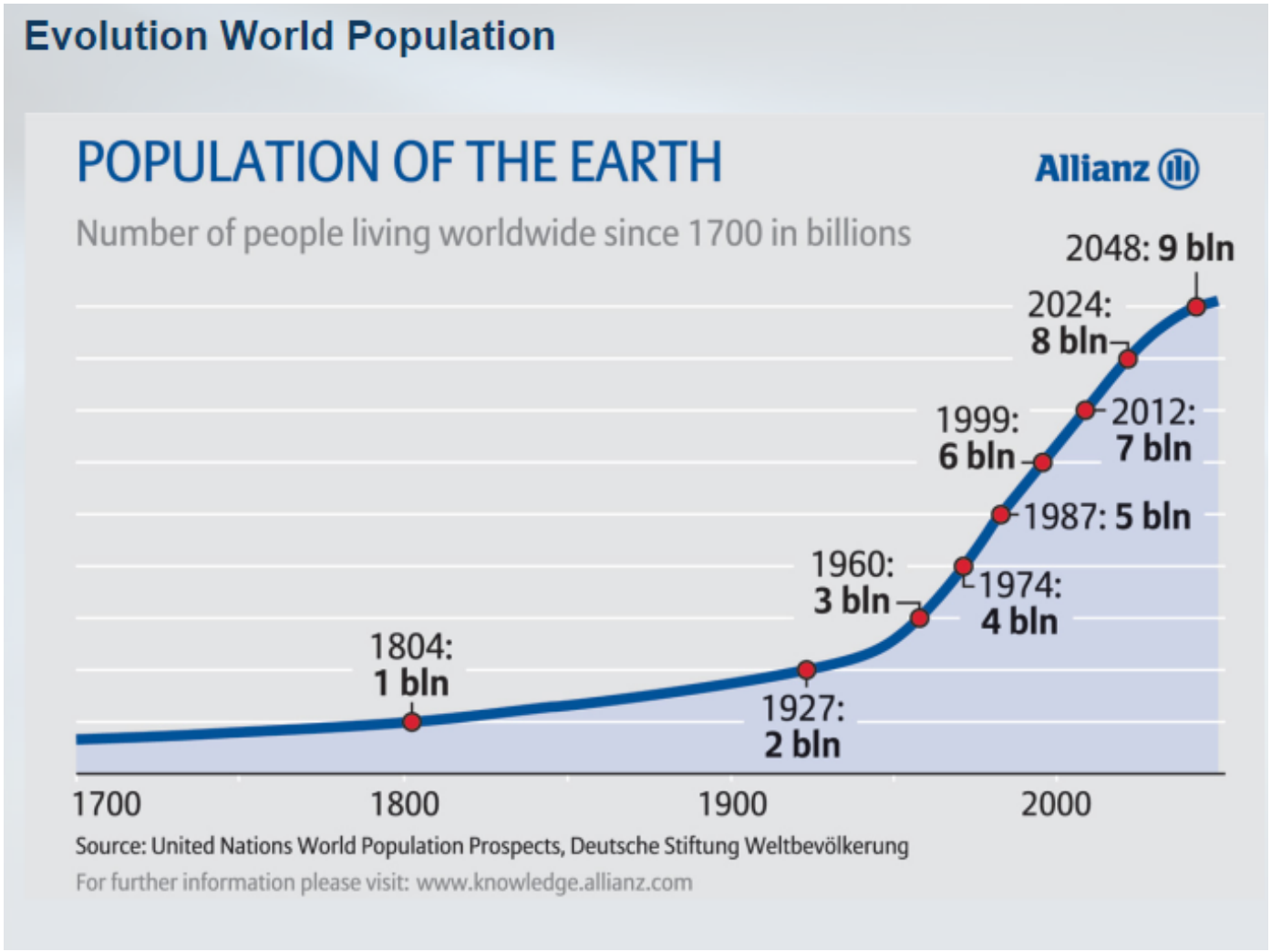
Heat recovery on batch retorts: possible process issues.

Suys Jo – manager Process Technology Center JBT Belgium

Overview

- **Introduction: lowering energy consumption – clear trend**
- **Heat recovery systems offered by suppliers**
- **Case-study: possible process issues**
- **Details on JBT solutions for energy/heat recovery**

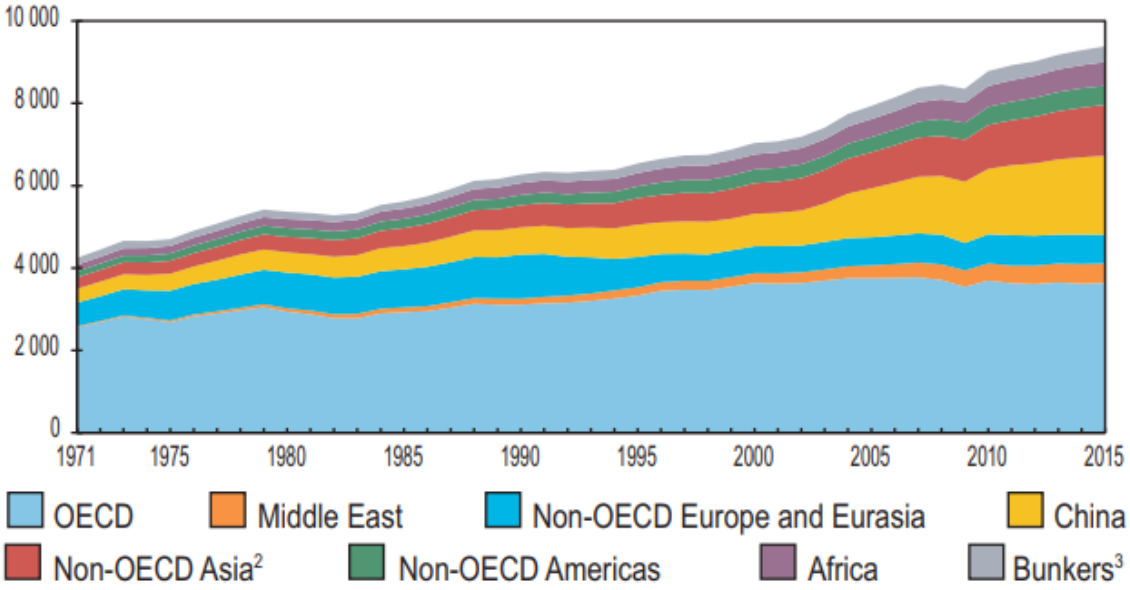
Introduction: lowering energy consumption



Introduction: lowering energy consumption

World total final consumption by region

World TFC[1] from 1971 to 2015 by region (Mtoe)



Toe: the **tonne of oil equivalent** (**toe**) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil.

Introduction: lowering energy consumption

Global warming…

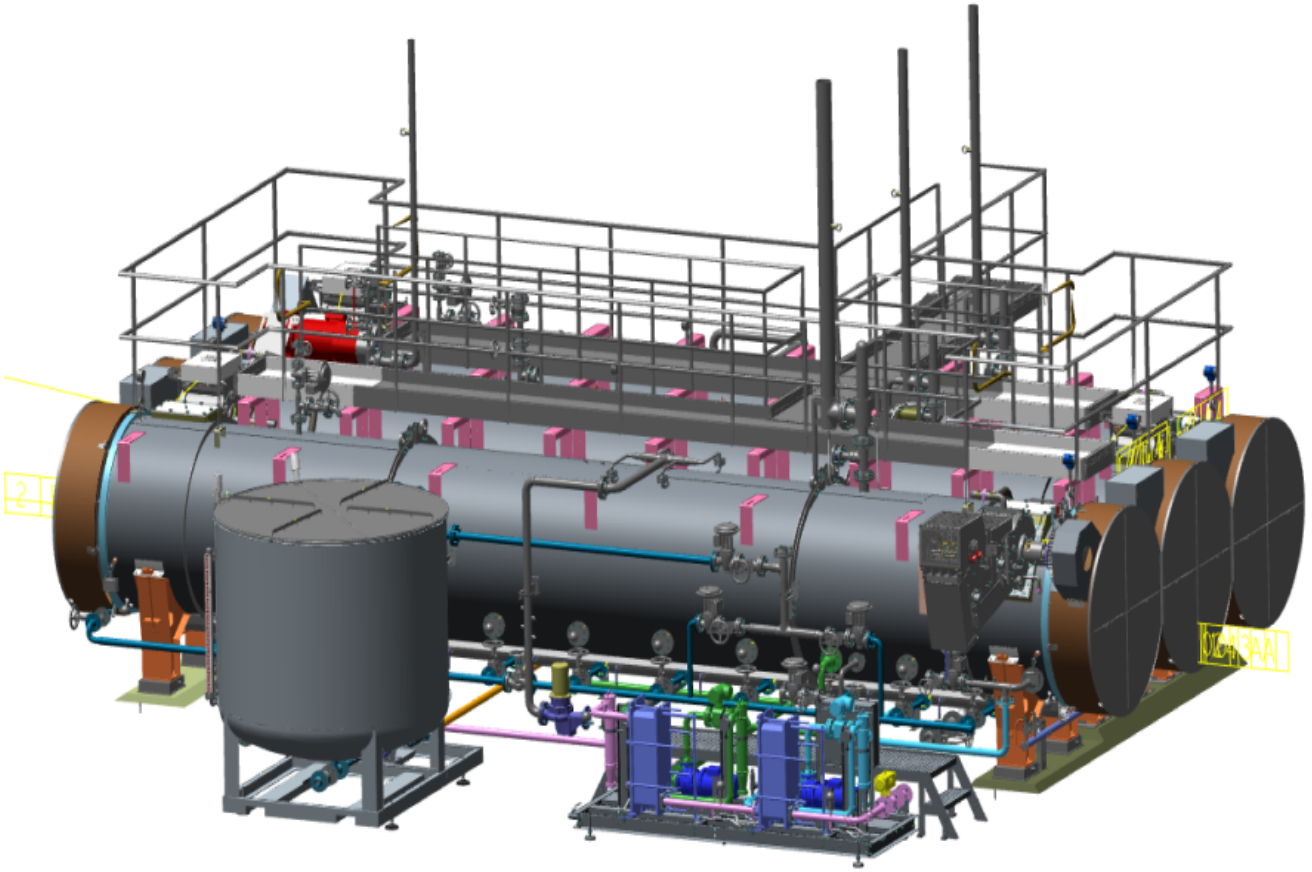
Introduction: lowering energy consumption

- **World Population is growing**
- **World total Energy consumption keeps growing**
- **Environmental issues force to look for alternatives:**

  - more and more initiatives to save and recuperate energy are introduced in industrial systems.
  - Also in sterilization systems energy recovery is becoming a “hot” topic. Saving energy = saving money!
  - JBT experience: energy recovery more often part of proposals (new machines and retrofits)

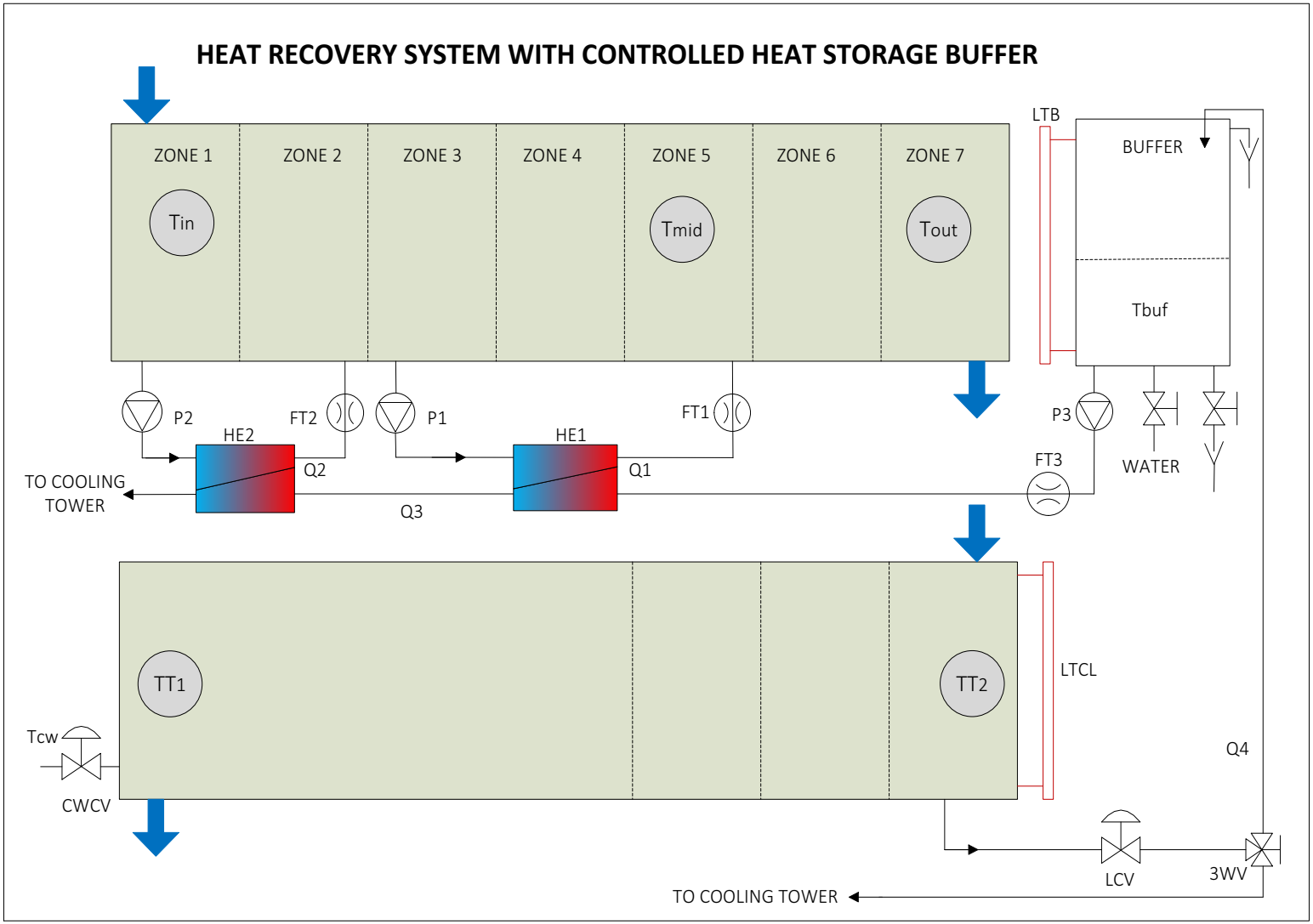
Examples: JBT rotary

Typical “milk line: preheat, cooker, cooler.



This document is intended solely for use by *Princes for* evaluating purchase of JBT equipment. It may contain confidential information for the sole use of *Princes.* Any review, use, distribution or disclosure by others is strictly prohibited.

Examples: JBT rotary



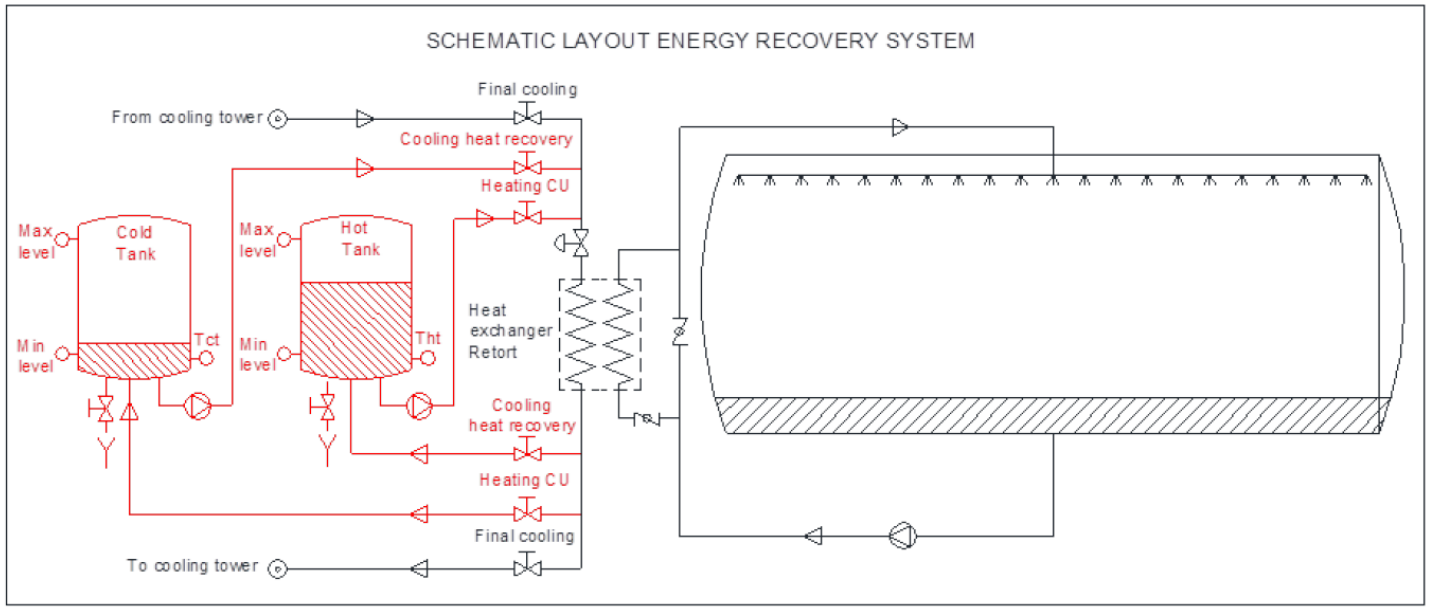
Examples: JBT rotary

Energy recovery system on JBT rotary
two heat exchangers and buffertank

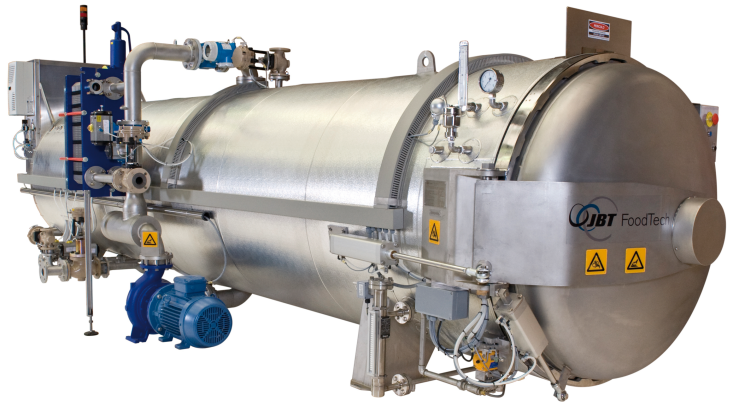
Heat from water drained form cooler is used to heat up preheater (milk line). No steam Consumption in first part preheater (35 tot 75°C)

The whole process is monitored/controled, no differences in preheater gradient with or without HRS

Examples: JBT retort



Energy recovery system on JBT retort: hot and cold tank.
Standard retort heat exchanger.
Energy from hot cooling water is used for first part of Come-up of the retort.
The whole proces is monitored/controled.
No difference in retort profile with or without HRS

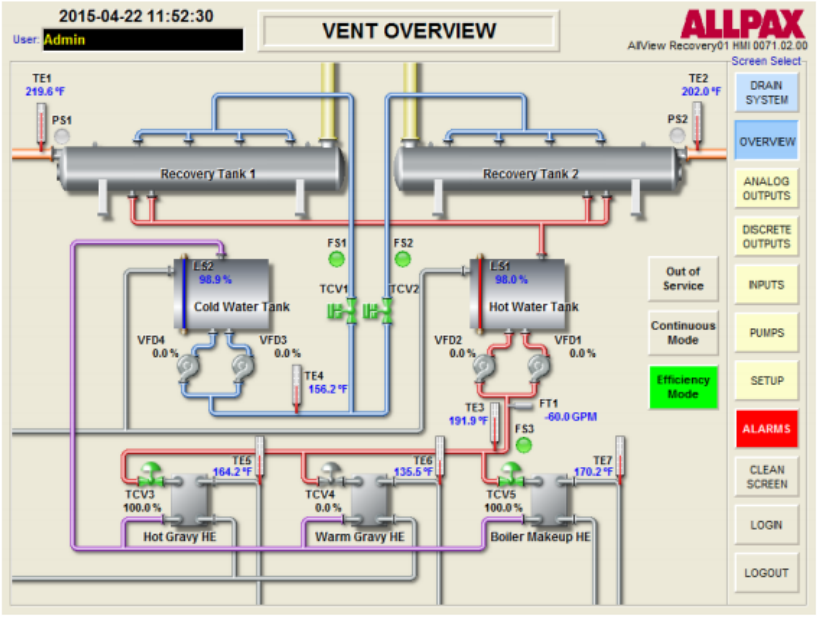


Examples: Allpax retort

RETORT ENERGY RECOVERY

Steam Recapture

Allpax developed technology designed to harness wasted energy on saturated steam retorts by capturing vented steam and creating free hot water for plant operations.

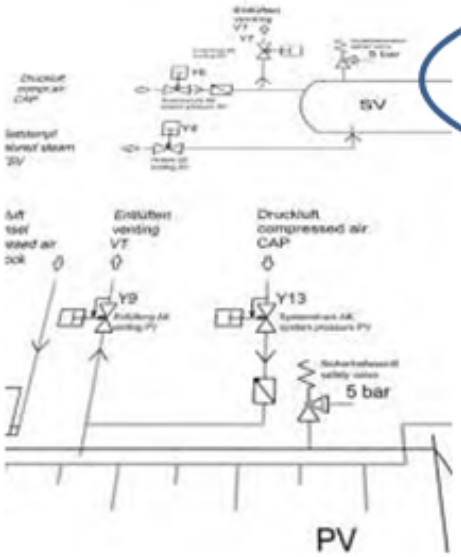


- **Allpax custom designs energy recovery systems to fit plant needs.**
- **PLC controls and graphic HMI screens capture the critical variables.**

Energy recovery system on Allpax saturated steam retort. Based on capturing vented steam, used to create hot water for other applications.

Examples: Stock retort

Cooling Water Recycling



The efficient use of energy and water earmarks more and more the economical use of sterilization systems. Thisdiagram shows an optimized process sequence for the retort operation. Besides the appropriate equipment of autoclave systems dft technology provides advice on the design of the steam, water, and cooling water supply.

Energy recovery

- **Different suppliers of continuous and discontinuous sterilizers deliver solutions for energy recovery**

- **The systems must be under control, the process cannot be influenced if the energy recovery system is active or inactive!**

- **Validation should prove that the heat/energy recovery system (new or retrofit) does not influence the process.**

Energy recovery – case

- European vegetable processor
- Water cascading retorts – new machines. More to be installed in future

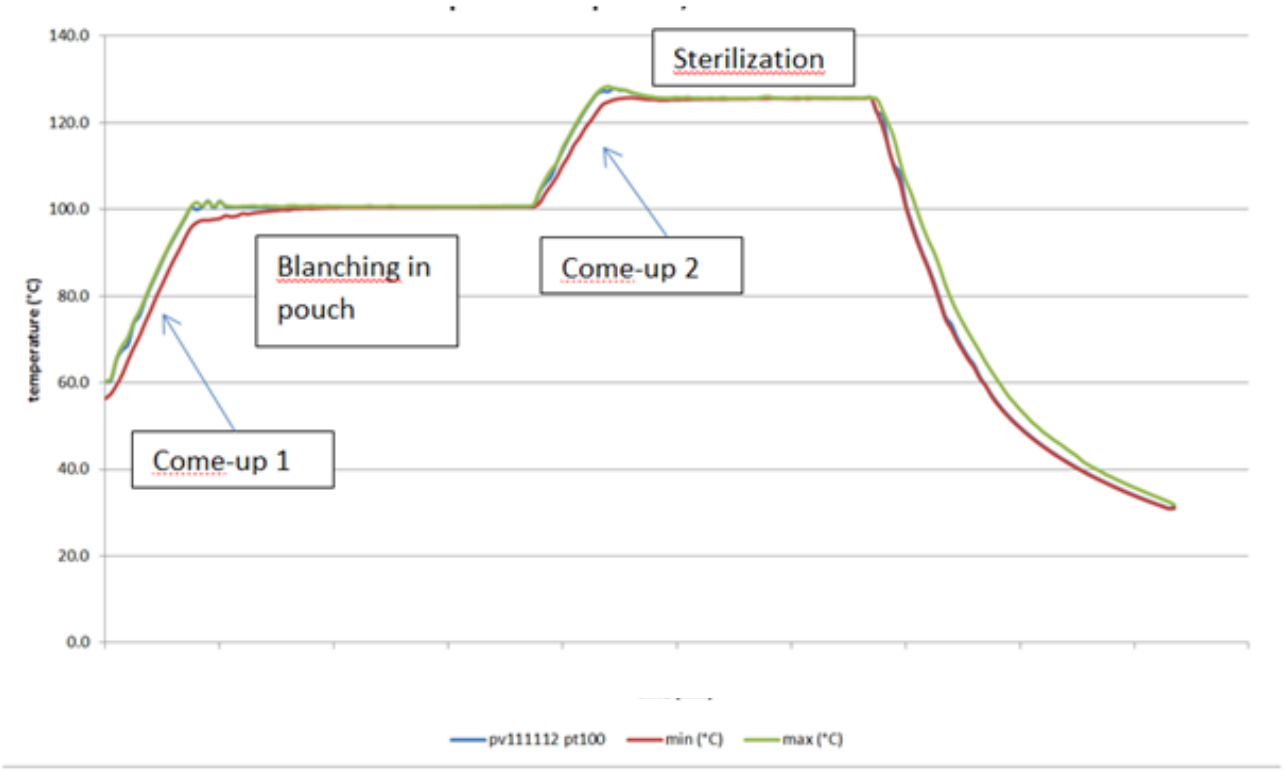
Energy recovery – case

- **As Thermal Process Authority (TPA) we were invited to validate the process for vacuum packed vegetables in pouches (pillow type – different sizes). TD and HP**

- **Tray with vacuum sealed pouches and stack of trays:**

Energy recovery – case

- **The vegetables are not blanched before the sealing of pouches. Sealing under vacuum, blanching in the pouch during the process. 25 to 30 minutes hold phase after come-up 1. This process is patented.**



Energy recovery – case

- **Customer designed and installed an energy recovery system, basic and straight forward:**

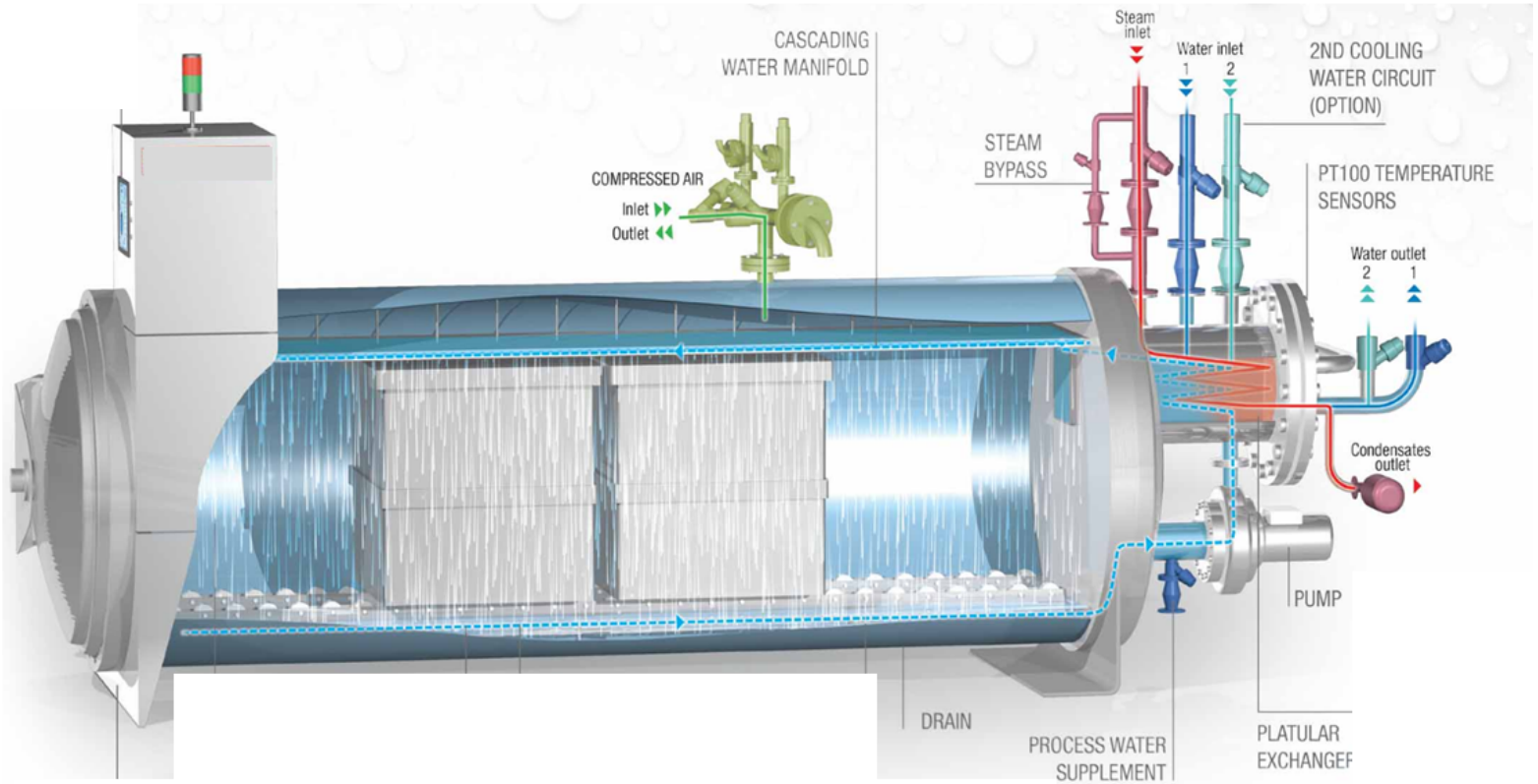
  - 1 hot water tank, +/- 11.000 ltrs
  - 1 cold water tank, +/- 11.000 ltrs
  - level control based on pressure measurement

  - The system has no flow meters in the circuit. The tanks have no temperature control.

  - 1 pump: filling with hot water on 1 retort and start the cool with water from « cold » tank on an other retort is not possible

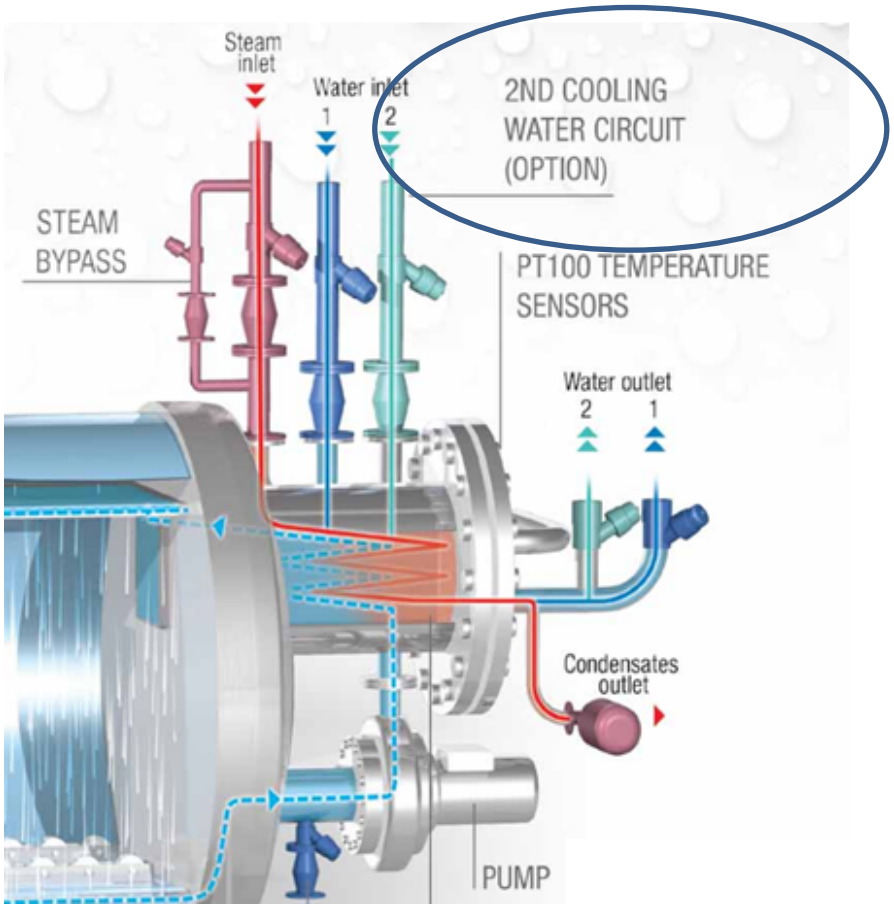
Energy recovery – case

- **Retort principle**



Energy recovery – case

- **Detail steam- and waterinlet**

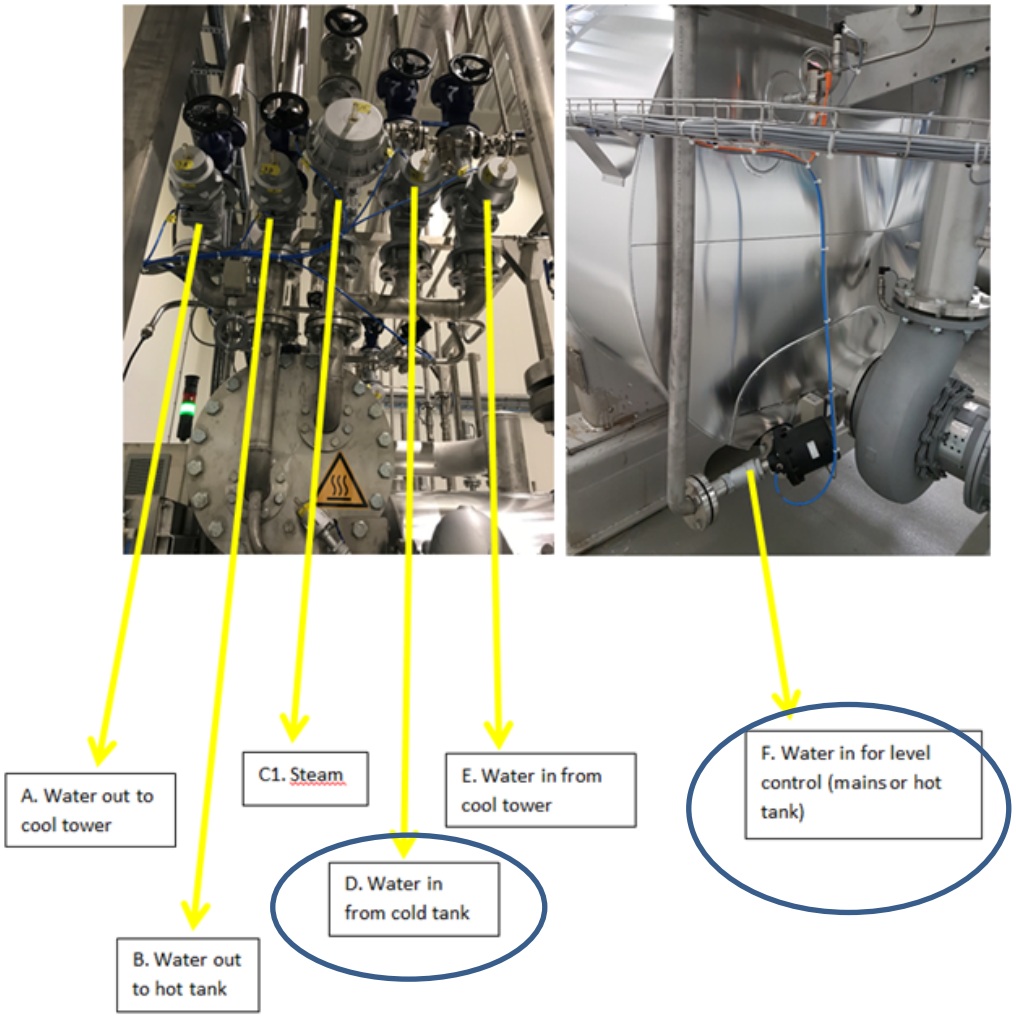


Water from cold tank (heat Recovery system)

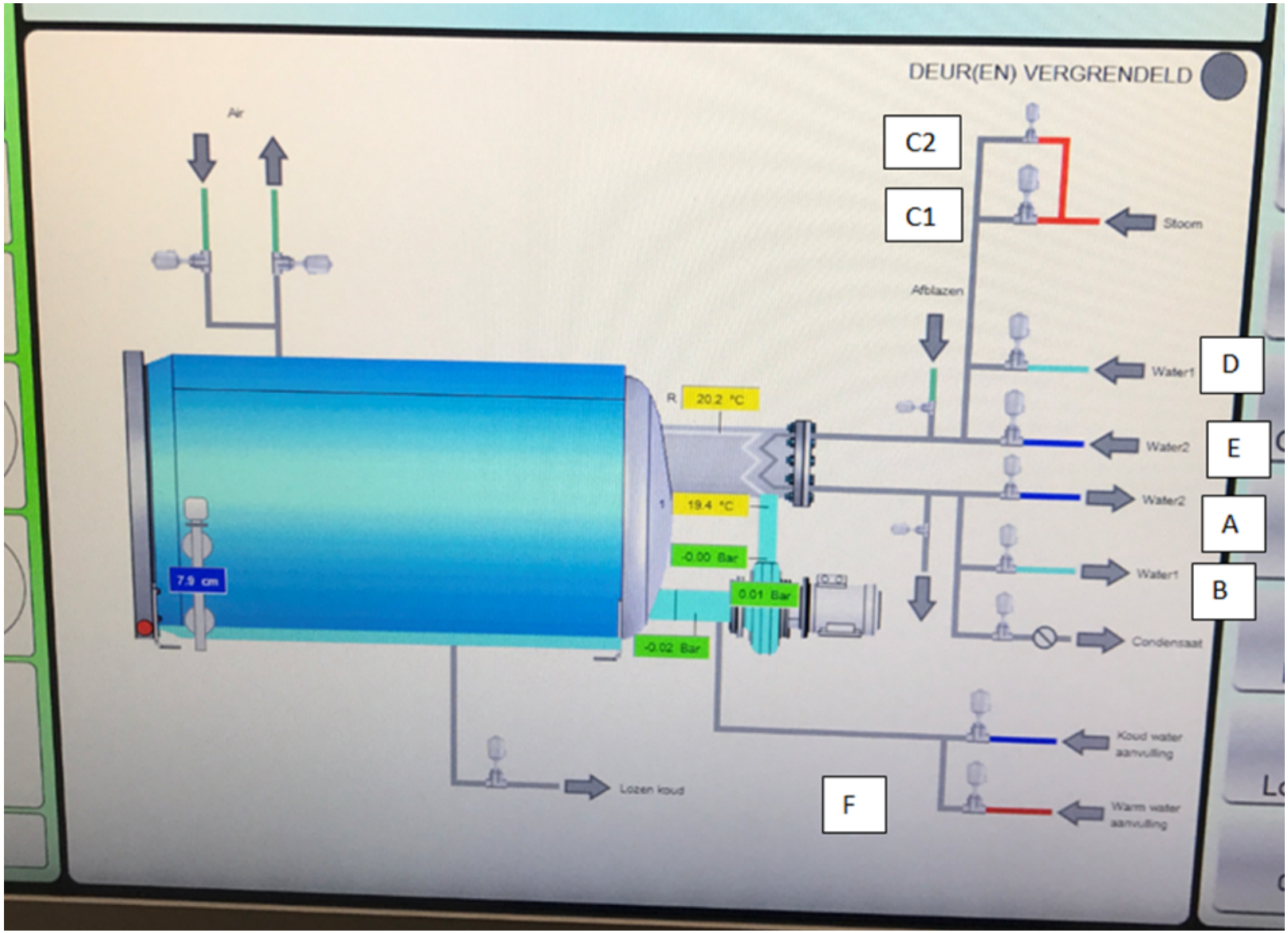
Energy recovery – case

Water from hot tank (heat Recovery system) or mains

Energy recovery – case



Energy recovery – case



Energy recovery – case

- **The initial waterlevel in the retort (380 mm) covers the first two layers in water.**

- **Once the pump starts running, the water is captured in the baskets/stack of trays (completely closed on the sides) and level drops beneath minimum**

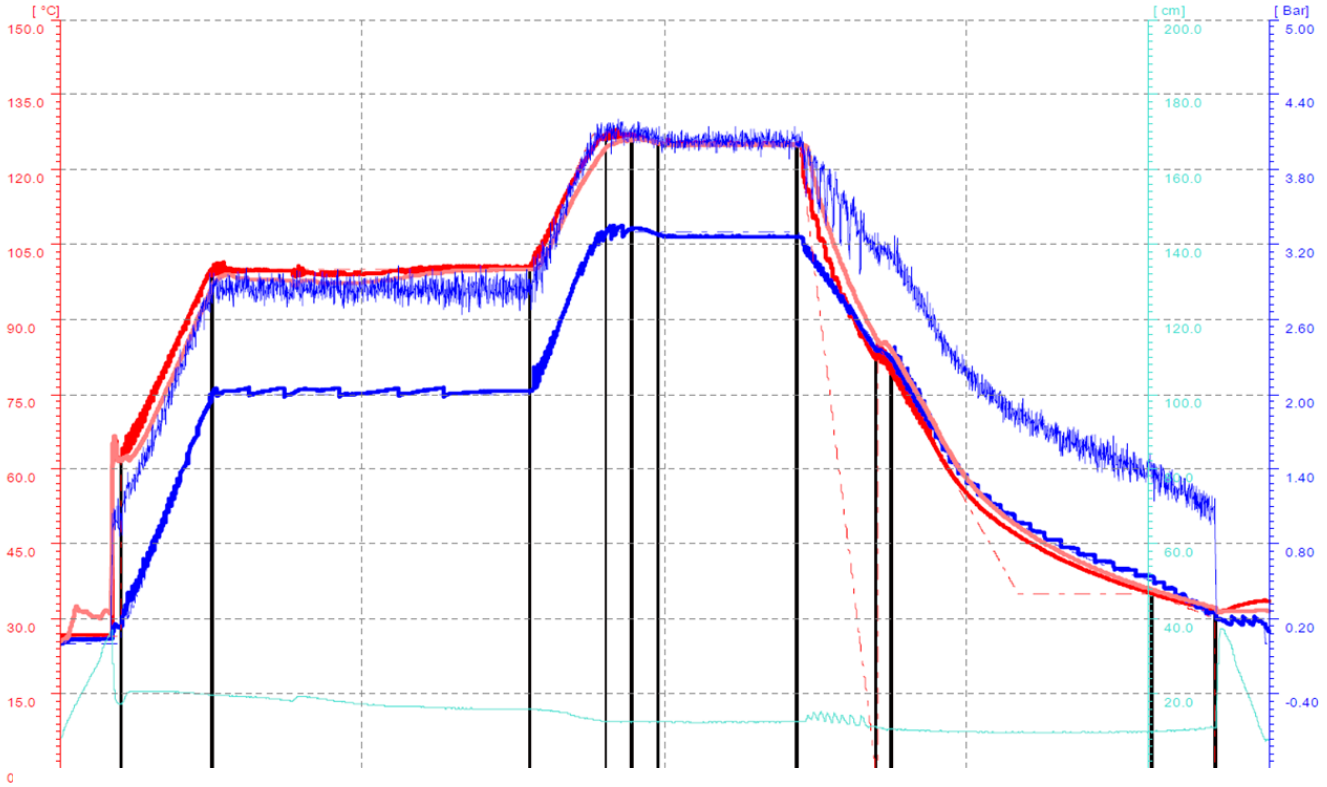
Energy recovery – case

- **To compensate for the volume captured in the trays <u>extra water is added</u>. The water used for this, is from the hot water tank (unless level is too low).**

Energy recovery – case

- Adding water from “hot tank” can cause that the first come-up is very variable and cannot always follow the programmed profile:

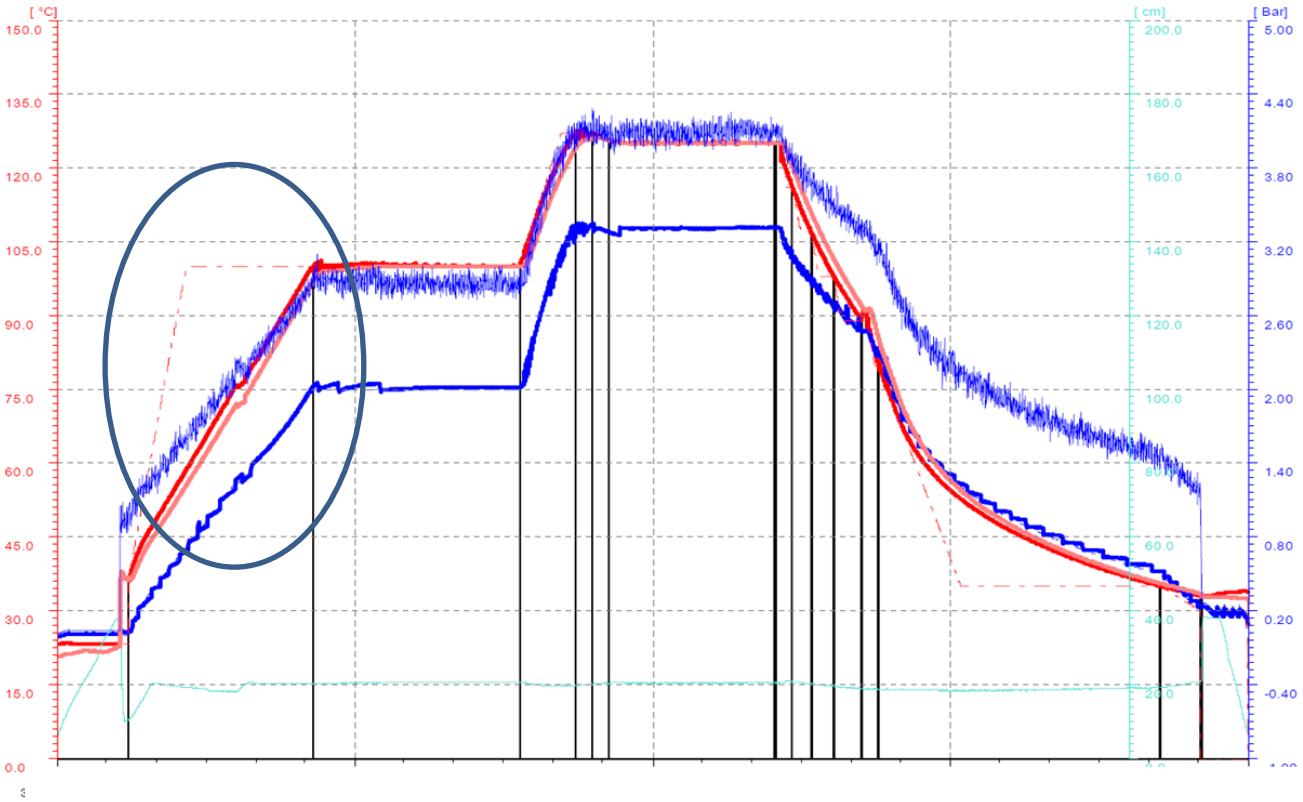
Hot water entering during first come-up: the programmed come-up is followed.



Energy recovery – case

- Adding water from “hot tank” can cause that the first come-up is very variable and cannot always follow the programmed profile:

Water form “hot” tank is too low in temperature (no control on tank) - > first come-up is more than double compared to programmed time!



Energy recovery – case

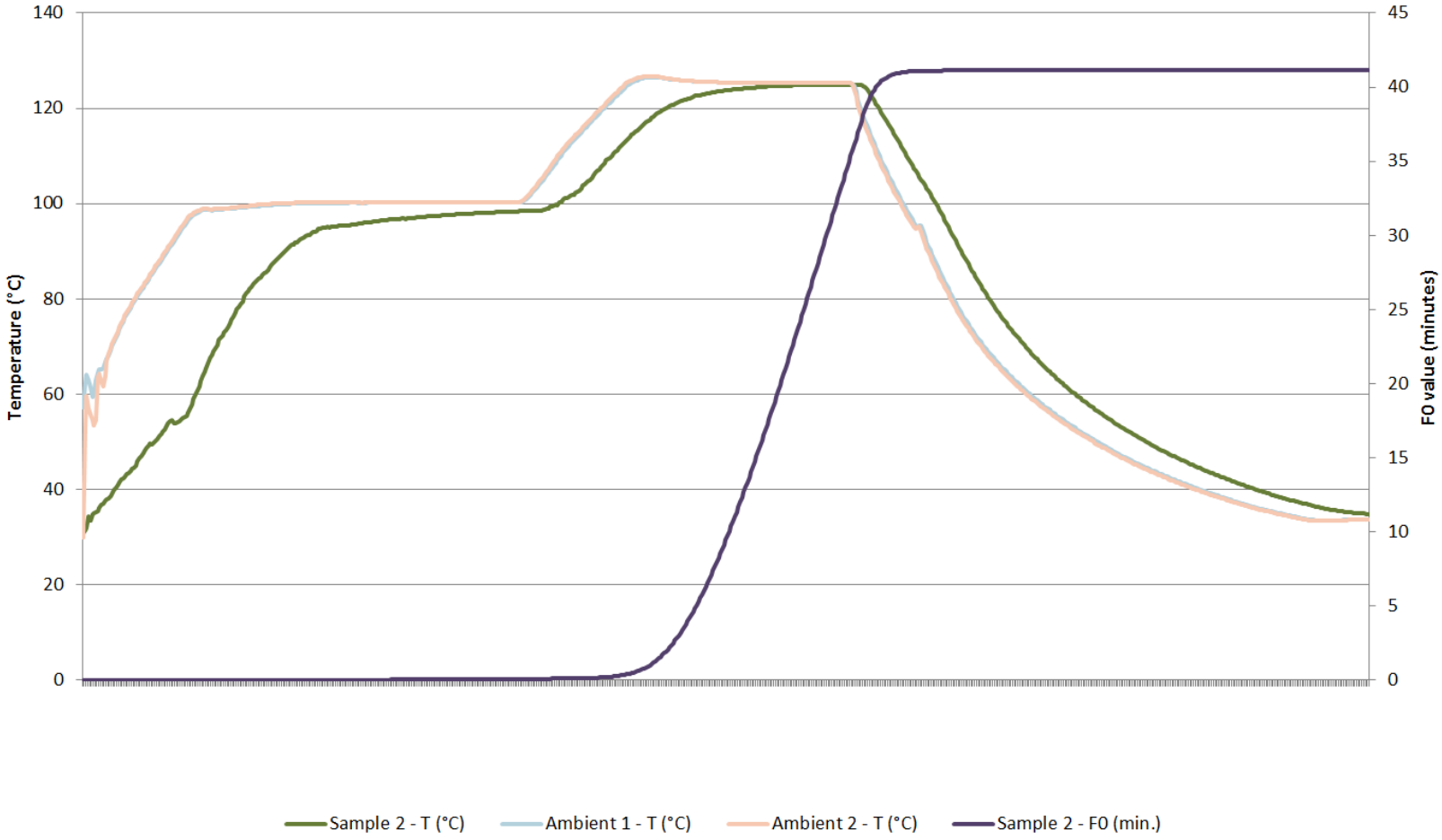
- **No temperature control in hot water tank (only volume)**

  In the morning: water cooled down
  - come-up 1 cannot be repeated identically every cycle
  - How to define minimum come-up in validation
  - Holding at 100°C should be changed in function of come-up

- **In this case No issue because:**
  - Come-up in validation report defined as time between 100°C and sterilization temperature
  - Relatively fast heating product: IT at start come-up always +/- 98°C (tested with coldest water in tank possible: ambient temperature)
  - Use “conservative” IT for process calculation (90°C). Influence on cook time!
  - No influence on final F0

Energy recovery – case

Relatively fast product heating - > little influence on IT before come-up2 if Blanching fase shorter



Energy recovery – case

- If machines were to be used without blanching fase: very difficult to define a come-up time. -first come-up phase is not under control.

- When 5 retorts are in production, of course there will be an overlap with one machine cooling, another one in come-up phase. As the design of the system foresees only one pump for both tanks, this will cause longer come-up times or longer cooling times

- If products would be hot fill, this might first cool down the product. If a producer would follow this principle without having an intermediate cooking phase, the complete process would not always be under control (not applicable in this case, this is a general remark).

Energy recovery – case

- The first step of the cooling is programmed as « forced » cooling : no setpoint control, max cooling possible for 6 minutes.

- This is based on the design : it was calculated that the system needs 6 minutes at max capacity to generate enough water for the hot tank.

- As the water temperature in cold tank is not under control, the retort temperature at end of cooling phase 1 (step 7) varies. (See next)

Energy recovery – case

Fase	Type	Start:	Einde:	Duur Fase	End phase temp. (°C)	Mean temp. (°C)	Min. temp. (°C)	Max. temp. (°C)	End phase press. (Bar)
1	Opwarming				100.01	71.91	32.28	100.01	
2	Opwarming				100.01	100.04	98.52	101.31	
3	Opwarming				127.19	114.09	100.01	127.19	
4	Opwarming				127.09	126.95	126.09	127.99	
5	Opwarming				125.29	126.14	125.29	127.09	
6	Opwarming				125.19	125.19	124.79	126.29	
7	Forced cool. 1	16:04:55	16:11:08	00:06:12	85.23	101.75	85.23	125.19	
8	Koeling 2				79.93	84.11	79.93	88.43	
9	Koeling 2				34.98	50.02	34.98	80.63	
10	Limited time cool. 2				29.98	32.60	29.98	35.18	
11	Lozen koud				31.88	31.05	29.98	31.88	

Fase	Type	Start:	Einde:	Duur Fase	End phase temp. (°C)	Mean temp. (°C)	Min. temp. (°C)	Max. temp. (°C)	End phase press. (Bar)
1	Opwarming				100.01	82.31	57.75	100.01	
2	Opwarming				100.01	100.03	98.52	101.31	
3	Opwarming				127.09	115.21	100.01	127.09	
4	Opwarming				127.19	127.08	126.19	127.99	
5	Opwarming				125.89	126.35	125.79	127.29	
6	Opwarming				125.19	125.21	124.99	125.89	
7	Forced cool. 1	12:34:20	12:40:32	00:06:12	92.32	106.35	92.32	125.09	
8	Koeling 2				79.93	86.99	79.93	96.02	
9	Koeling 2				39.27	51.51	39.27	81.13	
10	Limited time cool. 2				35.08	36.71	35.08	39.27	
11	Lozen koud				36.18	35.73	34.78	36.38	

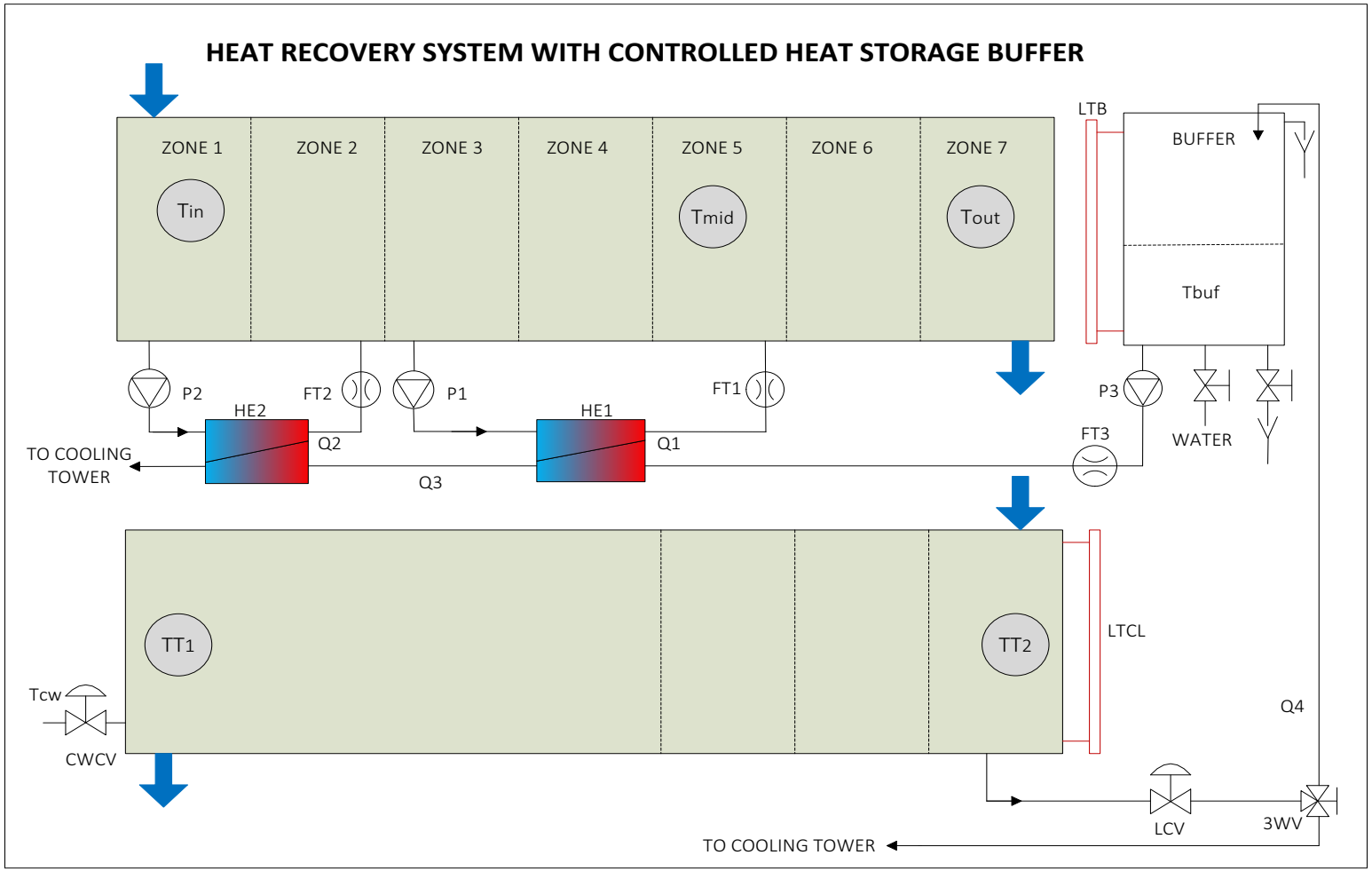
Energy recovery – case

- **The validation is for this reason based on an F0 heating (not F0 total), because cooling is not 100% reproducable each cycle. This limits the options for process time optimization.**

Energy recovery – case

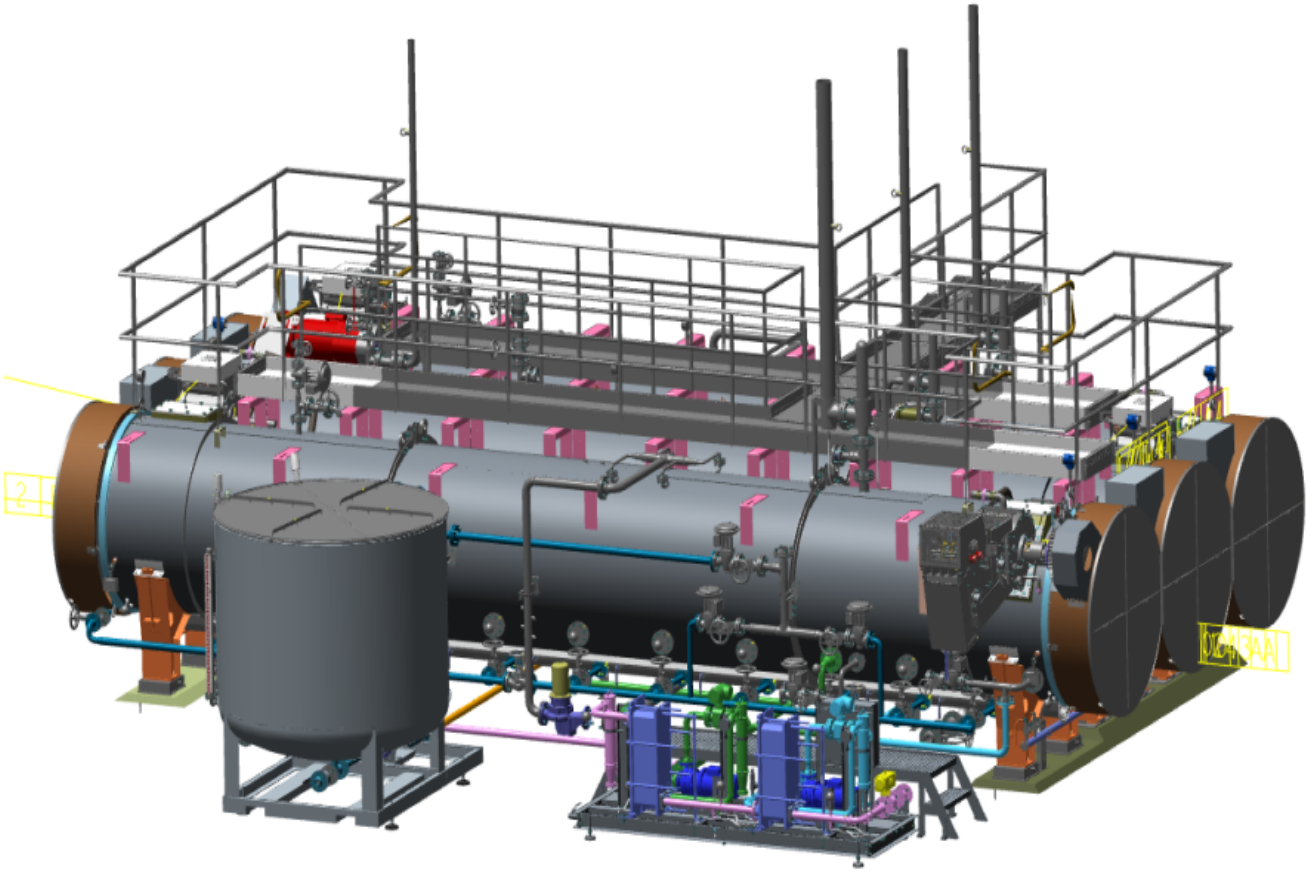
- Be careful with self-designed heat recovery systems (HRS)
- Make sure process conditions are always the same, with or without HRS
- Consider process, what is worst case?
- Revalidate if required
- Check impact on control software

Example HR on JBT rotary



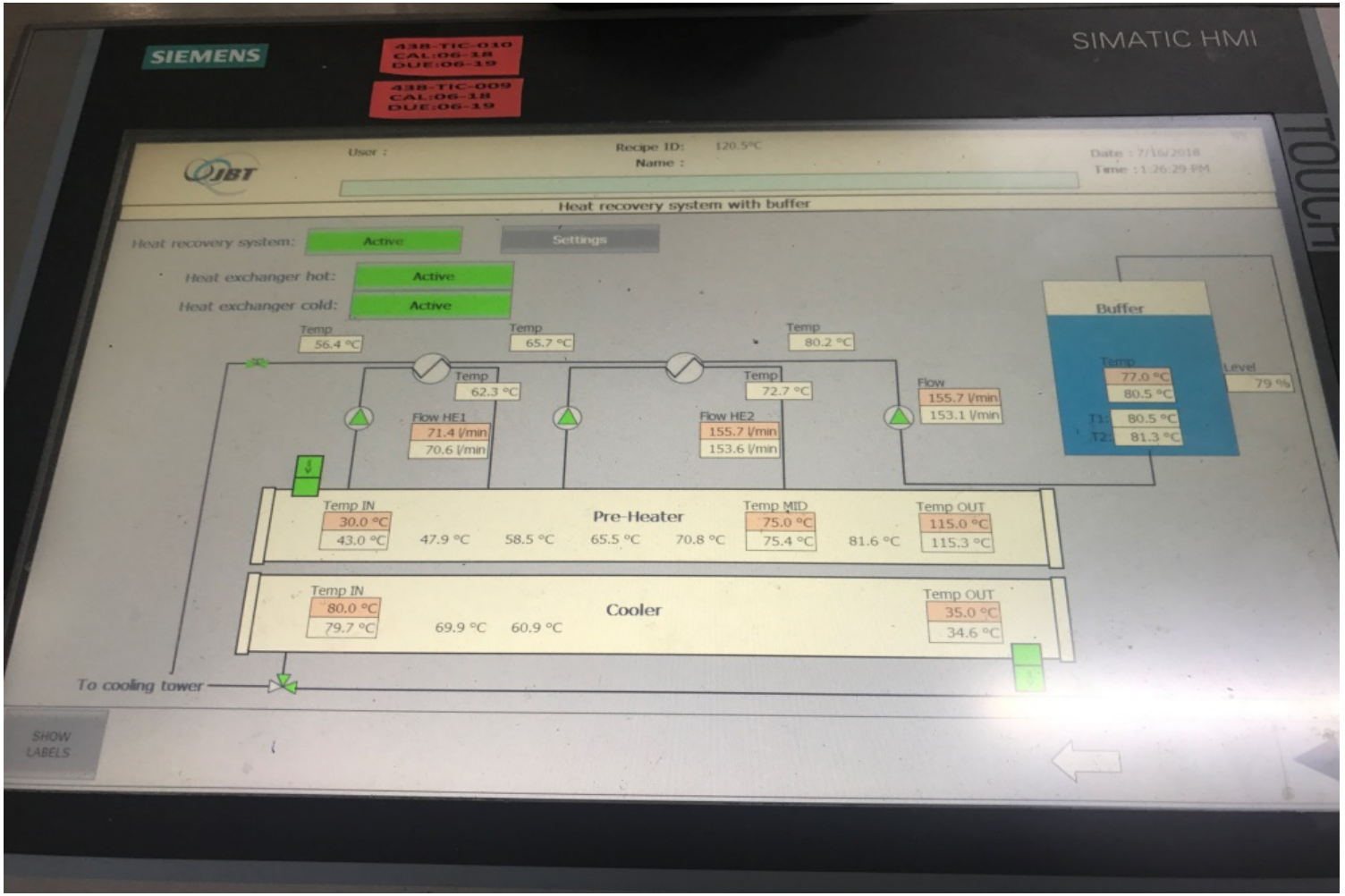
Example HR on JBT rotary

Typical “milk line: preheat, cooker, cooler.



This document is intended solely for use by *Princes for* evaluating purchase of JBT equipment. It may contain confidential information for the sole use of *Princes.* Any review, use, distribution or disclosure by others is strictly prohibited.

Example HR on rotary



Example HR on rotary

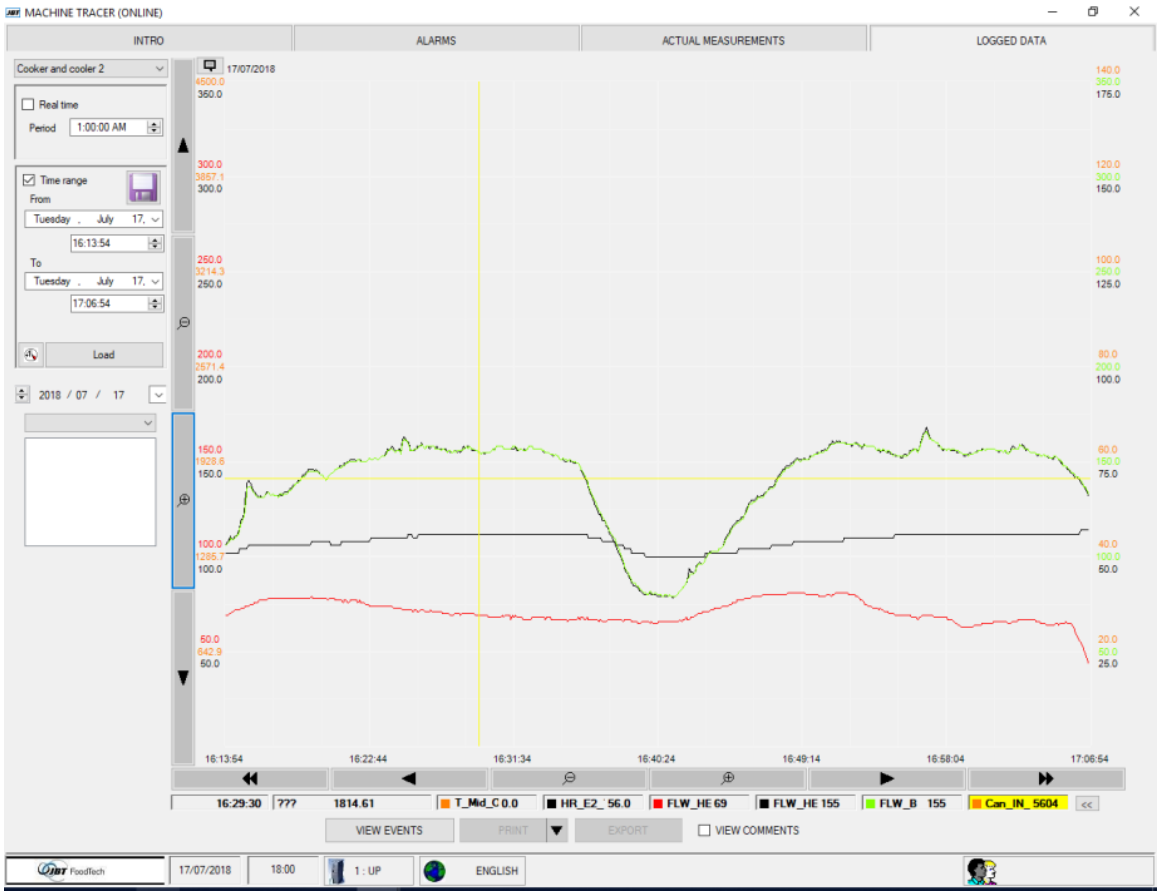
Energy consumption in zone 1,2 and 3/4/5 when HR not active

Green: steam valve opening in 1,2
Orange: steam valve opening in 3,4,5

Blue: temp middle preheater

Red: cans in machine.

Example HR on rotary



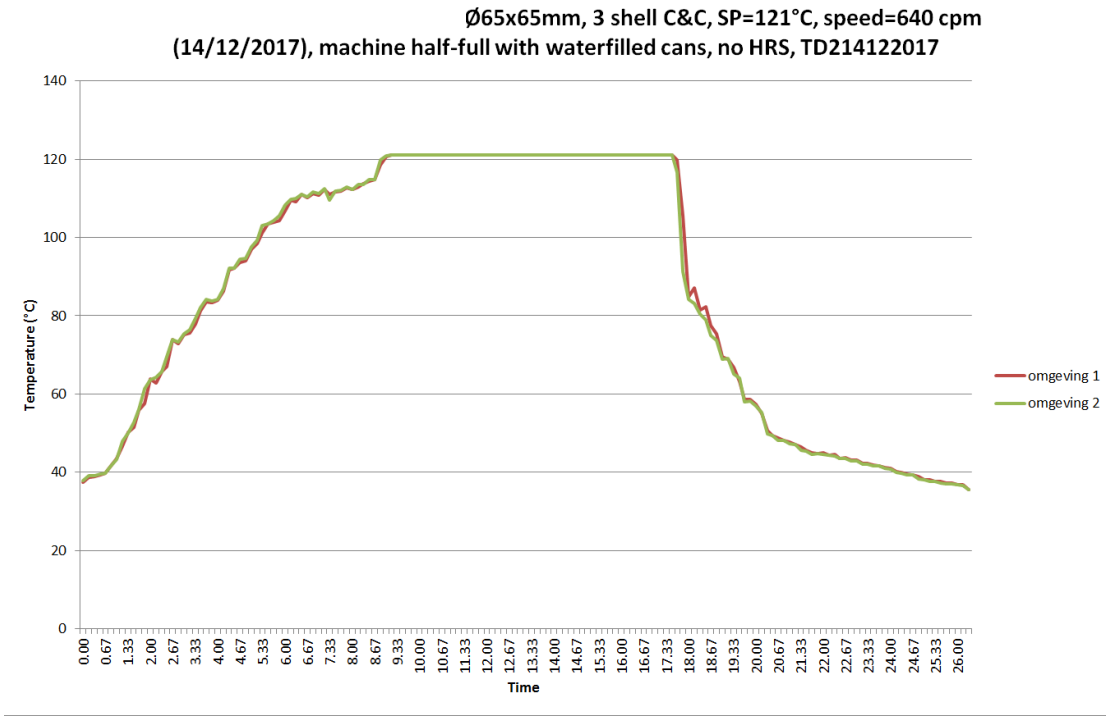
Energy consumption in zone 1,2 and 3/4/5 **<u>when HR active</u>**

Green and black: flow over HEX's and buffertank
Red: cans in machine

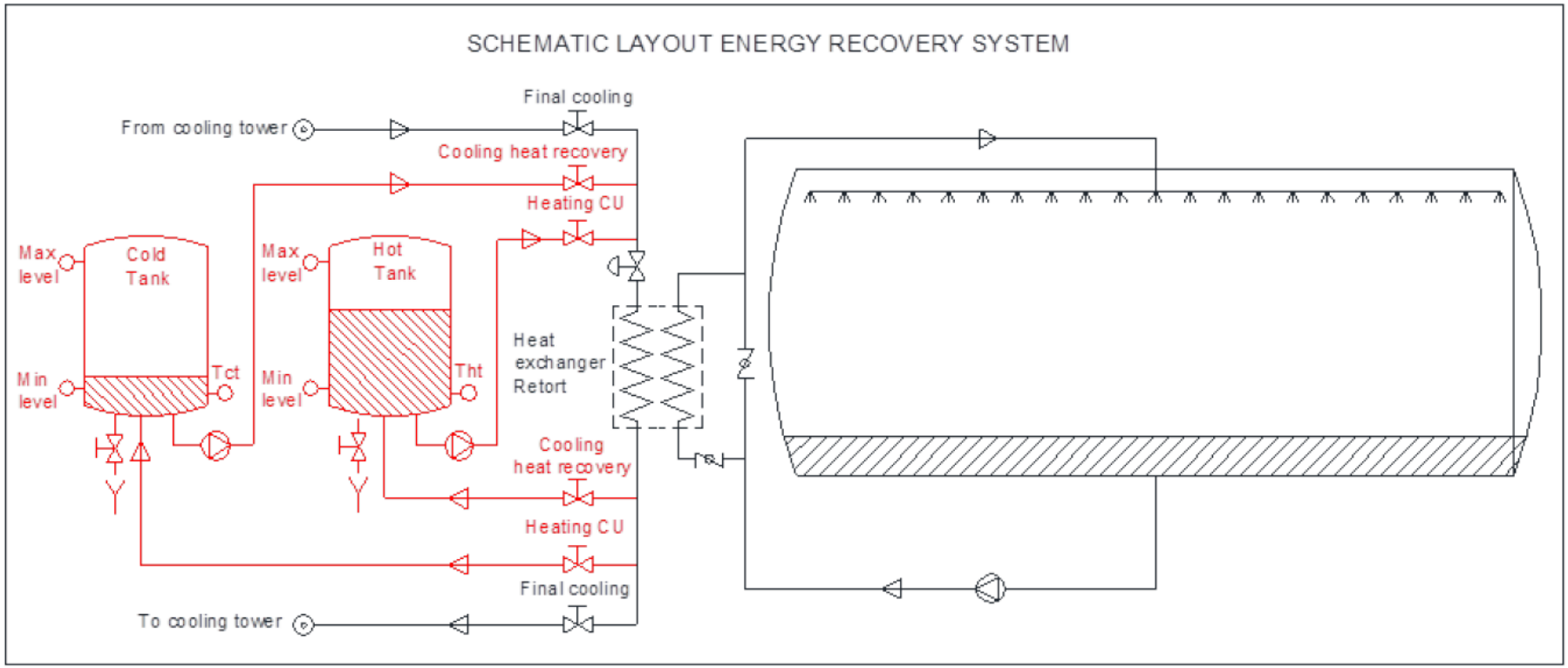
<u>Zero steam consumption</u> over a period of one hour in first half of preheater. Fast ROI!
First steam valves stay closed! Product from 6°C to 66°C based on energy recuperation from cooler.

Example HR on rotary

- **Imperative to do temperature distribution and heat penetration with and without HR active! Prove no process change between both situations**
- **Service provided by JBT, part of the installation!**



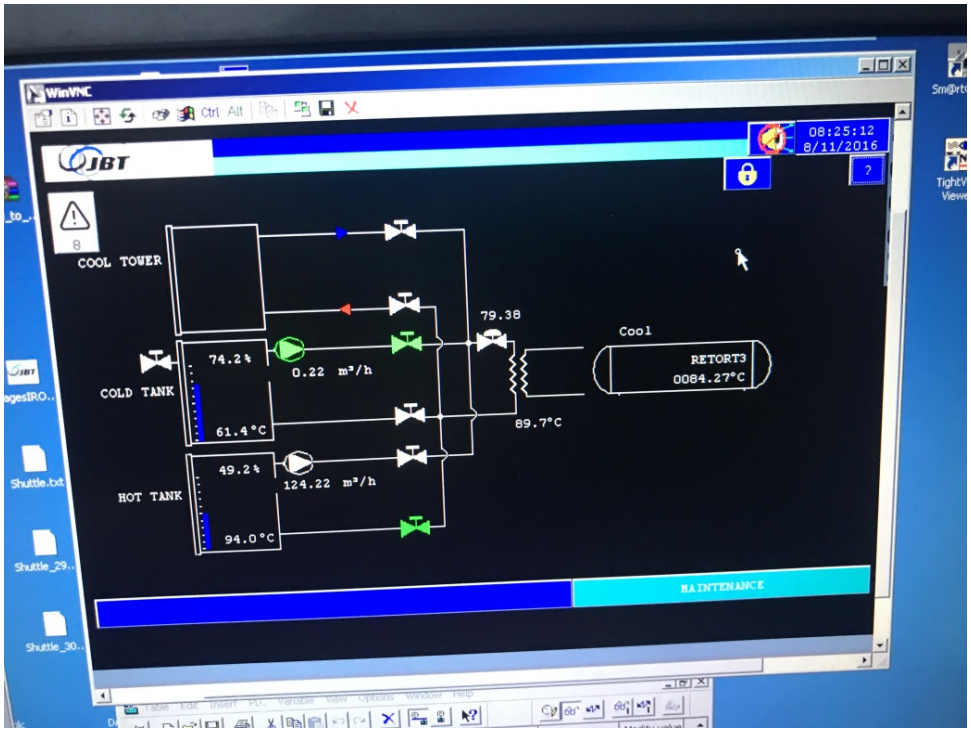
Example HR on JBT retort

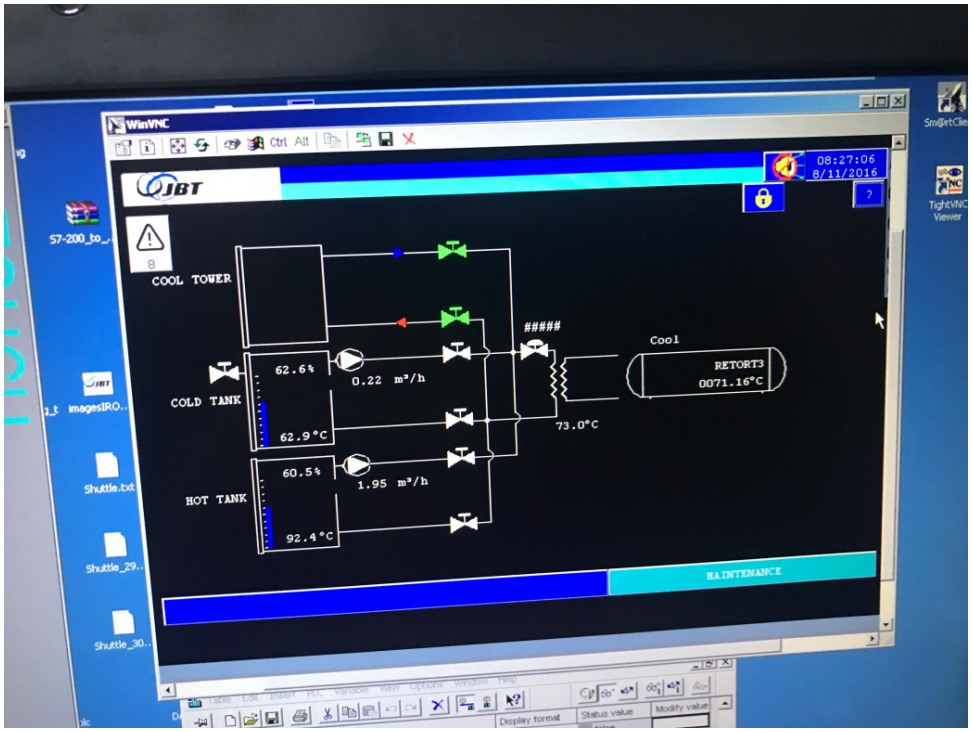


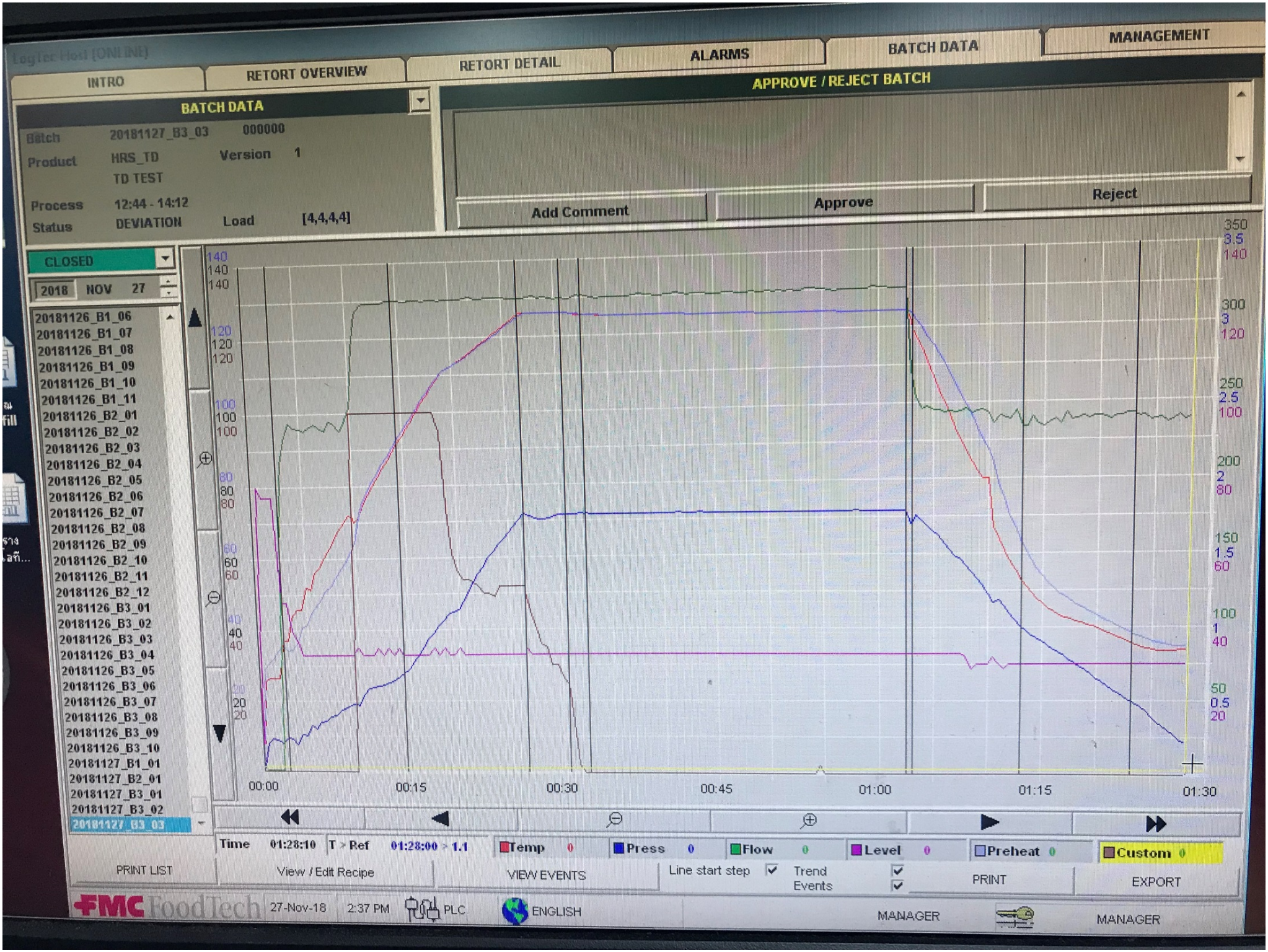
Example HR on retort

Example HR on retort

Example HR on retort






INTRO
RETORT OVERVIEW
RETORT DETAIL
ALARMS
BATCH DATA
MANAGEMENT
BATCH DATA
Batch 20181127_B3_03 000000
Product HRS_TD Version 1
TD TEST
Process 12:44 - 14:12
Status DEVIATION Load [4,4,4,4]
APPROVE / REJECT BATCH
Add Comment
Approve
Reject
CLOSED
2018 NOV 27
20181126_B1_06
20181126_B1_07
20181126_B1_08
20181126_B1_09
20181126_B1_10
20181126_B1_11
20181126_B2_01
20181126_B2_02
20181126_B2_03
20181126_B2_04
20181126_B2_05
20181126_B2_06
20181126_B2_07
20181126_B2_08
20181126_B2_09
20181126_B2_10
20181126_B2_11
20181126_B2_12
20181126_B3_01
20181126_B3_02
20181126_B3_03
20181126_B3_04
20181126_B3_05
20181126_B3_06
20181126_B3_07
20181126_B3_08
20181126_B3_09
20181126_B3_10
20181127_B1_01
20181127_B2_01
20181127_B3_01
20181127_B3_02
20181127_B3_03
140
120
100
80
60
40
20
350
3.5
140
300
3
120
250
2.5
100
200
2
80
150
1.5
60
100
1
40
50
0.5
20
00:00
00:15
00:30
00:45
01:00
01:15
01:30
Time 01:28:10 T > Ref 01:28:00 > 1.1
Temp 0 Press 0 Flow 0 Level 0 Preheat 0 Custom 0
PRINT LIST
View / Edit Recipe
VIEW EVENTS
Line start step
Trend
Events
PRINT
EXPORT
FMC FoodTech
27-Nov-18
2:37 PM
PLC
ENGLISH
MANAGER
MANAGER

Example HR on retort

- No steam consumption in first part of come-up.
- No cold water from cooling tower in first part of cooling

➢ Temperature distribution before and after installation heat recovery to prove no change in process conditions (heat provided with hot water over HEX in stead of steam)

➢ Service provided by JBT, part of the installation!

Thank you

www.JBTfoodtech.com