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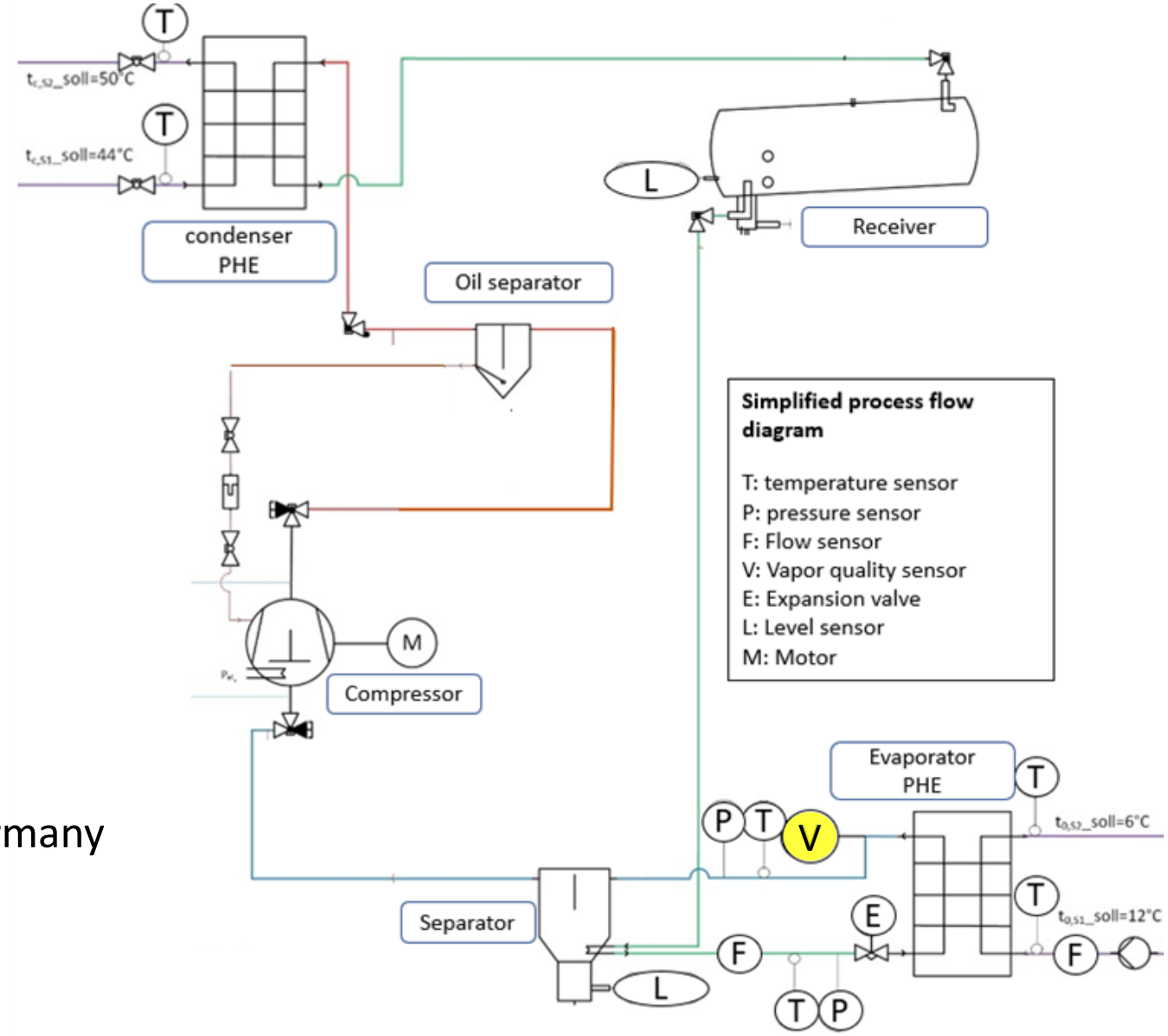
Large SEPR and COP improvement obtained by controlling an ultra-low-charge DX chiller using a vapor quality sensor

Simplified diagram

- Equipped with both
  - Superheat control
  - Vapor quality control
- 100 kW chiller 7/12°C
- 4 kg Ammonia
- Tested at Hochschule Karlsruhe, Germany
- Designed by Fischer Kälte, Germany



ECOdesign and SEPR requirements

(Seasonal Energy Performance Ratio)

ECOdesign

(EC directive)

SEPR process chillers
SEER comfort chillers
SCOP heat pumps

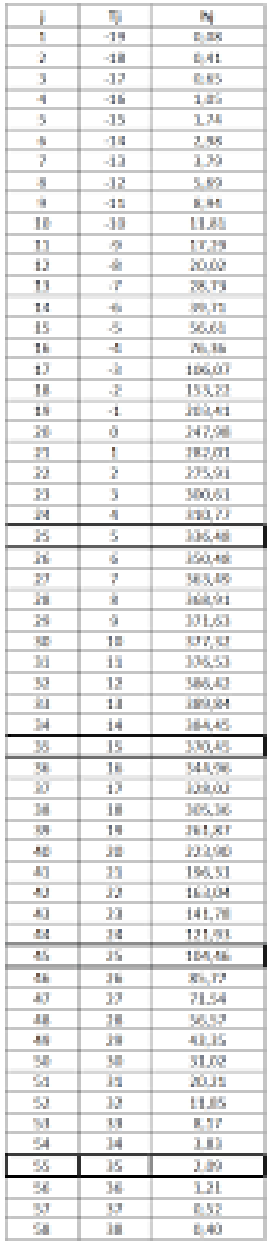
High temperature process chillers	From 01/2018	From 01/2021
	SEPR 12/7"	SEPR 12/7"
Air cooled < 400 kW	4,5	5,00
Air cooled 400 to 2000 kW	5,00	5,50
Water cooled < 400 kW	6,50	7,00
Water cooled 400 to 1500 kW	7,50	8,00
Water cooled 1500 to 2000 kW	8,00	8,5

Measured values for ammonia-based chiller					
	SEPR	Full load COP	Part load COP	Unit	Yearly energy consumption
Superheat 8K control	5.6	3.9	6.9	kW/kW	91.086 kWh
Vapor Quality control	8.2	4.7	10.5	kW/kW	63.140 kWh
Improvement	46	21	51	%	27.946 kWh

SEPR improvement on DX chiller

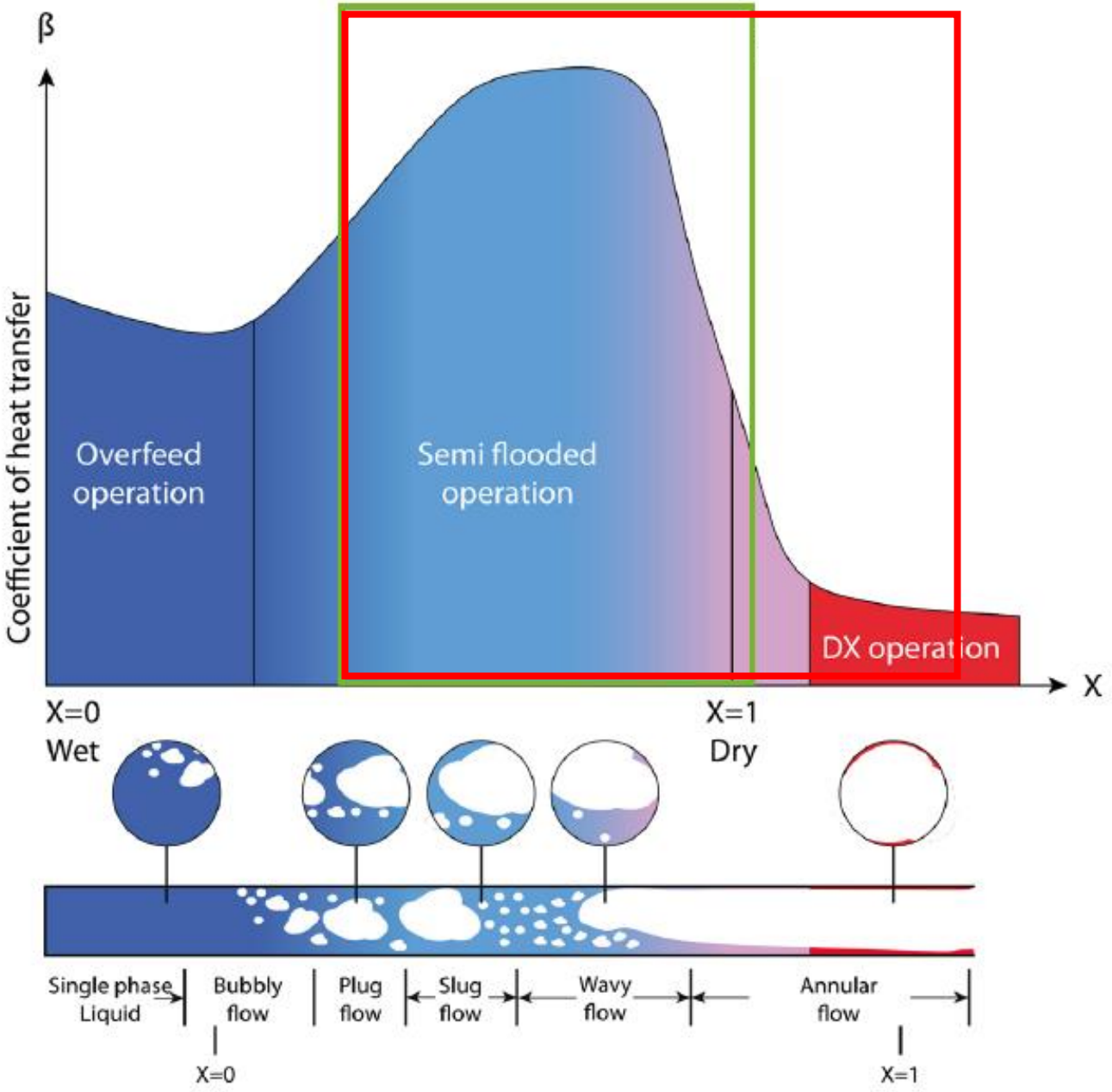
(Seasonal Energy Performance Ratio)

	SEPR	Point A	Point B	Point C	Point D
Outdoor temp °C		**30**	**23**	**16**	**9**
Load %		**100**	**93**	**87**	**80**
Cooling capacity Superheat 8K control		**76**	**72**	**66**	**61**
Power consumption Superheat 8K control		**20**	**15**	**11**	**9**
COP Superheat 8K control	**5.6**	**3.9**	**4.7**	**5.9**	**6.9**
Cooling capacity Vapor Quality control		**79**	**65**	**61**	**56**
Power consumption Vapor Quality control		**17**	**11**	**8**	**6**
COP Vapor Quality control	**8.2**	**4.7**	**6.1**	**8.2**	**10.5**
Improvement	**46**	**21**	**30**	**39**	**51**



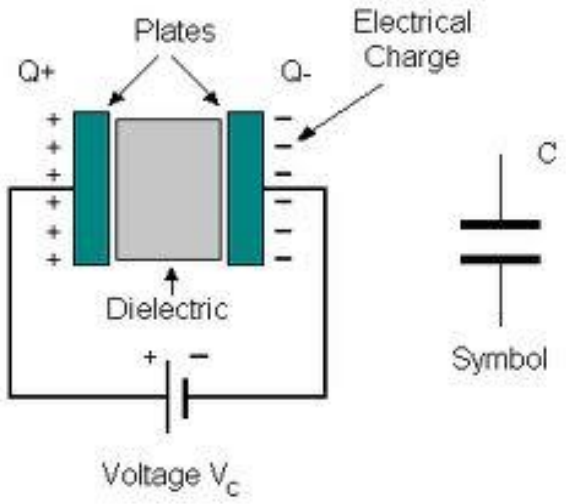
Heat transfer optimization

Superheat control
Vapor quality control

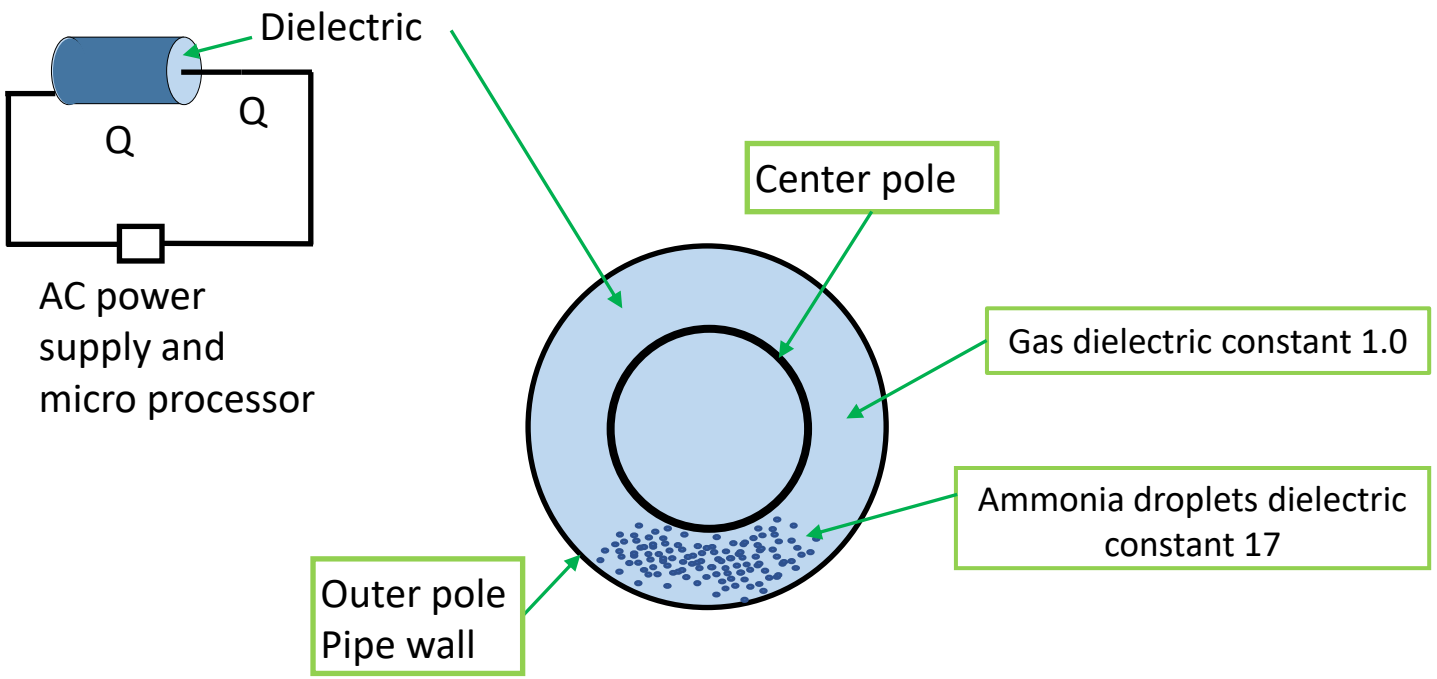


Vapor quality measurement principle

Capacitor

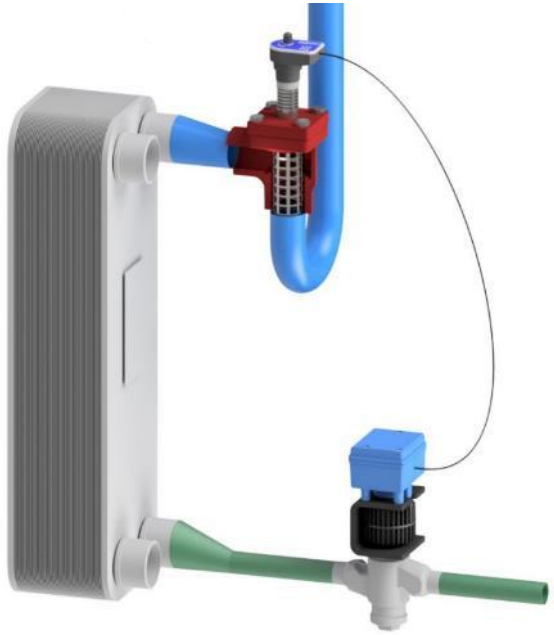


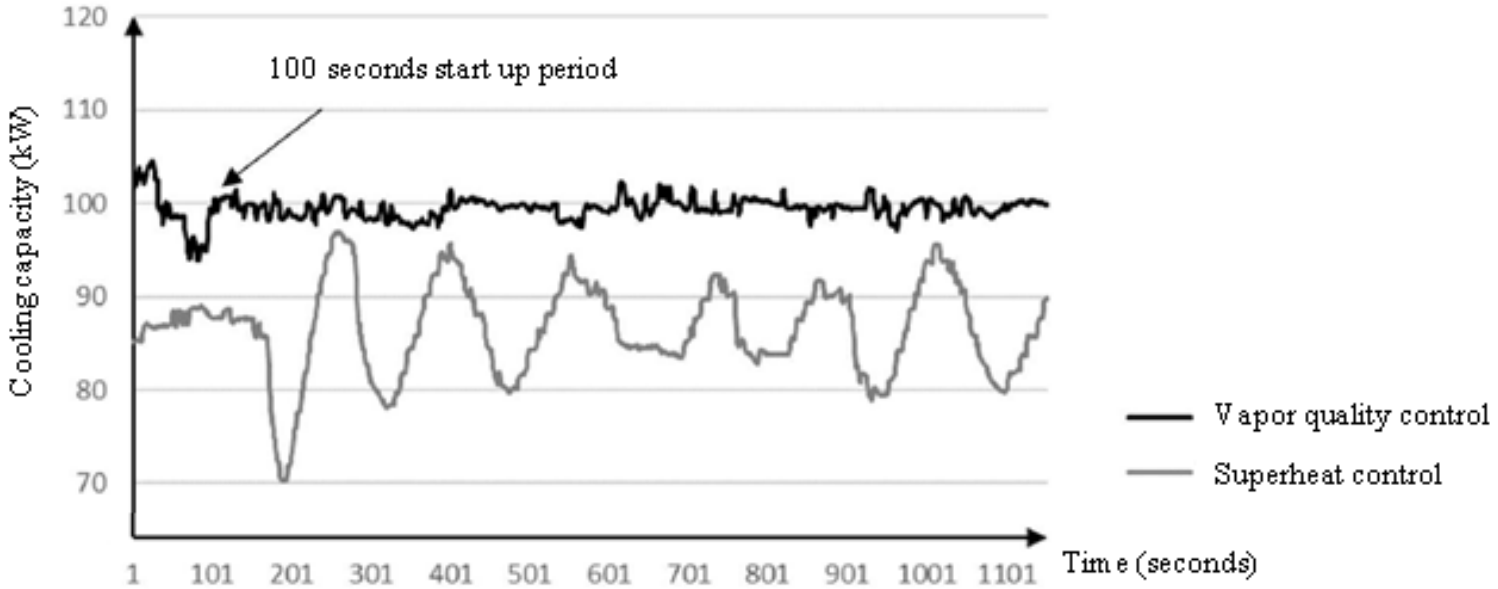
Sensor



Why is vapor quality control better?

- Faster control loop compared to superheat control
- Superheat is reduced to a minimum
- Increased evaporator capacity
- Reduced pressure loss

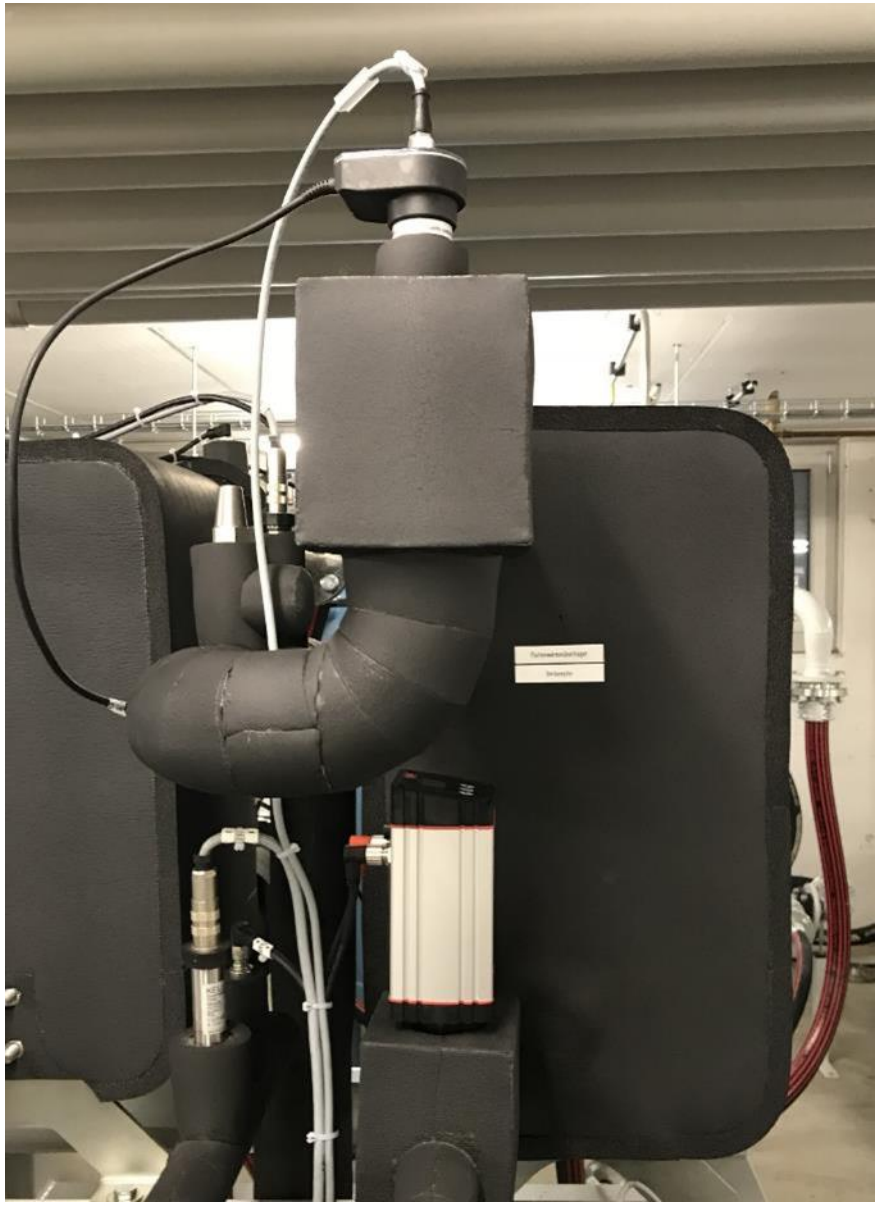




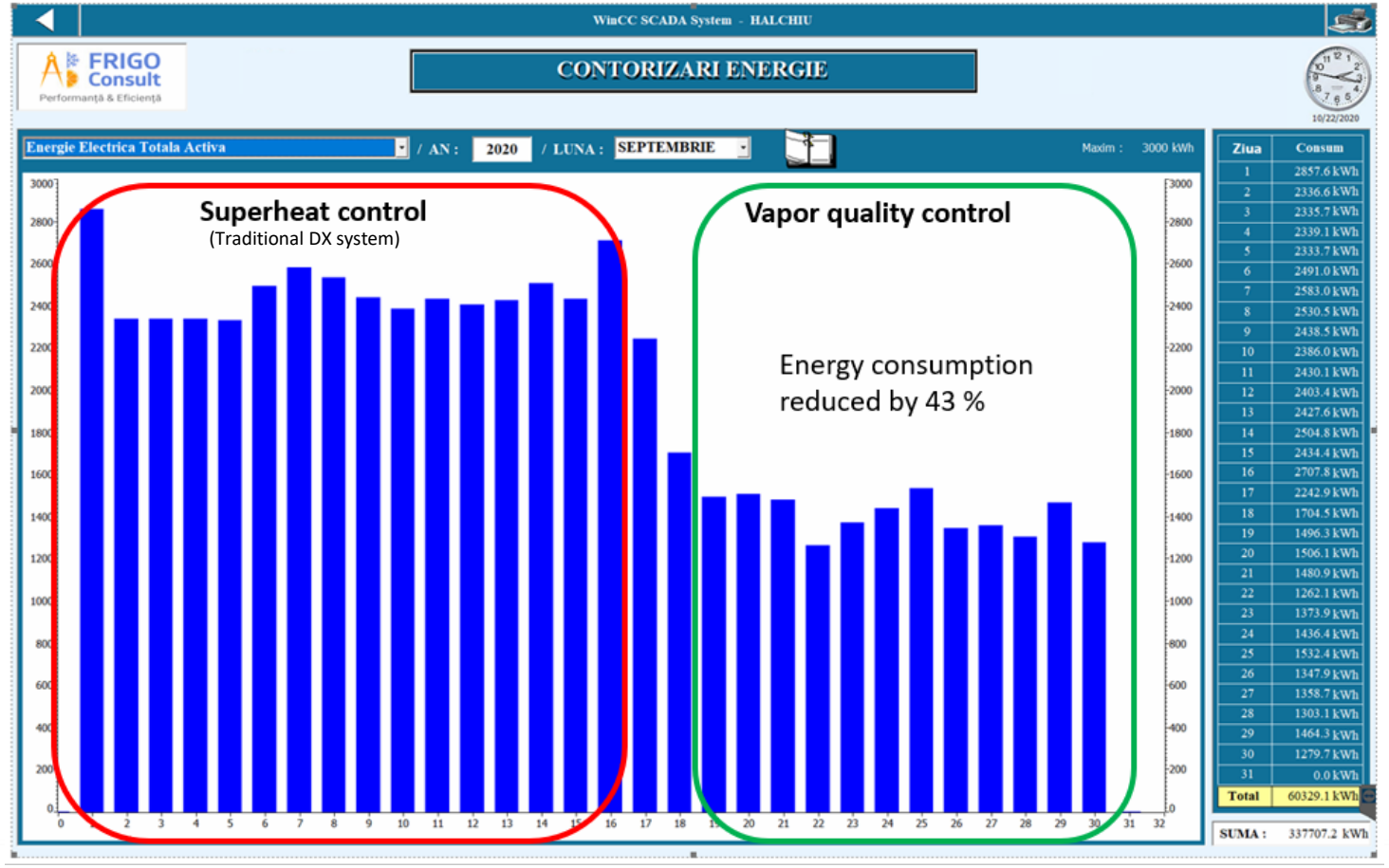
Cost saving and CO2 reduction

- Considerable annual electricity cost saving
- CO2 saving will depend on the energy source used for electricity generation

	Annual energy consumption	Annual electricity cost EU	Annual CO2 emission EU
Superheat 8K control	91,086 kWh	10,930€	27 tons
Vapor Quality control	63,140 kWh	7,577€	19 tons
Improvement	27,946 kWh	3,353€	8 tons



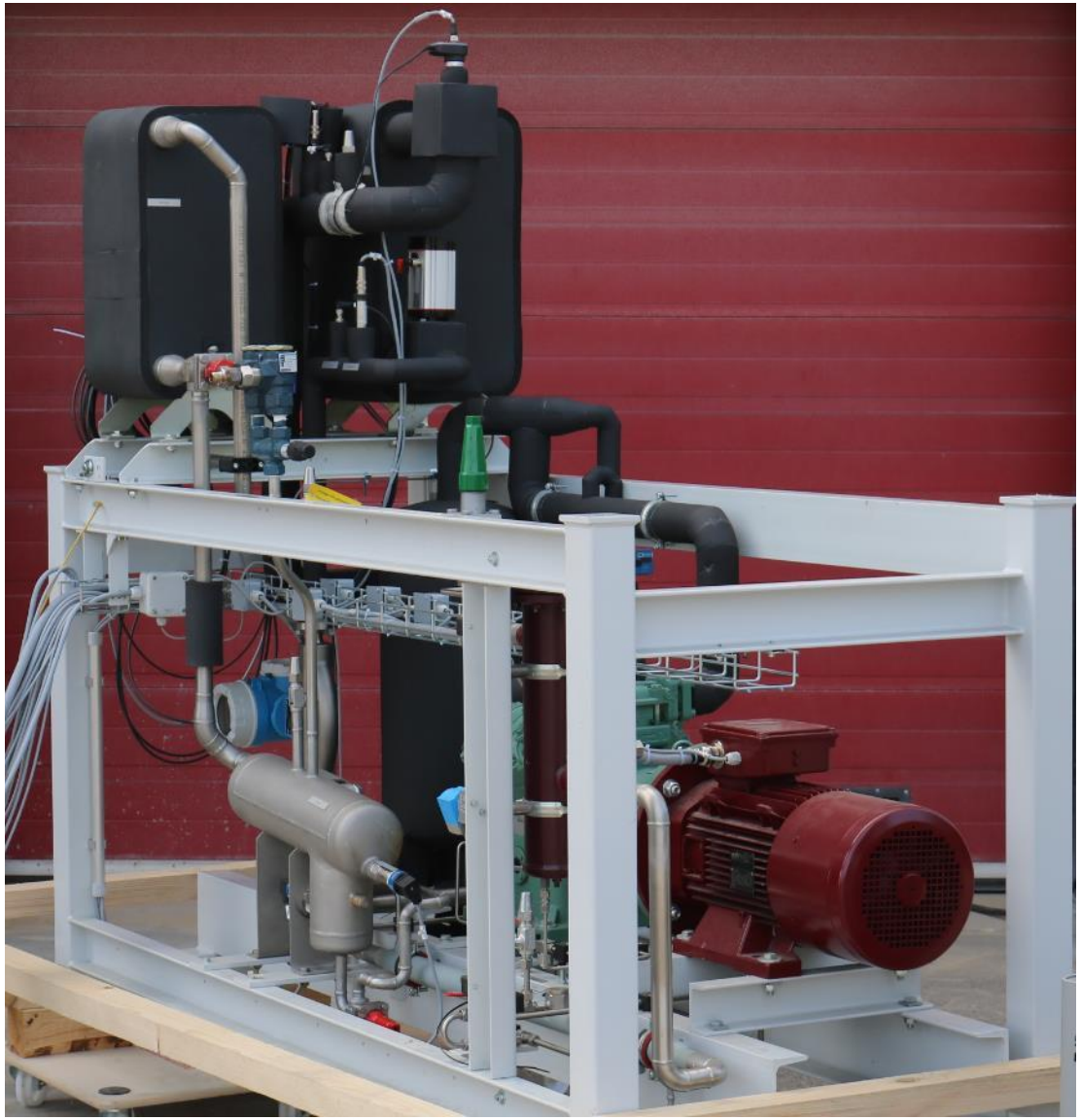
Similar savings in complete cold store



- The bar graph shows the daily energy consumption of the Halchiu plant in Romania.
- Here vapor quality control, replaced superheat control in September 2020.
- The total energy consumption for the refrigeration system was reduced by 43%.
- Annual saving 383 MWh and 110 T CO_2

Thank you for your attention

The test unit will now be installed in Aarhus Denmark, where it will be used for demonstration and further test



More information is available on www.hbproducts.dk
Questions can be sent to hk@hbproduct.dk