PILLER IN STEAM GENERATING HEAT PUMPS

Piller Blowers & Compressors GmbH

PILLER AT A GLANCE
FACTS AND FIGURES

PILLER
Blowers & Compressors

Founded	1909
Employees *ww/Moringen*	450 / 370
Export ratio	85%
Sector	Machine Building
Headquarters	Moringen, Germany
Subsidiaries	Piller BC Shanghai, China Piller SEA Pte. Ltd., Singapore Piller TSC Blower Corp., USA
Joint Ventures	Piller Global (India), India Piller SUR, Brazil Sunteco Ltd., Korea
Production	Piller Blower Technologies Taicang, China

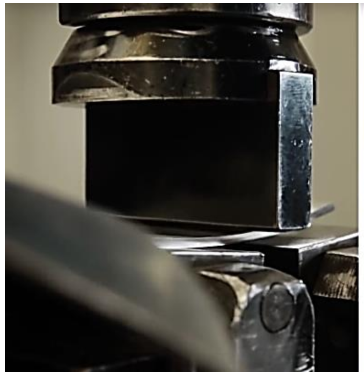
MADE BY PILLER

ENTIRE FAN CONSTRUCTED IN GERMANY

EXPERTS IN WELDING AND BALANCING

TOP MACHINERY EQUIPMENT

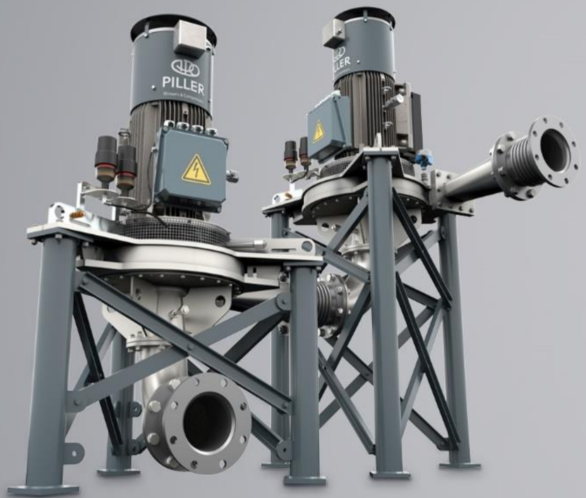
HIGH SKILLED PERSONNEL

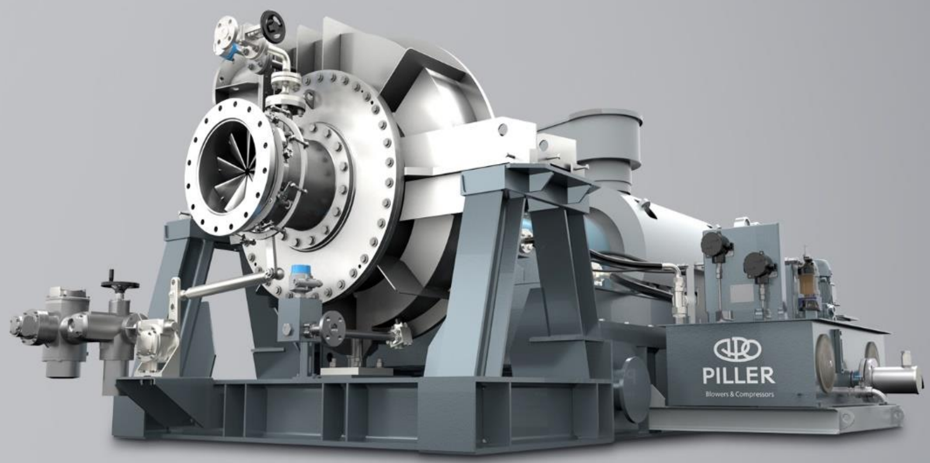


PILLER
Blowers & Compressors

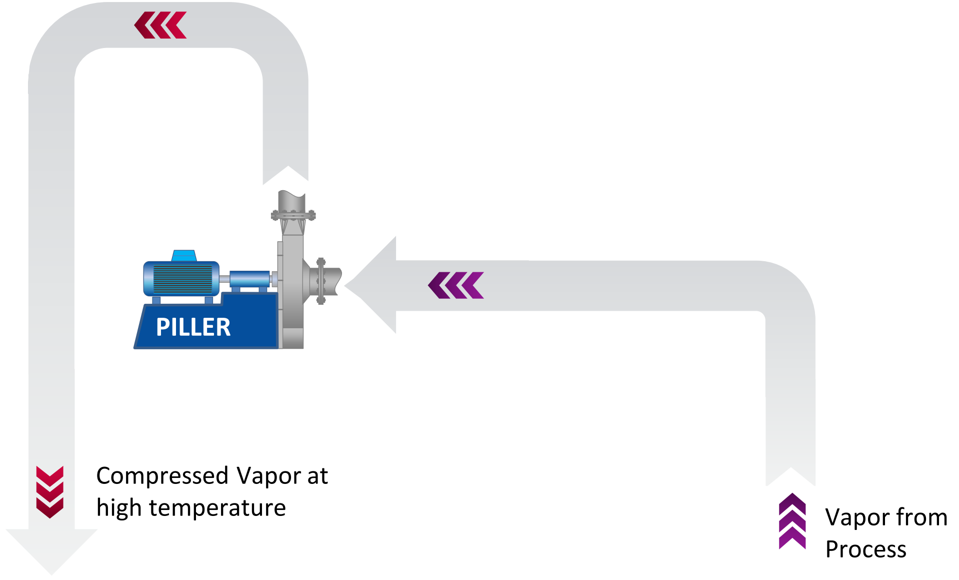
VAPOLINE

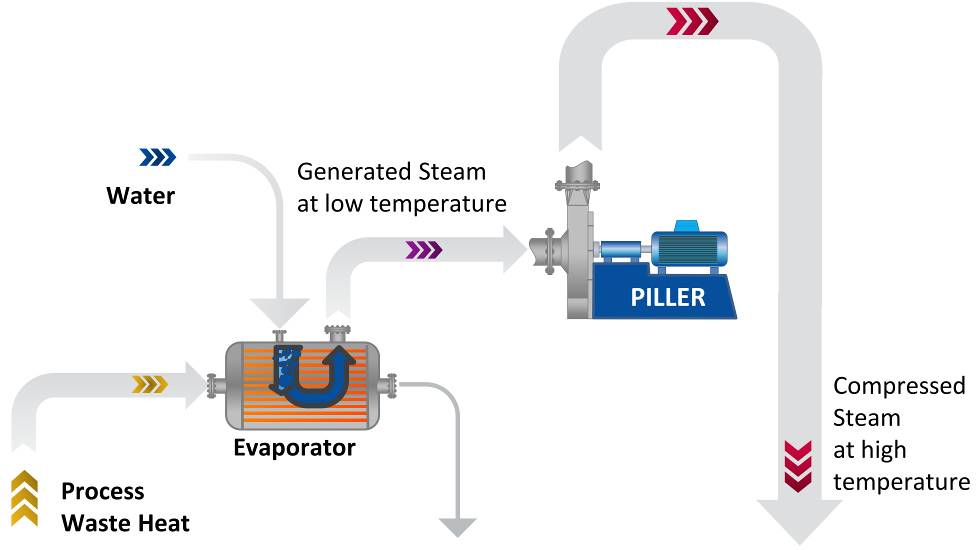
Blowers and Compressors for Vapor Compression





PILLER BLOWERS FOR HEAT PUMP APPLICATIONS





Compressed Vapor for
- Process heating
- Steam generation

Process Vapor from
- Evaporation
- Crystallisation
- Distillation
- Rectification
- Stripping
- Condensate tanks (flash vapor)

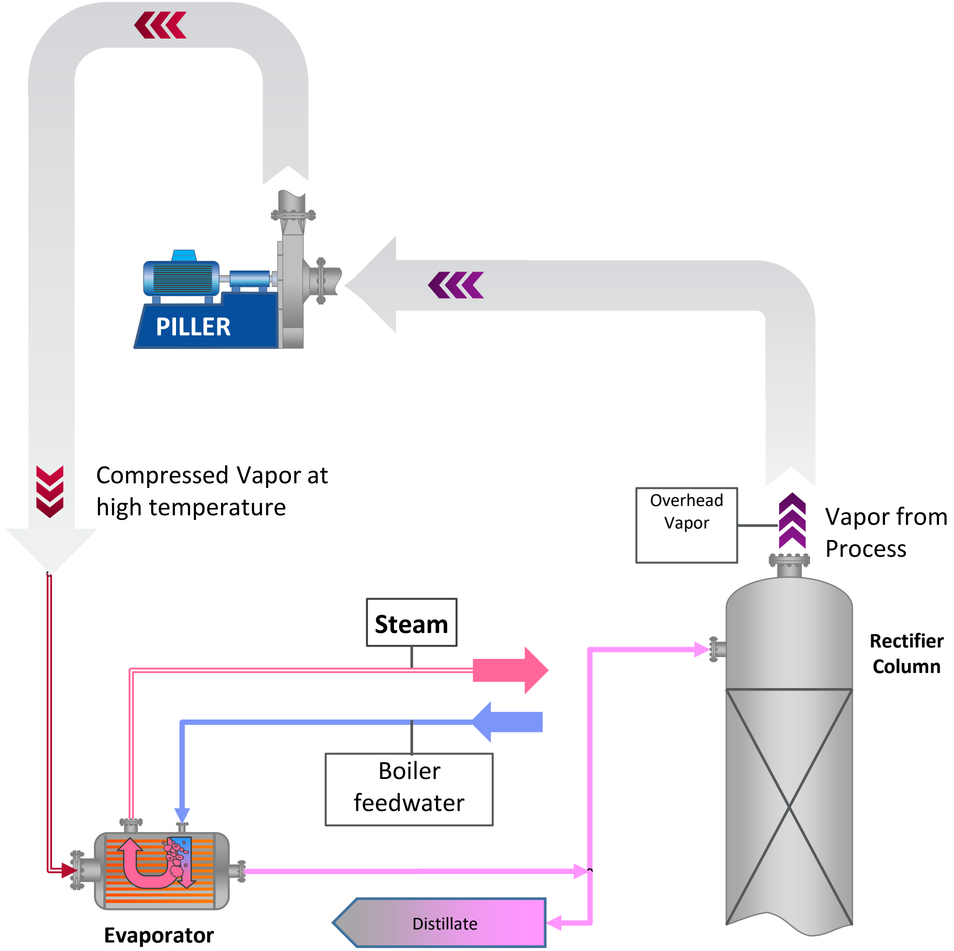
Waste Heat from
- Contaminated Process vapor
  - Evaporation
  - Crystallisation
  - Distillation & Rectification
  - Reactors
  - Stripping
- Waste water
- Waste gas

High Temperature Steam for
- Process heating
- Feed in steam line

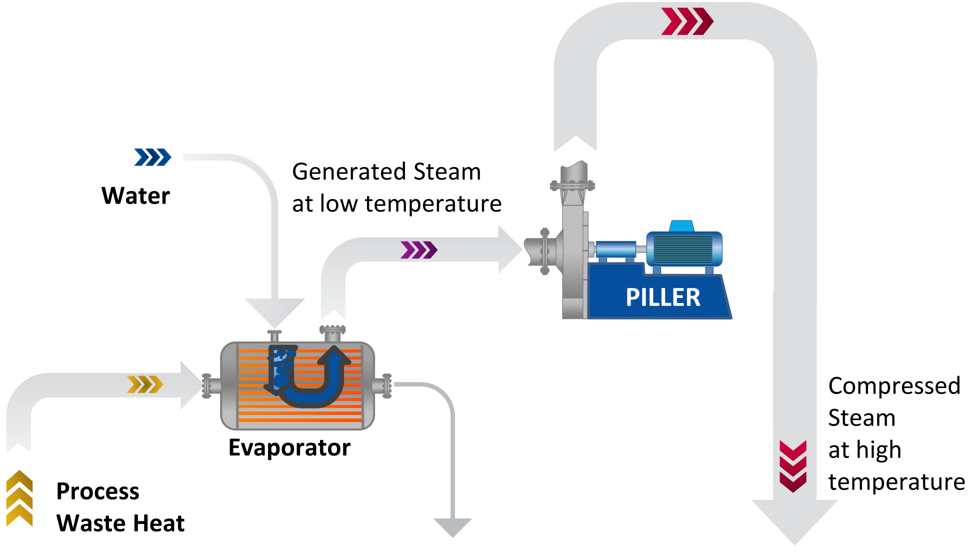
VAPOR COMPRESSION | **STEAM GENERATION**

HEAT PUMP SYSTEMS WITH PILLER BLOWERS & COMPRESSORS DIRECT VAPOR COMPRESSION

PILLER
Blowers & Compressors



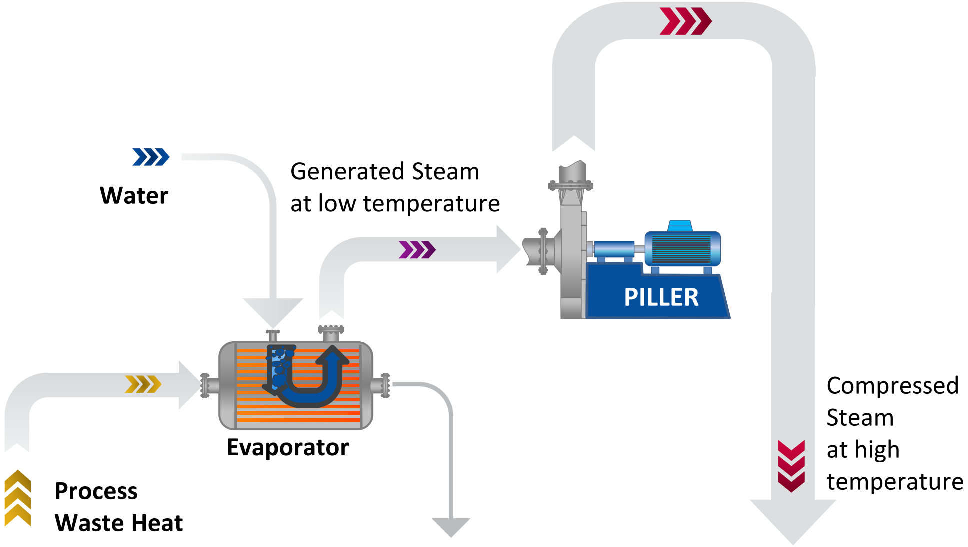
VAPOR COMPRESSION



STEAM GENERATION

HEAT PUMP SYSTEMS WITH PILLER BLOWERS & COMPRESSORS
DIRECT VAPOR COMPRESSION

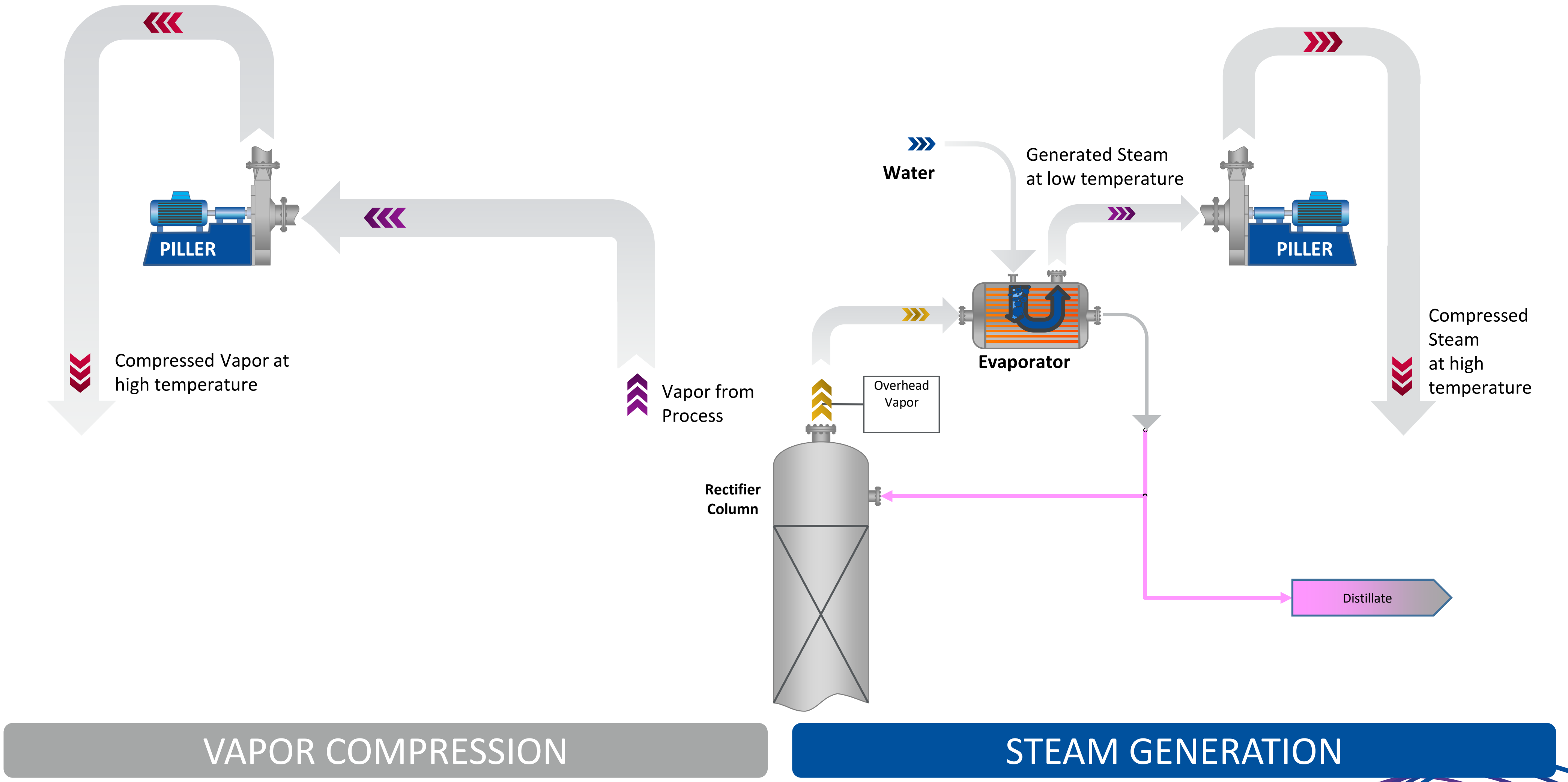
PILLER
Blowers & Compressors



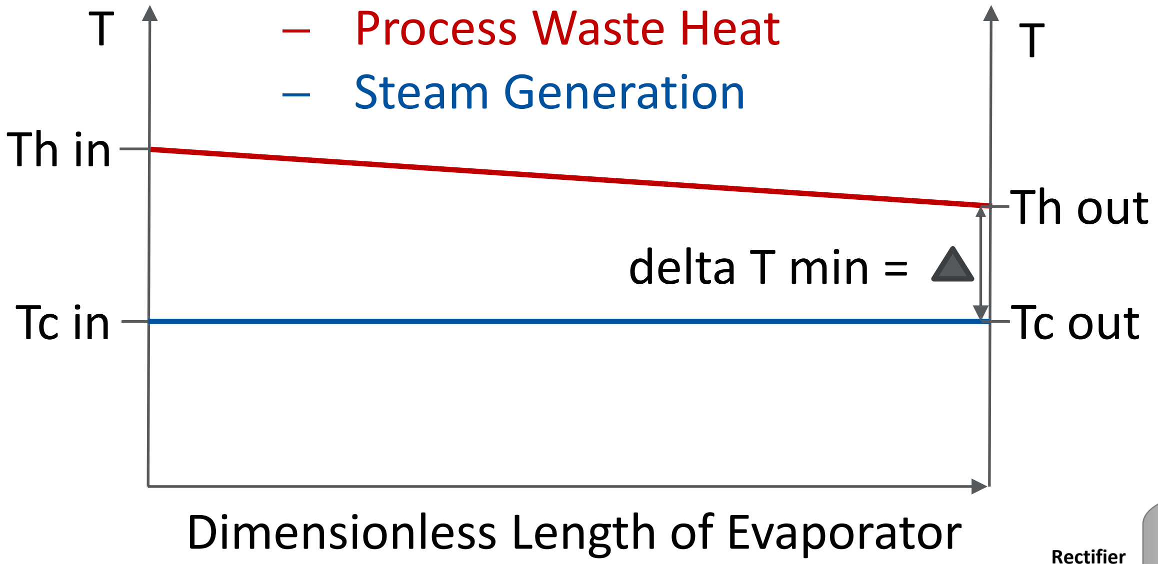
VAPOR COMPRESSION

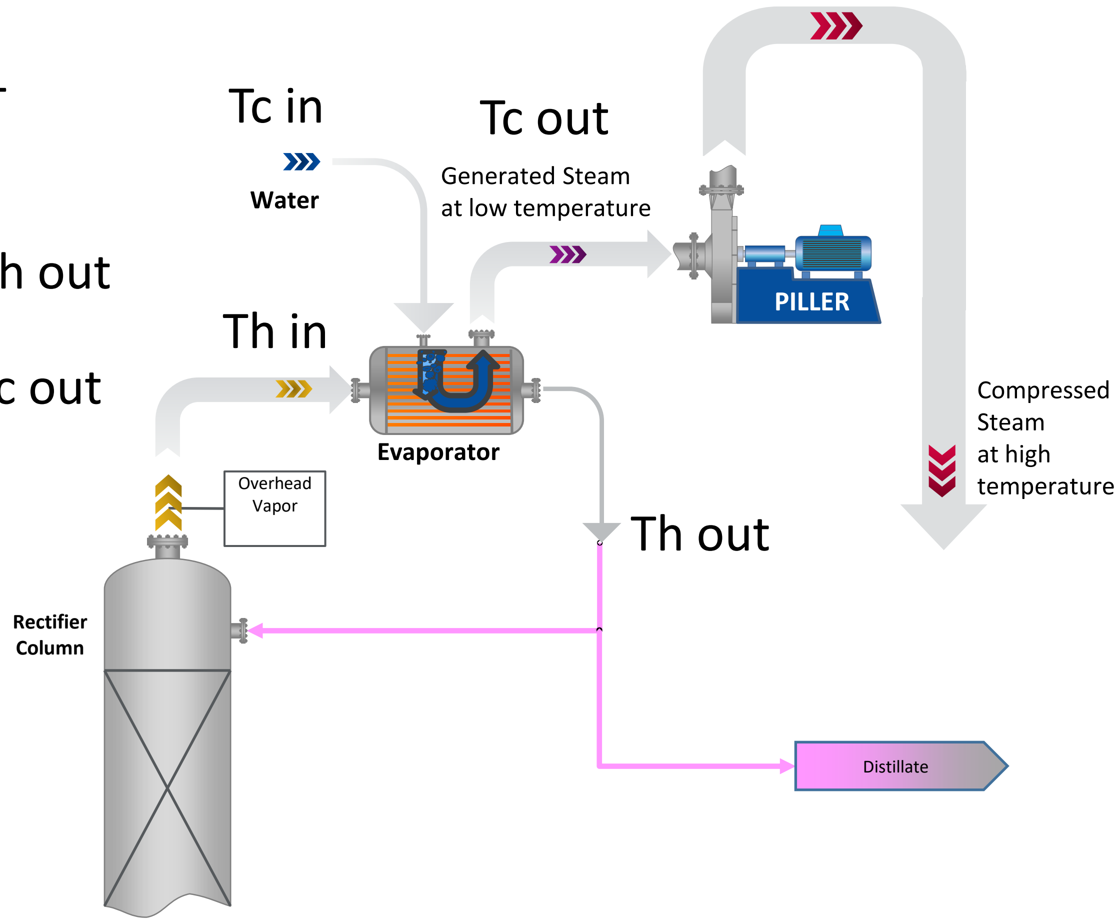
STEAM GENERATION

HEAT PUMP SYSTEMS WITH PILLER BLOWERS & COMPRESSORS
STEAM GENERATION AND COMPRESSION



STEAM GENERATION TEMPERATURE PROFILE



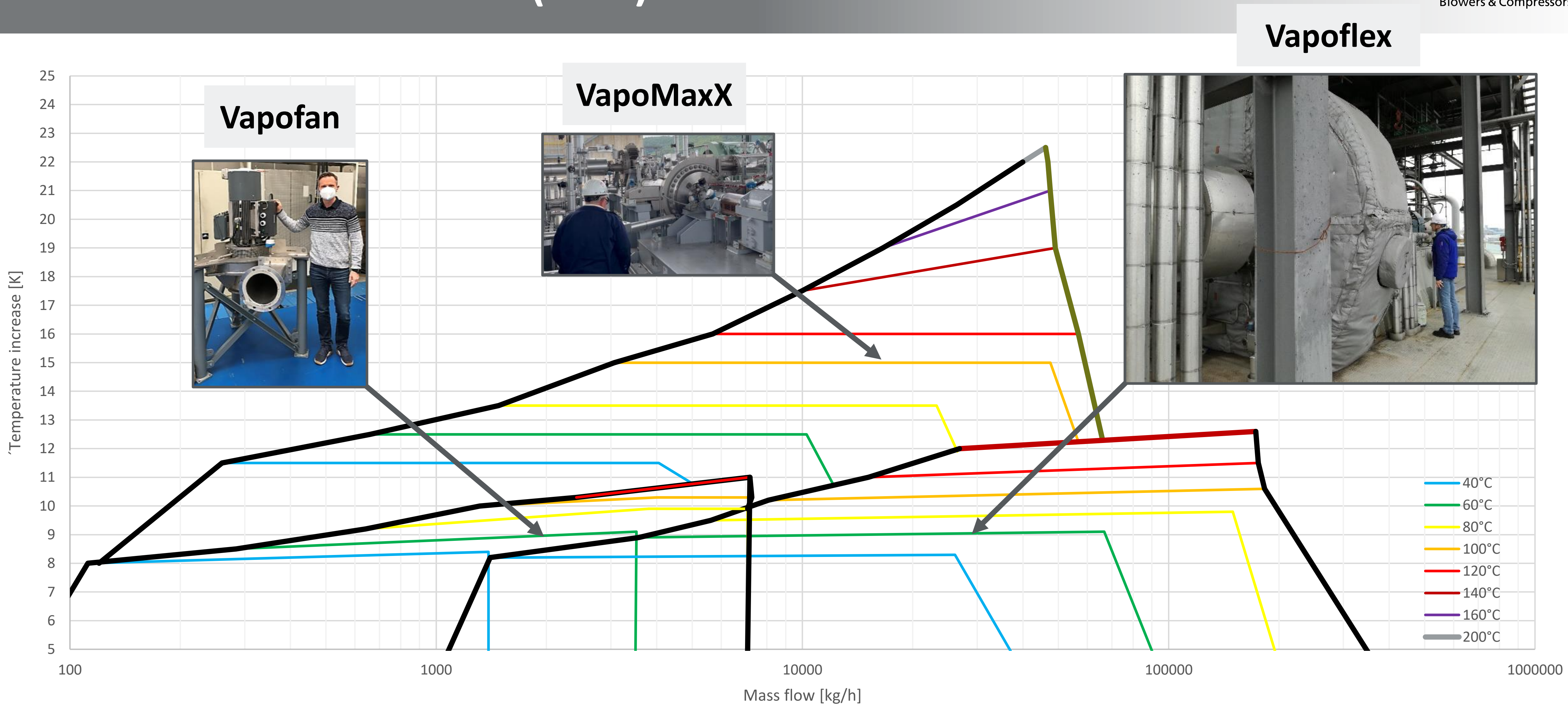


- Th out defines waste heat stream or vice versa
- Th out and delta T min define steam inlet to compressor
- Waste heat stream defines mass flow of generated steam

STEAM GENERATION

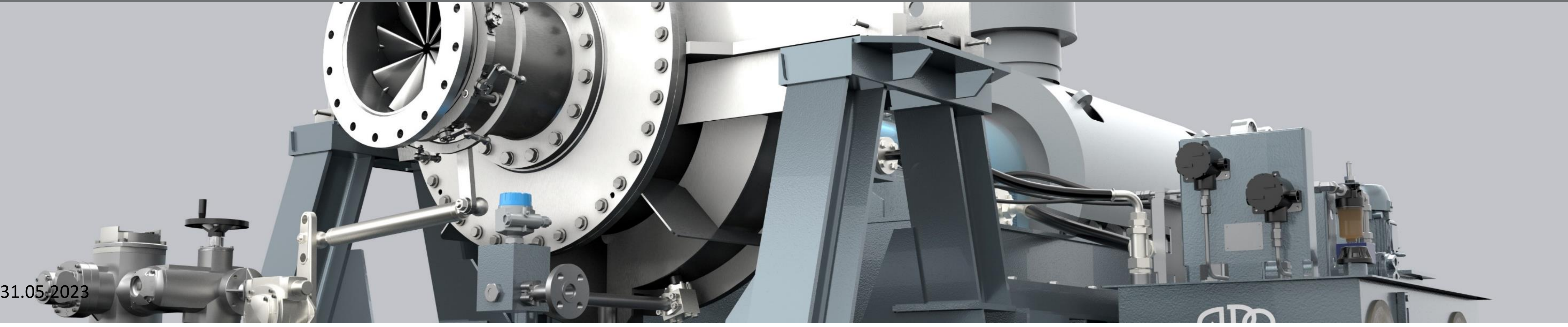
COMPRESSOR SELECTION
OPERATION RANGE MVR (H2O)

PILLER
Blowers & Compressors



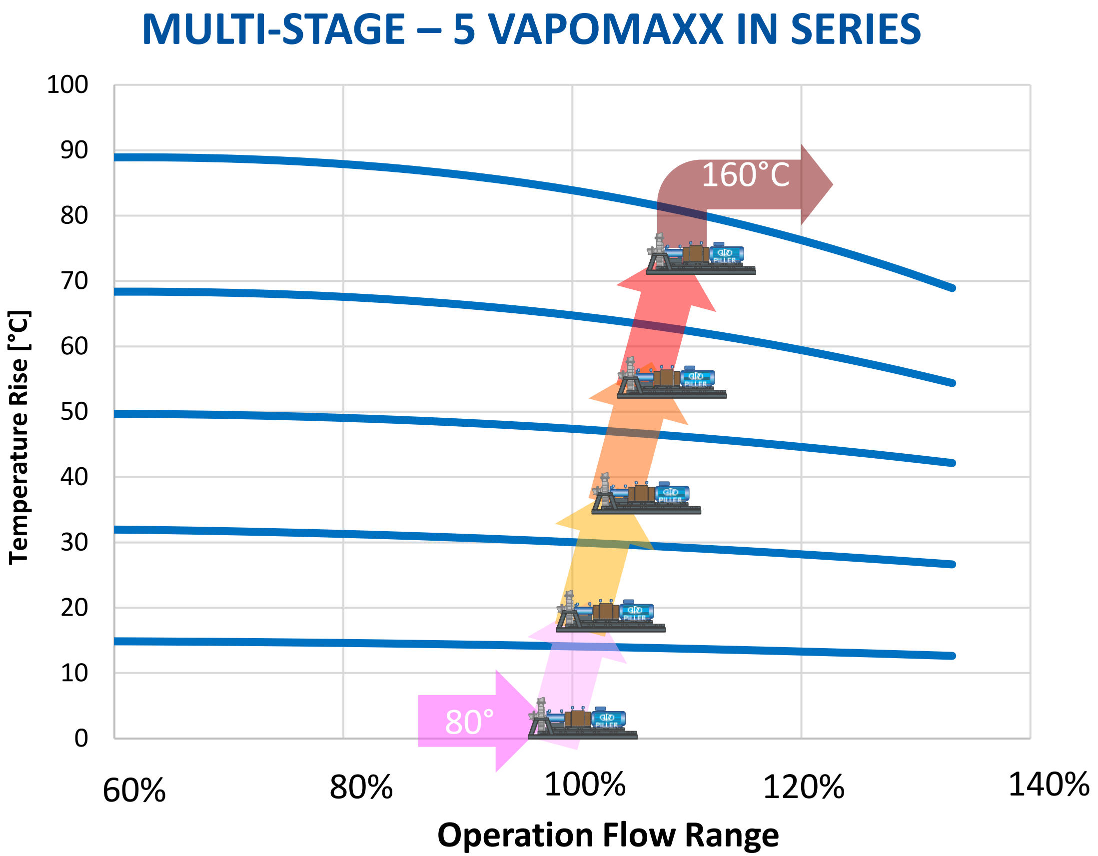
PILLER VAPOMAXX APPLICATION

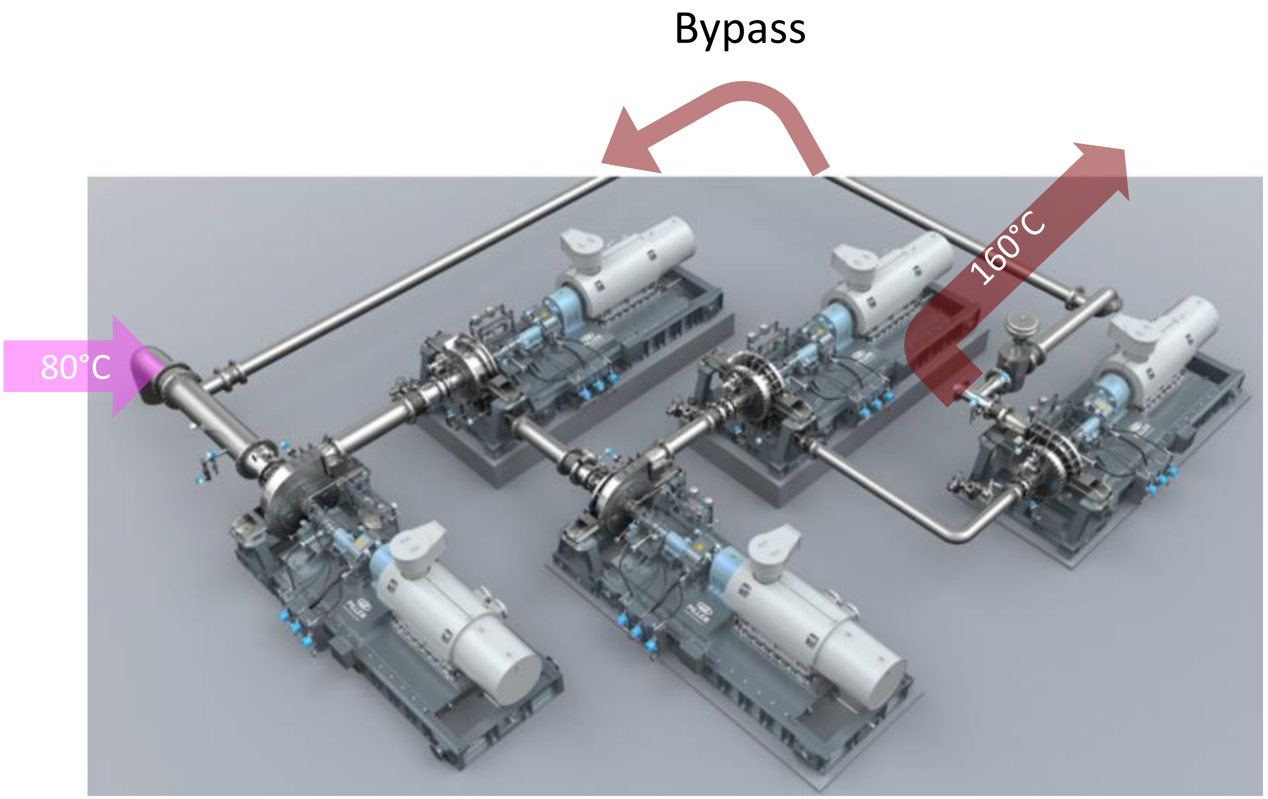
High Performance vapor compressor



MULTI STAGE CONFIGURATION

PILLER
Blowers & Compressors

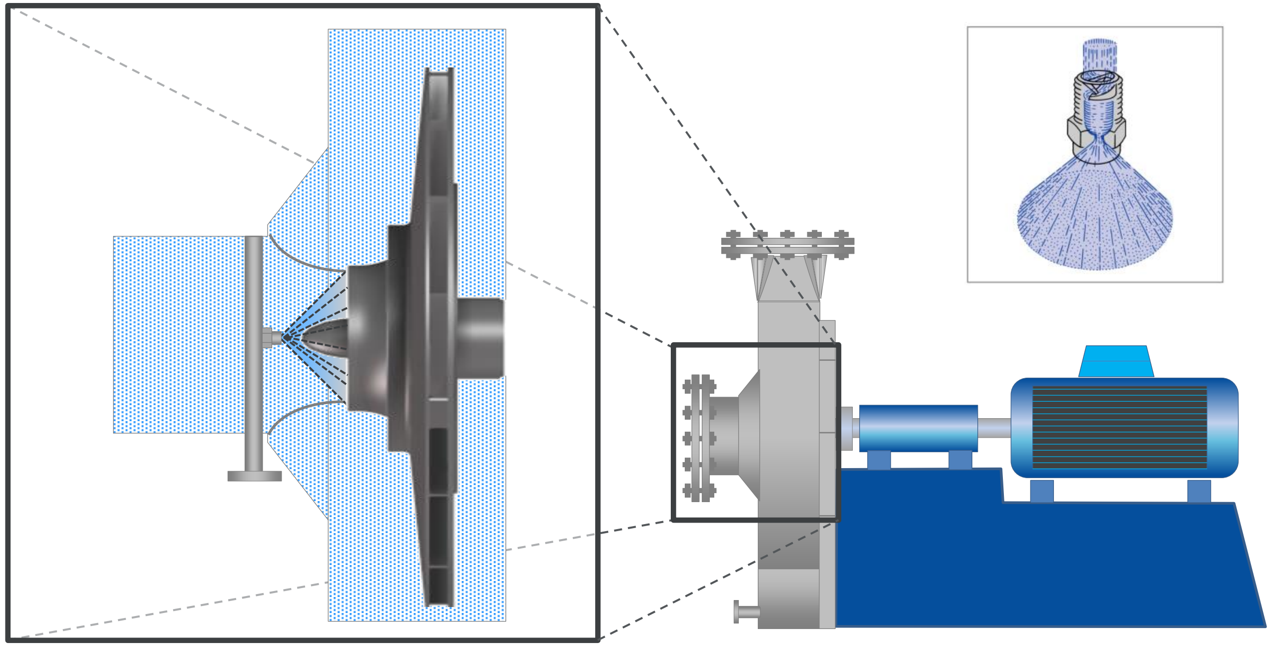


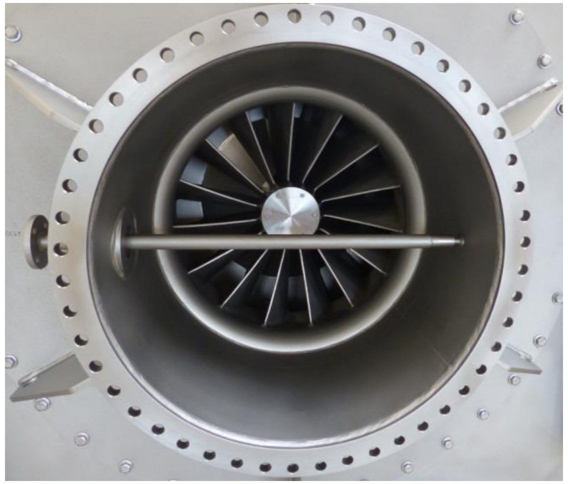


WATER INJECTION: DESUPERHEAT

INJECTION WATER

- Saturation to optimize heat transfer
- Cleaning effect
- Nearly the same temperature as the vapor
- Amount depending on operating point

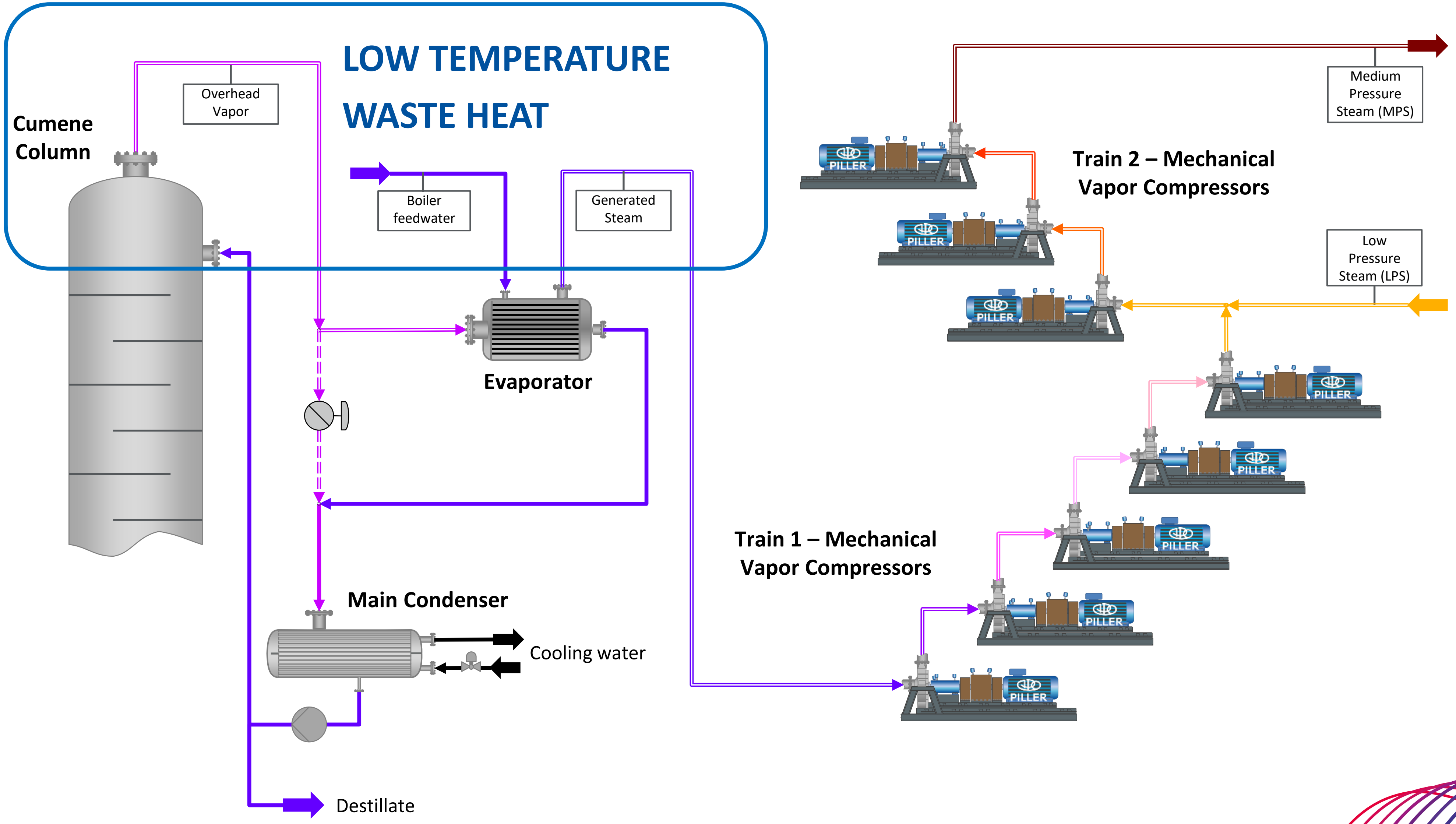




Sight Glass for Visual Inspection

IMPLEMENTING AN INDUSTRIAL HEAT PUMP TO A CUMENE COLUMN

PILLER
Blowers & Compressors



Vapor
Liquid

Temperature [degC]		Line Color
222.5	230.0	
215.0	222.5	
207.5	215.0	
200.0	207.5	
192.5	200.0	
185.0	192.5	
177.5	185.0	
170.0	177.5	
162.5	170.0	
155.0	162.5	
147.5	155.0	
140.0	147.5	
132.5	140.0	
125.0	132.5	
117.5	125.0	
110.0	117.5	
102.5	110.0	
95.0	102.5	
87.5	95.0	
80.0	87.5	

CASE STUDY: OPTIMIZING ENERGY EFFICIENCY WITH VAPOR COMPRESSION TECHNOLOGY

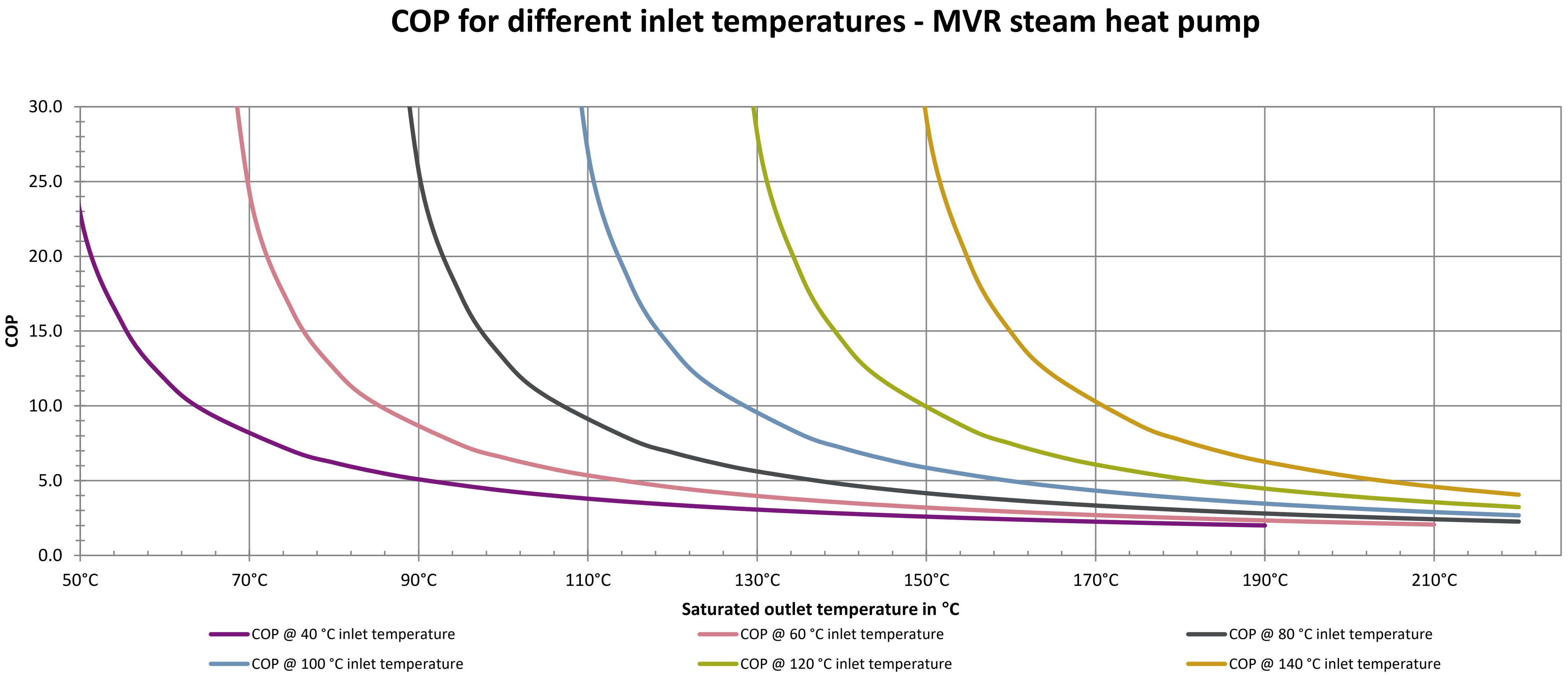
PILLER
Blowers & Compressors

IMPLEMENTING AN INDUSTRIAL HEAT PUMP TO A CUMENE COLUMN

- 42 tons of steam are supplied per hour
- Energy cost savings: 8 Million € per year
- Reduction of CO_2 emissions by 10.650 tons per year
- Resulting COPs
  - First train: 3.81
    compression from 0.47 bara and 80 degC saturated steam to 5.2 bara and 160 degC low pressure steam (LPS)
  - Second train: 5.29
    resulting in medium pressure steam (MPS) at 19.6 bara and slightly superheated to 230 degC
  - Combined: 2.24
    compression from 80 degC to 211.5 degC saturated (train 2 weighted by inlet mass flow)

PREDICTION OF COP – STEAM COMPRESSION WITH INJECTION COOLING

PILLER
Blowers & Compressors



PREDICTION OF COP – STEAM COMPRESSION WITH INJECTION COOLING

PILLER
Blowers & Compressors

COP for different inlet temperatures - MVR steam heat pump