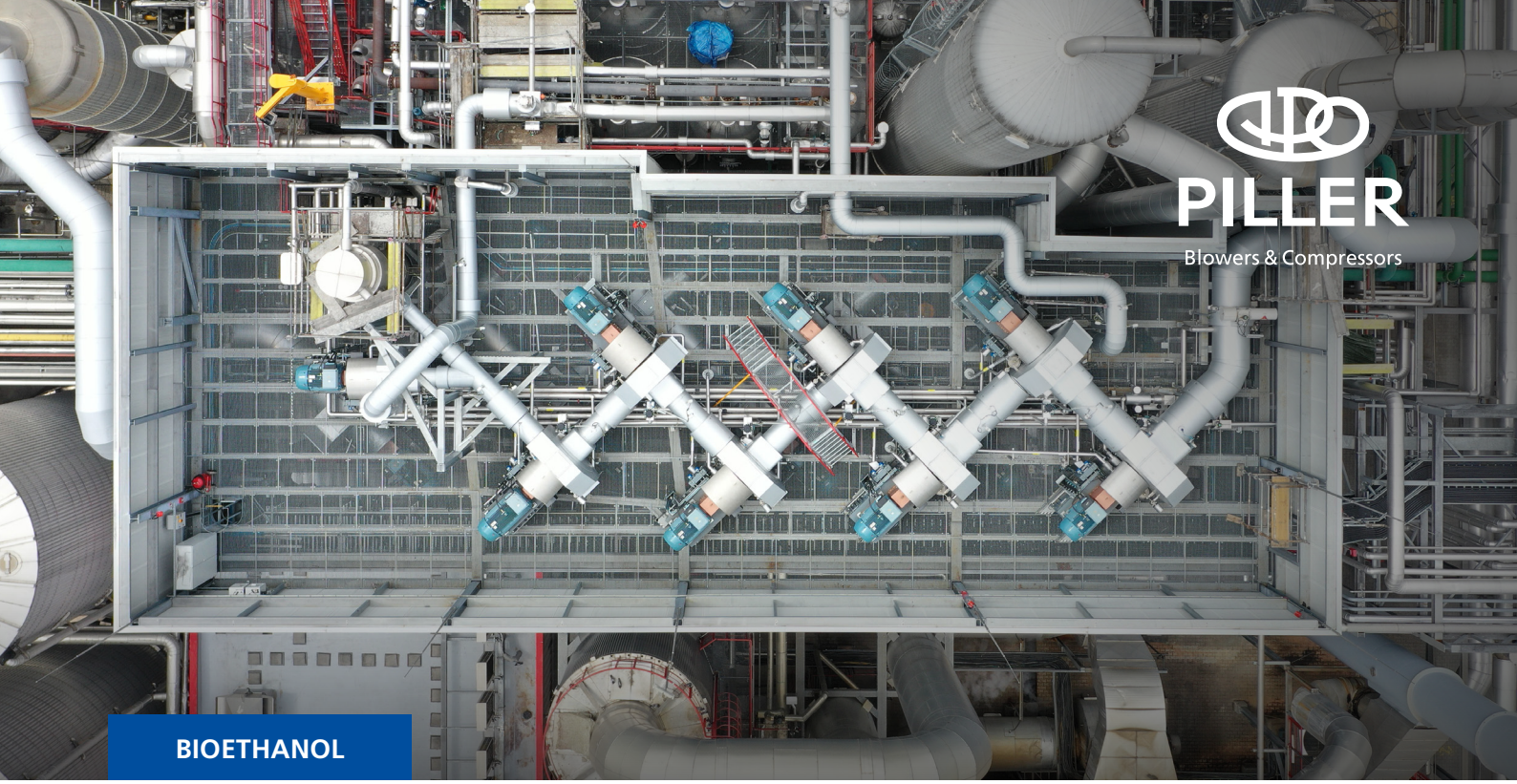


PILLER
Blowers & Compressors

BIOETHANOL

INNOVATING THE FUTURE OF HEAT: INTEGRATING VAPOR COMPRESSION HEAT PUMP TECHNOLOGY

Pannonia Bio Operates Europe's Largest Bioethanol Site, Setting New Industry Standards in Efficiency and Carbon Reduction

Recognized as one of the most efficient refineries worldwide, Pannonia Bio's bioethanol site leverages state-of-the-art technology. Despite this benchmark status, ambitious goals remain: further reducing carbon emissions and enhancing energy efficiency.

CHALLENGES OF BIOREFINERIES

- **Energy-intensive processes:** Distillation and dehydration are most energy intensive processes in a biorefinery.
- **Significant energy waste:** The manufacturing process involves condensation with cooling water and then evaporation of rectified ethanol with boiler steam resulting in massive waste of energy.

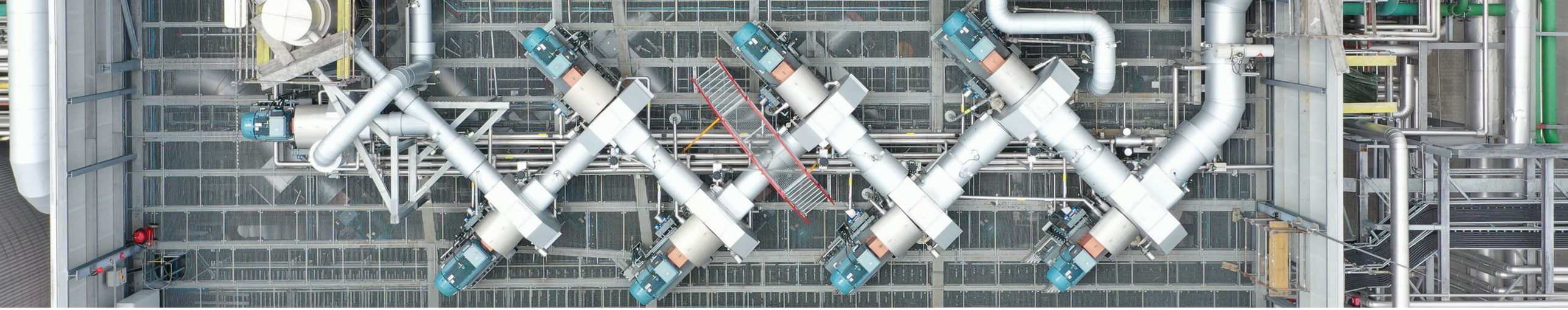
ABOUT THE REFERENCE

- Pannonia Bio Zrt.
- Bio Ethanol Plant
- Market position of Pannonia Bio:
  Pannonia Bio is a cornerstone of Europe's biorefining landscape, producing over 550 million litres of bioethanol annually.
- Number of Employees: ~ 400
- Production: Dunaföldvár, Hungary
- PILLER Product: VapoFlex®

PannoniaBio

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ALWAYS ADVANCING



PROJECT GOAL

The primary objective was to reduce carbon emissions and production costs by avoiding unnecessary cooling and reheating thereby improving overall energy efficiency.

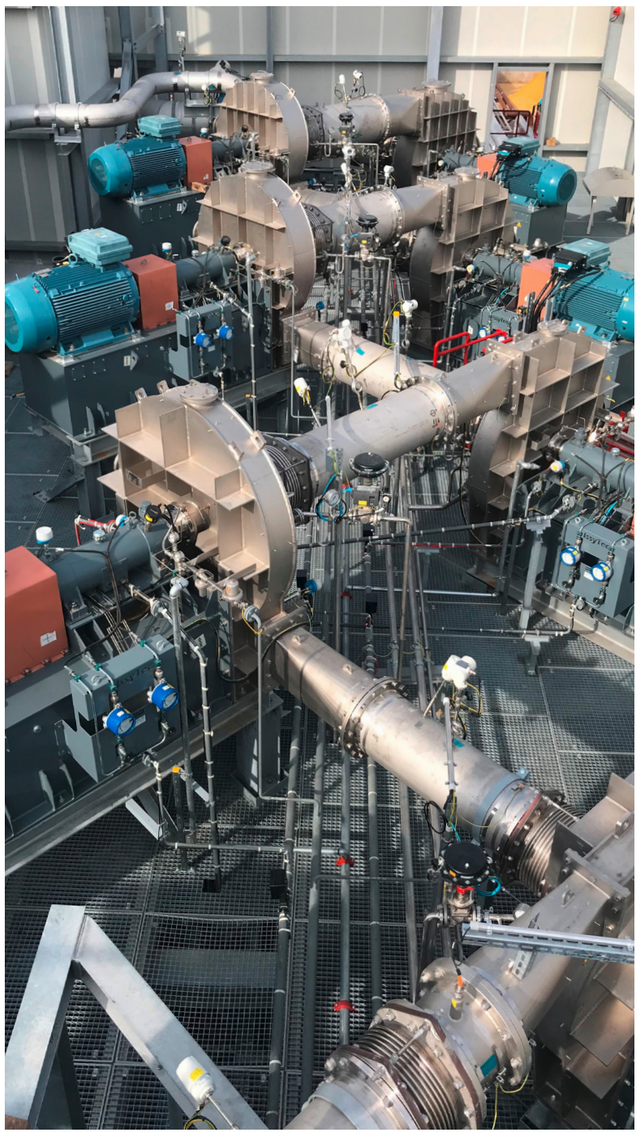
Obstacle
A major obstacle during the integration of the MVR heat pump system was the lack of available floor space at ground level, which required the installation of the equipment on elevated steel platforms. Also, Ethanol vapor-air mixtures can create flammable atmospheres, requiring all nearby equipment to comply with strict safety design standards for use in potentially hazardous areas.

SOLUTION: HEAT PUMP INTEGRATION WITH VAPOR COMPRESSION SYSTEMS

PILLER´s solution involved compressing highly concentrated ethanol vapors (190 proof/95 Vol.-%) to increase vapor pressure and temperature. This approach enabled the recovery of energy previously lost to cooling towers and reintegration into the plant's processes, creating a smart heat integration loop.

Retrofitting the process with industrial-scale heat pumps delivered:

- Reduced carbon emissions
- Lower energy costs
- Enhanced competitive advantage



TECHNICAL IMPLEMENTATION

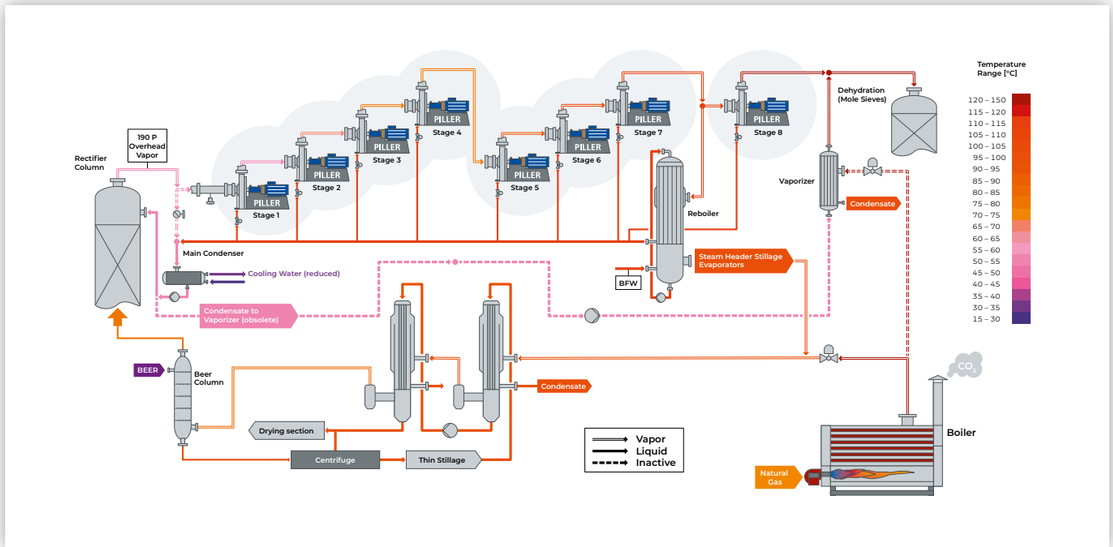
Two bioethanol production lines were completely retrofitted with PILLER Mechanical Vapor Recompression (MVR) Heat Pump systems as core technology.

Initial Process

- 190 proof vapors were fully liquefied on the rectifier's main condenser, losing heat to cooling towers.
- After rectification, the distillate was evaporated again using boiler steam for dehydration.
- The rectifier column operated at the lowest temperature level in the heating cascade, making its heat potential inaccessible without heat pump technology.

Retrofitted Process

- MVR systems compress a major portion of the column overhead vapor to feed the dehydration unit and produce steam for stillage evaporation.
- Compression Steps:
  - **Step 1:** Two compression trains (7 MVR blowers per rectifier column) lift vapor from 340 mbar(a)/53 °C to 3,000 mbar(a)/108 °C saturation temperature.
  - **Step 2:** Vapor streams split:
    - Stream 1: Condenses in reboiler to generate 100 °C water vapor for stillage evaporation, replacing steam from natural gas fired boiler.
    - Stream 2: Passes through an eighth stage to feed molecular sieves at 4,000 mbar(a)/140 °C superheat.
- To control the 23 K compression superheat control a small amount of 190 proof condensate is injected into the compressors.



PILLER MVR Retrofit – direct 190 proof vapor compression for steam generation and molve sieve supply



PILLER High-Performance Blower in bioethanol plant

IMPACT

This project demonstrates that industrial separation processes can be transformed into heat pump networks, unlocking waste heat for high-temperature demands. Further compression stages for higher temperature heat sinks are feasible for regions with high gas prices or ambitious CO_2 reduction targets.

KEY RESULTS

- **33 % lower energy requirement**
- **Achieved a reduction of 6.75 tonnes per hour in greenhouse gas (GHG) emissions (as CO_2 equivalent)**
- **MVR Heat Pump heating only COP of 4.56**
- **33 MW natural gas saving and only 5.9 MW electricity consumption substantially reduces operation cost**

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