PILLER
Blowers & Compressors

ENERGY EFFICIENT BIO-ETHANOL PRODUCTION WITH PILLER MVR BLOWER SYSTEMS

The largest single site bio-ethanol plant in Europe, located in Hungary, was already considered as the most efficient refinery in the world, using state-of-the-art technology. But there still were high ambitions to minimize carbon emissions and to increase energy efficiency.

DECARBONIZING BIOREFINERIES

In biorefineries, distillation and dehydration are among the most energy intensive processes, constituting a significant part of the overall energy consumption.

Within the process, condensation and subsequent evaporation of rectified (hydrous) ethanol turned out as massive waste of energy. Therefore, cooling and reheating should be bypassed, but the conditions of the vapor streams did not match. The solution: increasing the pressure and temperature by compressing the highly concentrated ethanol (190 proof / 95 Vol.-%) vapors.

BEACON IN ENERGY TRANSITION: INTEGRATING HEAT PUMP SYSTEMS

Recapturing the energy previously lost to cooling towers and returning it to the plant's processes leads to smart heat integration and boosting energy efficiency. This project turned out as a beacon in the energy transition. Retrofitting the process with industrial scale heat pumps leads to:

- minimized production costs
- minimized carbon emissions and thus a competitive advantage

Heat pump technology: Vapor compression line with PILLER MVR Blowers

As main result of the open loop heat pump integration, the steam production from boilers dropped by more than 40 tons of steam per hour.

The direct 190 proof vapor compression significantly reduced carbon emissions and energy costs by electrifying process heating at a high COP.

Additionally, the debottlenecked steam generation enables further growth on other production facilities.

VAPOR COMPRESSION SYSTEMS – MADE BY PILLER

Two production lines of bio-ethanol were completely retrofitted.

Core element of the installed solution is the vapor compression system with PILLER MVR Blower Technology.

Ethanol compression with PILLER MVR Blower Systems

- Mass flow app. 100 t/h in two compression lines
- Temperature Rise 64 K saturated
- 33 MW natural gas were saved at a cost of 5.9 MW electricity
- Cuts the plant's energy needs in half
- Reduced greenhouse gas (GHG) emissions by 6.75 t/h of carbon dioxide
- COP of 4.56 for heating

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ALWAYS ADVANCING

In the initial process, 190 proof vapors are fully liquified on the rectifier's main condenser losing the heat to the cooling towers. After the rectification, the distillate is evaporated again with boiler steam to feed the mole sieves for dehydration. The rectifier column had the lowest temperature level within the original heating cascade. This heat potential can only be unlocked with a heat pump technology.

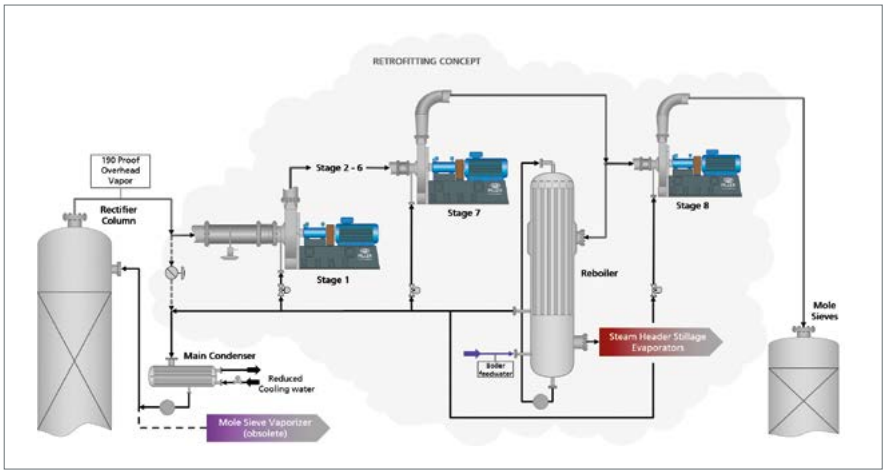
RETROFITTING FOR GREENER BIOETHANOL

In the retrofitted process, the Mechanical Vapor Recompression (MVR) system with PILLER Blower Technology compresses a major part of the columns overhead vapor to directly feed the dehydration unit and to produce steam for the stillage evaporation.

The compression takes place in two steps. In the first step, two compression trains, consisting of seven MVR Blowers – each for one rectifier column – lift the vapor from 340 mbarA and 53 deg C to 3000 mbarA and 108 deg C saturation temperature. After the seventh stage, the vapor flows are split into two streams:

1. One stream is directed to the steam generating heat exchangers (reboilers). This stream condenses and generates 100 deg C water vapors for the stillage evaporation process – replacing steam from the natural gas fired boilers.
2. The other stream goes into the eighth stage which feeds the molecular sieves at 4000 mbarA and 140 deg C superheat.

To perfectly control a superheat of 23 K, a small amount of the 190 proof condensate produced in the reboiler is injected into the compressors.



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

MATCHING CONDITIONS WITH VAPOR COMPRESSION LINES

The high temperature heat demand of the dehydration unit and the stillage evaporator was consuming large quantities of steam from the boiler house. The mechanical vapor compression systems link the low temperature waste heat of the rectifier with the high temperature heat demand and perfectly close the heat recovery cycle over the whole production.

PILLER'S SYSTEM INTEGRATION SERVICES

The key to the project's success is the heat pump effect created by the mechanical vapor compression unit. PILLER supports its customers in the development of initial concepts for heat pump systems based on vapor compression.

The Blowers and Compressors – Made by PILLER – are therefore customized to the individual process conditions and connected to a multi-stage system.

PILLER High-Performance Blower in the bio-ethanol plant

Solutions for heat pumps with temperatures up to 200 deg C, even in hazardous areas, can be realized with that technology.

ESTABLISHING SUSTAINABLE PROCESSES

With a COP of 4.56 the heat recovery is an outstanding business case.

The success of this recovery cycle outlines that various industrial separation processes can be turned into heat pump loops. Further compression for higher temperature demand is possible and more likely to be considered in regions with high gas prices or high ambitions on CO_2 reduction.

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