#01

EPOS TECHNOLOGY FOCUS

Technologies for industrial processes

December 2017

WASTE HEAT

Heat recovery, reuse and recycling (part 1)

EPOS

SYMBIOSIS IN INDUSTRY

About the EPOS Technology Focus

Within the scope of the EPOS project, extensive literature and market research reviews were performed in order to identify different technological, organisational, service and management solutions that could be applied to different industrial sites and clusters. The collected information will aid in establishing on-site and/or cross-sectorial industrial symbiosis opportunities; additionally, to enhance overall sustainability, performance and resource efficiency of different process industry sectors. Through the cooperation of project partners, a longlist of different technological options was created. Resource material for this list included: scientific articles, project reports, manufacturer's documentation and datasheets.

WASTE HEAT

Industrial processes in different sectors, depending on the process, may either require or generate enormous amounts of thermal energy. Much of the waste heat is disposed of into the environment; meaning heat sources are frequently not optimally utilised.

Utilisation of waste heat is one of the core and generic activities for achieving industrial symbiosis and resource efficiency. When it is utilised, the waste heat is often reused in the process itself (e.g. pre-heating). Waste heat can also be used in other on-site processes, transformed into electrical energy, integrated into district heating networks or used for provision of industrial steam [1]. An alternative option is to sell the waste heat to energy supply companies, which can transform it into electricity using the appropriate technological process (e.g. Organic Rankine Cycle). [2]

Utilisation of the waste heat is mainly dependent on its quality, i.e. temperature of the waste heat streams. Historically, there was a common belief that the utilisation of waste heat is only (economically) suitable for waste heat streams of moderate temperatures (e.g. more than 500°C) [1]. With the availability of new technological options, valorisation of waste heat streams of lower temperatures is possible (e.g. industrial heat pumps, Organic Rankine Cycle, etc.).

HEAT RECOVERY, REUSE AND RECYCLING

The techniques, methods and technologies presented here relate to heat recovery, heat reuse and heat recycling.

- Regenerator
- Recuperator
- Heat pipe
- Shell and tube heat exchanger
- Plate heat exchanger
- Plate and shell heat exchanger
- External hot water network

TECHNOLOGIES FOR HEAT RECOVERY, REUSE AND RECYCLING

Technology 1: Regenerator

A single flow path in which the hot and cold fluids alternately pass through. It is usually implemented as a circular honeycomb matrix of heat-absorbing material, which is slowly rotated within the supply and exhaust air streams of an air-handling system. As the thermal wheel rotates, heat is picked up from the exhaust air stream in one-half of the rotation and given up to the fresh air stream in the other half of the rotation. Thus waste heat energy from the exhaust air stream is transferred to the matrix material and then from the matrix material to the fresh air stream. [3]

Figure 1 Regenerator [4]

Applicability

To recover the latent heat from hot air/gas streams. It is widely used in various industry sectors.

Maturity

Commercial.

Project/product reference

Regenerative heat recovery, Bloom Engineering, USA.

Technology 2: Recuperator

Hot and cold flows are separated by a wall, through which heat is directly transferred. [3]

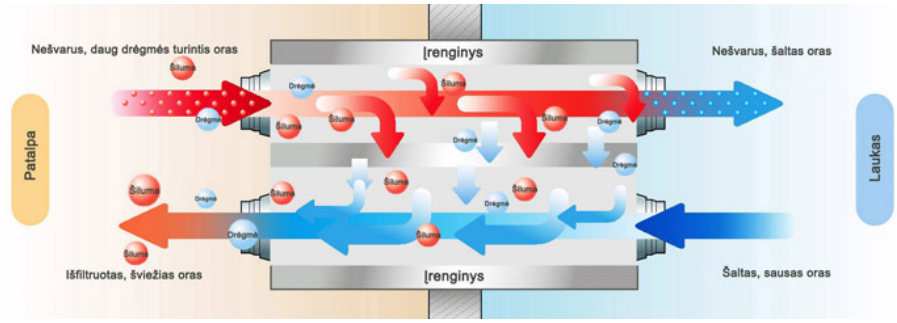

Figure 2 Recuperator [5]

Applicability

To recover the waste heat from hot air streams. It is suitable only to recover a latent waste heat. It is widely used in various industry sectors.

Maturity

Commercial.

Project/product reference

Wabtec Corporation radiation recuperators.

Technology 3: Heat pipe

A closed evaporator-condenser system consisting of a sealed, hollow tube, with inside walls lined with a capillary structure or wick. At the hot interface, liquid in contact with the thermally conductive solid surface turns into a vapour by absorbing heat from that surface. The vapour then travels along the heat pipe to the cold interface and condenses back into a liquid, releasing the latent heat. The liquid then returns to the hot interface. [6]

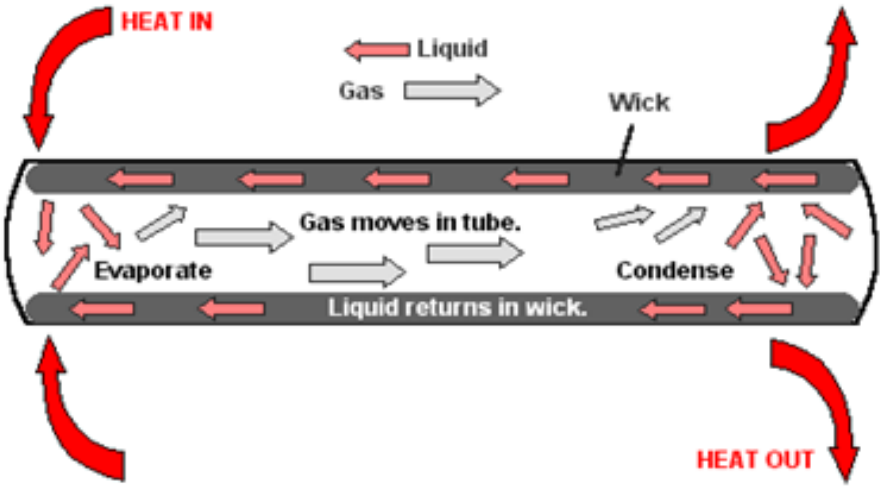

Figure 3 Heat pipe [7]

Applicability
Used to recover waste heat from air or water. It is widely used in various industry sectors, particularly where the traditional designs of heat exchangers would not be suitable.

Maturity
Commercial.

Project/product reference
SpiraxSarco heat pipe HE.

Technology 4: Shell and tube heat exchanger

Consists of a series of tubes; inside the tubes, the fluid is either heated or cooled. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. [8]

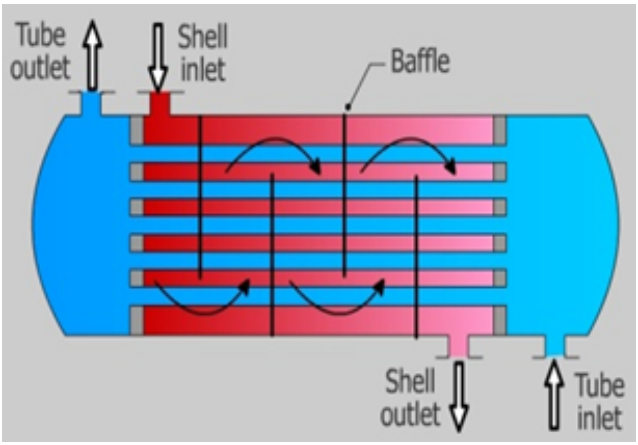

Figure 4 Shell and tube heat exchanger [9]

Applicability
For the recovery of (waste) heat. It is typically implemented in high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260 °C). It is widely used in various industry sectors.

Maturity
Commercial.

Project/product reference
Alfa Laval's shell and tube heat exchangers.

Technology 5: Plate heat exchanger

Is composed of many thin, slightly separated plates that have very large surface areas and small fluid flow passages for heat transfer. [8]

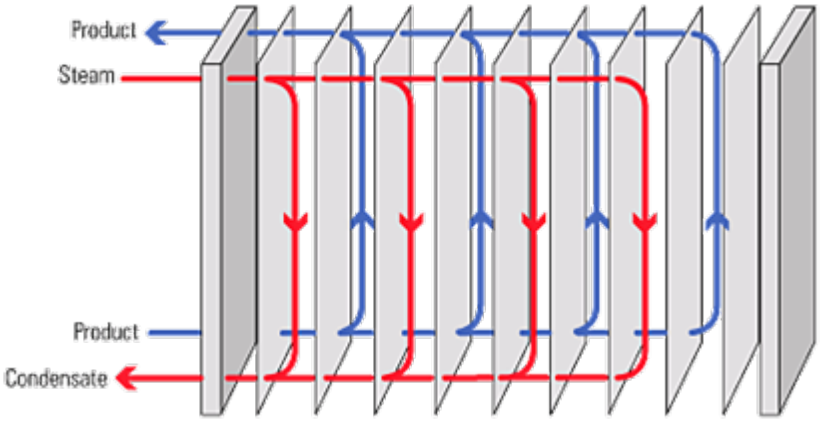

Figure 5 Plate heat exchanger [10]

Applicability
For the recovery of (waste) heat. It is typically implemented in low/ medium pressure applications. It is widely used in various industry sectors.

Maturity
Commercial.

Project/product reference
Alfa Laval's plate heat hangers.

Technology 6: plate and shell heat exchanger

Plate and shell heat exchanger combines plate heat exchanger with shell and tube heat exchanger technologies. [8]

Figure 6 Plate and shell heat exchanger [11]

Applicability
For the recovery of (waste) heat. It is typically used in cases where the heat streams are of high pressure and/or temperature.

Maturity
Commercial.

Project/product reference
Vahterus' plate and shell HE.

Technology 7: External hot water network

Short description: The utilisation of waste heat (hot water) streams with lower temperatures (approx. 100 °C) in other industrial processes (e.g. heating). A hot water stream is fed through the pipes, heat is released using heat exchangers and the cold water stream is returned into the plant.

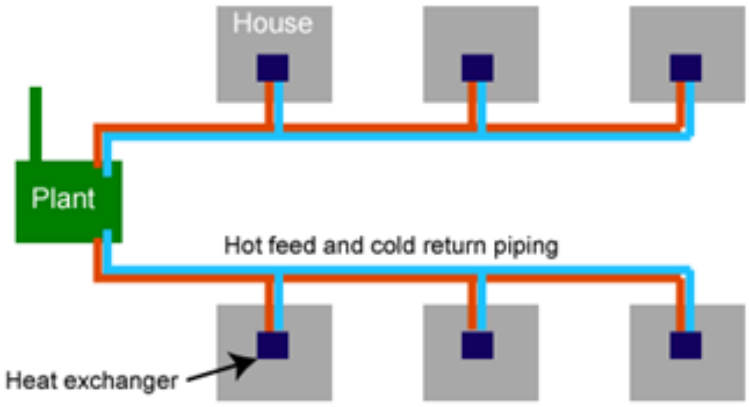

Figure 7 External hot water network [12]

Applicability

To valorise the waste hot water with low temperatures (approx. 100 °C), by using it for other purposes (e.g. district heating). It is widely used in various industry sectors.

Maturity

Commercial.

Project/product reference

Šostanj Thermal power plant in Slovenia - waste hot water for industry and households of surrounding area.

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CREDITS

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