Sustainable waste water cooling in paper mills: The role of BM Green Cooling GmbH in heat recovery solutions

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INTRODUCTION:

The paper industry is a significant contributor to the global economy, supplying a wide range of essential products for companies and individuals alike. However, the environmental impact of paper production, particularly in terms of waste water management, has led to increased scrutiny and regulatory pressure. One of the key challenges is the temperature of the waste water discharged from paper mills. As environmental regulations become tighter, paper mills are compelled to find new sustainable and efficient ways to cool their waste water before it is released into natural water bodies.

Even though the company name Green Cooling suggests only to cooling, in the last years circulating the heat energy has taken a bigger role. When cooling, heat energy gets transferred between mediums, and previously the heat was usually dissipated to the environment, to water or to air. When circulating the existing heat energy however, less heat needs to be produced in the first place, saving valuable resources. The challenge in using the recovered heat is providing the heat to a consumer that benefits from the heat, and that the source side and the consumer side are in balance during the operation.

Environmental Regulations and the Tighter Control:

With constantly growing environmental awareness, regulatory bodies worldwide are tightening the reins on industries that contribute to pollution and climate change. As energy intensive units, paper mills are no exception, facing increasingly stringent regulations regarding the temperature of waste water discharge. The impact of elevated waste water temperatures on aquatic ecosystems is well-documented, ranging from thermal pollution to disruptions in aquatic life and ecosystems. As a response to these concerns, paper mills are seeking advanced technologies to comply with these regulations without compromising their production efficiency.

BM Green Cooling GmbH: A Pioneer in Sustainable Cooling Solutions

BM Green Cooling GmbH emerges as a leader in providing innovative and sustainable cooling solutions for industries facing waste water temperature challenges. Waste water can be cooled in various ways, ranging from cooling pools to mechanically cooled systems. Usually the cooling is wanted to be made as cost effectively as possible, as all the resources used in waste water cooling are, well, wasted. For this reason for example a mechanical cooling for the waste water is not optimal solution, as the energy and money used to cool the water is poured down the drain.

However if the heat energy harvested from the waste water could be utilized somewhere and reduce the need for providing energy for that part of the process, we are not talking about wasting the energy anymore, but an actual and viable heat recovery.

BM Green Cooling specializes in heat recovery solutions utilizing the modernest heat pump technology. Heat pumps offer a unique opportunity to not only cool waste water efficiently but also recover the heat for various beneficial applications within the paper production process.

Heat pumps as the missing link between the temperature levels

During the last years heat pumps have been in the middle of great attention as Europe is moving away from fossil fuels. Many have installed a heat pump to their house or office, but the big applications and the range of possibilities are less known for the public.

In basic principle the heat pumps move energy between two mediums with a compressor. Efficiency of heat pumps is measured in COP (Coefficienct of Performance), the relationship between the power (kW) that is drawn out of the heat pump as cooling or heat, and the power (kW) that is supplied to the compressor. For example if the compressor uses 2 kW of power and heat pump gives out 10 kW of heat, the COP is 5 (10 kW / 2 kW).

The efficiency is dependent on the temperature difference between the two sides, as seen in the table:

The range of applications for the warm side is wide, as is the temperature range that can be achieved with modern heat pump technology. Applications include heating the halls, offices or selling the heat for the district heating. Inside paper mills the heat can also be for example utilized in preheating the process water.

Expanding the range of possible consumer side temperatures results to the applications for heat recovery becoming more versatile.

Natural refrigerants

Refrigerant regulations are also a consideration when designing a heat pump system. In Europe the regulations are getting tighter as the upper limit of allowed GWP (Global Warming Potential) of refrigerants is lowered. Natural refrigerant possess good properties, but safety needs to be taken into consideration when choosing the right refrigerant for an application. Many of the natural refrigerants are flammable, but there are also low-GWP options for flammability class A1 (not flammable) to provide more security. These include for example R513A and a more exotic choice R744 (CO2).

COP in relation to the temperature lift

Source water temperature [°C]	*User side temperature [°C]*	*Temperature lift [K]*	*COP*
24	25	1	12,99
24	30	6	9,91
24	35	11	8,00
24	40	16	6,69
24	45	21	5,74
24	50	26	5,01
24	55	31	4,43
24	60	36	3,95
24	65	41	3,55
24	70	46	3,20
24	75	51	2,89
24	80	56	2,62
24	85	61	2,37
24	90	66	2,13

Refrigerant: *R513A*

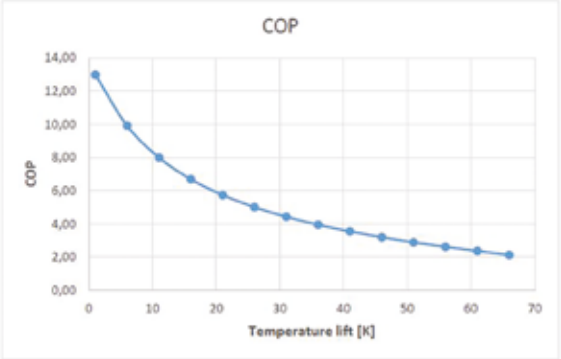


Figure 1: Temperature lift affects the COP.

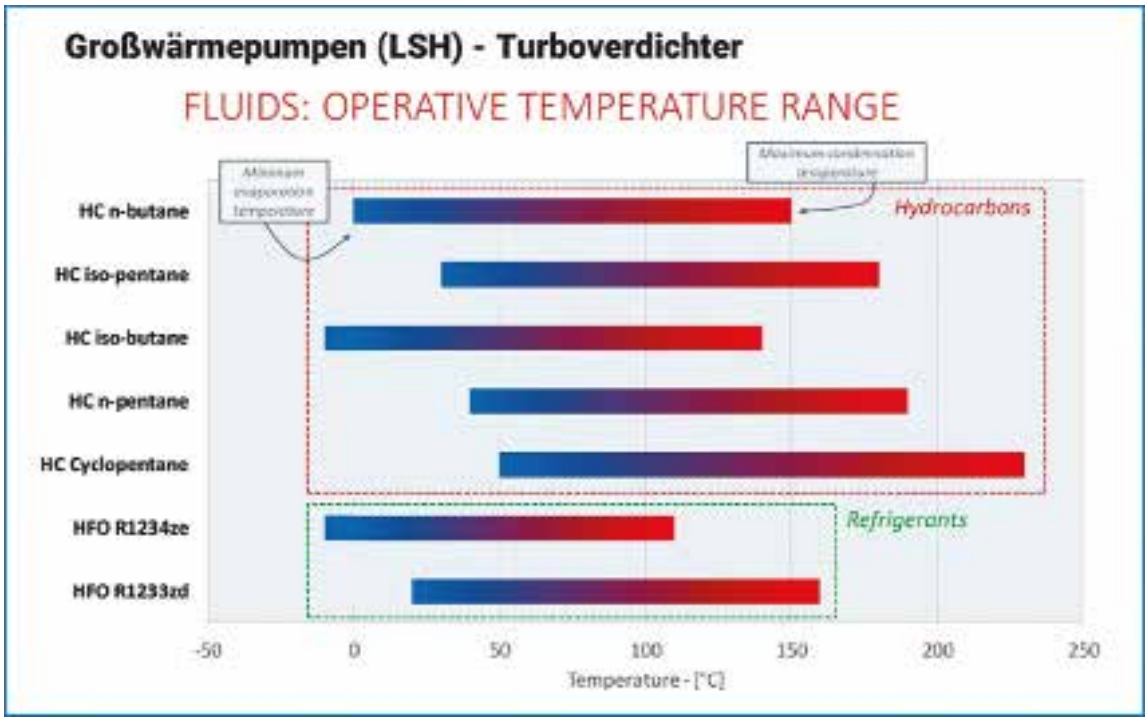


Figure 2: Temperature ranges for different refrigerant with Turbo compressor.

Absorption cooling for sustainable waste water cooling

Other innovative way that has been less explored is to cool the waste water with Absorption cooling, which utilizes heat as the energy needed for the cooling. In absorption process the electrical power needed in a normal mechanical cooling is replaced by utilizing heat energy. If there is waste heat available during the times the waste water is too warm, absorber can utilize that waste heat to cool down the waste water sustainably. Mostly this would happen in summer when there is too much heat energy in the mill, and there are no applications for heating. This can also be seen as heat recovery, when otherwise wasted energy flows will be utilized for a beneficial use.

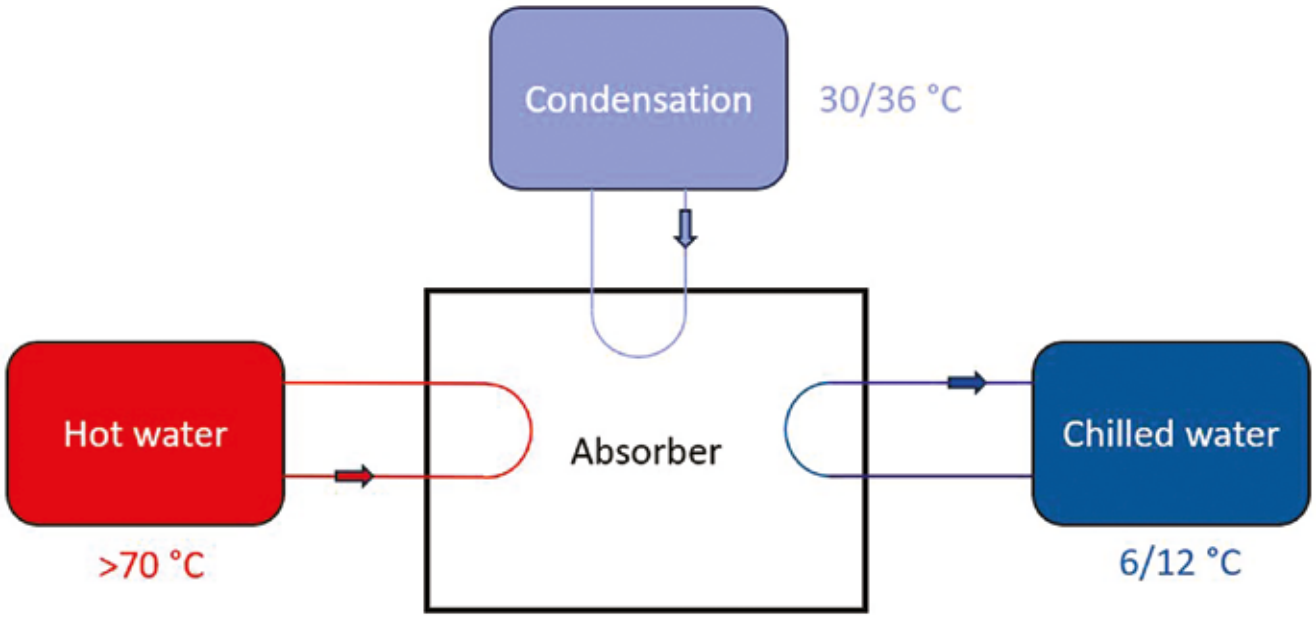
Absorption cooling needs a hot medium, which can be either water or steam. With our low temperature absorption line, water from 70 °C and above can be utilized for the absorption cooling process.

Absorption cooling consists of three different circulations. One being the chilled water circulation, one being the heat energy circulation and the third one being the condensation circulation that rejects the heat from the two other circulations to bring it away from the cooled process.

Heat pumps applied in the context of Cooling Waste Water:

Heat pumps offer an energy-efficient means of cooling waste water to comply with regulatory requirements. By extracting heat from the waste water and releasing it into the environment at a lower temperature, the company ensures that the discharged water meets or exceeds regulatory standards. This not only addresses environmental concerns but also positions paper mills as responsible users of natural resources while reducing the costs.

Figure 3: Three circulations for the absorber



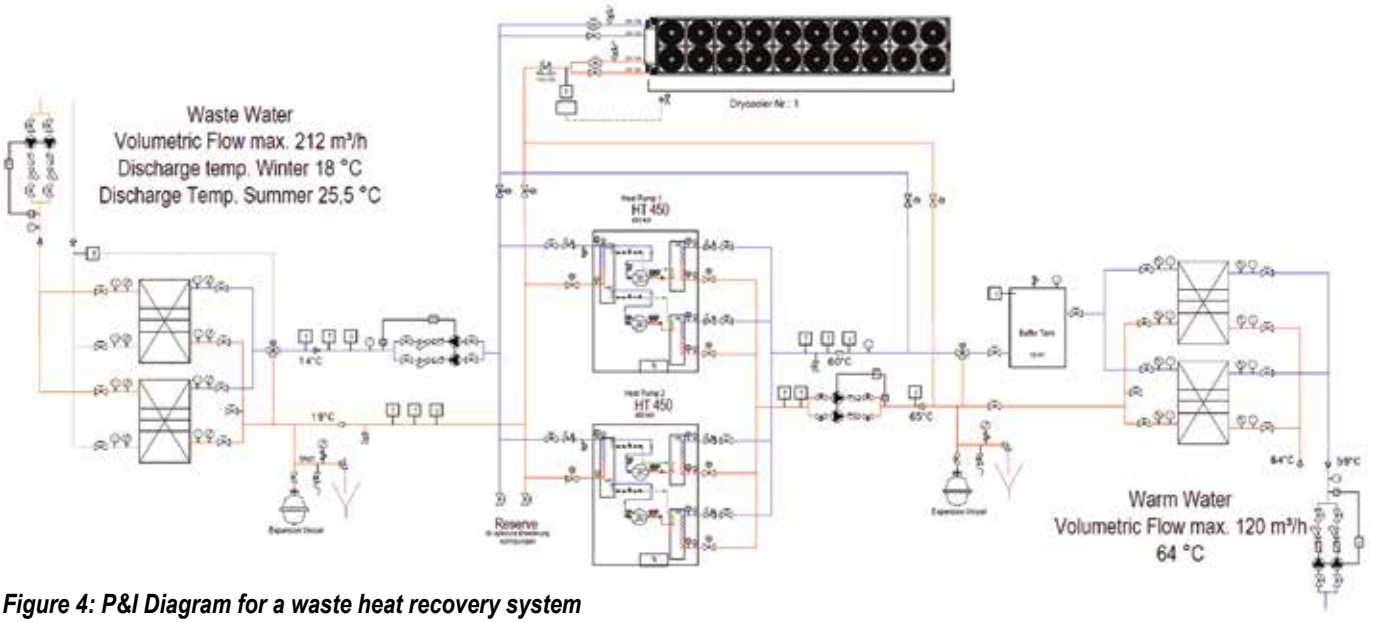


Figure 4: P&I Diagram for a waste heat recovery system

An example diagram of a waste water cooling system in a concept project for a paper mill above:

Here the waste water will be cooled down to 18 °C in Winter, and to 25,5 °C in Summer, and the warm side will provide heat for 64 °C. In this occasion the cooling aspect is more important in the winter, as in winter the allowed discharge temperature is lower as in summer, but the process produces always warm waste water. During the times heat recovery is not a viable option on the mill, dry cooler will act as a heat sink to make sure the waste water temperature is regulated at all times.

Heat Recovery Applications:

The recovered heat from the cooling process is not wasted; instead, it is redirected for various applications within the paper production process. One primary application is the pre-heating of process water. By utilizing the recovered heat, BM Green Cooling GmbH assists paper mills in optimizing their energy consumption and reducing overall operational costs. The incorporation of heat recovery into the production cycle aligns with the principles of circular economy and resource efficiency.

Future Prospects for heat recovery with heat pumps: High-Temperature Heat Pumps for Steam Production:

As technology continues to advance, BM Green Cooling GmbH envisions a future where high-temperature heat pumps can directly produce steam for industrial processes. While this concept is still in the development phase, the potential benefits are substantial when it becomes commercially available. Steam is a vital component in paper production, and the ability to generate it through heat pumps would mark a significant leap towards sustainability in the industry.

As the temperatures provided by the heat pumps are increasing in the next years, also other exciting possibilities will open in the heat recovery section as the heat harvested from low level temperatures can be implemented in higher and higher temperatures on the receiver side. At the moment several European heat pump manufacturers are making pilot projects for heat pumps that can reach 200 °C and above on the condensation side.

Advantages of Steam Production with Heat Pumps:

- Reduced Dependency on Fossil Fuels: Steam is traditionally generated through the combustion of fossil fuels. The integration of high-temperature heat pumps could reduce this dependency, contributing to a significant reduction in greenhouse gas emissions as less steam needs to be produced with fossil fuels.
- Increased Energy Efficiency: Heat pumps are known for their high efficiency in converting low-grade heat into usable energy. By employing them for steam production, paper mills can enhance their overall energy efficiency, aligning with global sustainability goals.

Challenges and Considerations:

While the prospects of utilizing high-temperature heat pumps for steam production are promising, there are challenges that need careful consideration. These include technical feasibility, scalability, and economic viability. The development phase requires thorough testing and optimization to ensure seamless integration into existing paper production processes, and for the technology to mature enough to be financially viable option for the application.

In the temperature level of under 100 °C heat pumps there are already applied and proven systems for heat recovery. Connecting these heat pumps to the water flows on the paper mill in a way that benefits the process, utilizes the waste heat effectively and remains easy to use and service needs meticulous planning to achieve the best possible system.

Conclusion:

In conclusion, the paper industry faces increasing pressure to address environmental concerns associated with waste water temperature. BM Green Cooling GmbH emerges as a pioneer in providing sustainable cooling solutions for paper mills through its innovative heat recovery solutions with heat pumps.

By efficiently cooling waste water and recovering the heat for beneficial applications within the production process, the company not only helps paper mills comply with stringent regulations but also contributes to resource efficiency and environmental sustainability. The ongoing development of high-temperature heat pumps holds the promise of further elevating the industry's sustainability, marking a positive way towards a greener and more responsible future for paper production.

As industries worldwide strive to balance economic prosperity with environmental responsibility, energy efficiency solutions like those offered by BM Green Cooling GmbH become integral components of a sustainable and resilient future.