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Research area: general aims

Energy // Energy use

Key words:

Condensate, paper, drying section, membrane

TITLE:

Increasing the efficiency of water and energy use in papermaking by new concepts of heat integration and condensate recycling from moist exhaust air from the drying section

Background/Problem area

High energy input is needed in the drying sections of paper production. To some extent, this energy gets lost with the warm and moist exhaust air leaving the drying section. State of the art is a single-stage heat recovery system in which heat is transferred from the exhaust air to cold supply air. Anyway, today the excess heat and the condensates from paper mill drying sections are not used completely in most cases. Only some of the paper mills are using a multi-stage heat recovery process in the drying section. In such mills, even more thermal energy is obtained and a stream of condensate forms since the moist exhaust air continues to be cooled. In many cases the condensates arising in the heat recovery system have a high water quality - depending on the produced paper grade - and could be used for special recycling purposes. The process of multi-stage heat recovery in the drying section is very profitable already due to the energy recovered. Coupled with recycling of condensate water, the benefits will be even greater. The basic idea of this research project was to reuse condensates as boiler feed water, as these processes require very high water qualities.

Objectives/Research results

The objective of the project is to develop integrated concepts for the combined use of excess heat from the drying sec-tion and the condensate thereof. A new process of water treatment has to be developed with the aim of increasing the quality of condensates to meet the needs of boiler feed water. Methods like filtration, reverse osmosis and ion exchange, among others, have been considered.

Precondition for the use of condensates is the presence of a multi-stage waste heat recovery system in the paper mill. The quality of drying hood condensates strongly depends on the stage of the heat recovery system where the condensate arises, on the produced paper grades and on the degree of closure of the water circuit. In the studied paper mills the chosen drying hood condensates basically are of good quality concerning conductivity (60-80 µS/cm), salt content and amount of solids (largely free of solids). Hardness (0.03-0.2 mmol/l), pH (4-6), organic load (COD: 100-550 mg/l; TOC: 34-160 mg/l) and organic acids (acetic acid equivalents: 20-200 mg/l) have to be improved. The required water quality depends on the type and operation mode of the boilers. In the studied paper mills the amount of drying hood condensate of a suitable quality averages about 6 and 20 m³/d. The required amount of make-up water for the boiler is in the same range or below.

In water treatment trials the quality of the drying hood condensates could be improved. The best results have been achieved by reverse osmosis (RO): hardness down to 0.014 mmol/l; pH 5-7; COD 7-100 mg/l; acetic acid equivalents <1 mg/l; conductivity 12-60 µS/cm. Varying the pH significantly influenced the efficiency of the RO treatment. PH 7-10 showed to be most effective in terms of reduction of organic load (COD elimination up to 93% at pH 7 and 10) and conductivity (elimination up to 97% at pH 7). Flocculation and treatment with different types of activated carbon showed minor effects.

Multi-stage systems offer the opportunity to enhance the degree of thermal recovery, thus lowering the heat requirements in production. Depending on the heat sinks available, the additional amount of energy recovered from the exhaust air can be used to preheat the workshop air or to heat water (e.g. fresh water, process water).

Since the availability of heating steam is essential for paper production, using treated drying hood condensates as boiler feed water intervenes in one of the most sensitive parts of the production. This is why a workshop was held to identify the possible risks, to evaluate and to derive solutions to minimize these risks. Representatives of paper mills, suppliers of heat recovery systems and water treatment plants and experts in the field of requirements and treatment of boiler feed water discussed their knowledge and experiences as well as expected impacts of a change in boiler feed water quality - caused by the use of drying hood condensate as makeup water - on the operation of the boiler, steam production and the entire steam system.

Application/Economic benefits

Small paper mills, in particular, have the greatest potential of benefiting from the results compared to big and medium-sized enterprises, because they very rarely have multi-stage heat recovery units. The contribution made to increasing their competitiveness is a significant reduction in production costs. In order to implement the project results, investments must be made for condensate treatment processes and heat exchangers. This would benefit plant manufacturing companies in turn.

An assessment of economic efficiency conducted during the application phase showed very high savings potential when condensate is used as boiler feed water. This possibility exists for all possible user groups in the paper industry. For instance, new plants could of course be designed in an energy-saving manner, although such possible savings can be achieved in a similar manner in existing plants. For example, existing ion exchange plants could be unburdened with reverse osmosis that would pay even within a short time

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Remarks

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