Improvement of energy efficiency in the steel industry by utilization of low temperature waste heat

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Abstract

At present the Austrian steel industry is consuming about 32.239.489 GJ oil, 46.675.484 GJ petroleum gas und 0,93 GJ electricity but parts of the used energy is squandered unused into the surrounding. Regarding the five priority steps[2] for utilization of waste heat, companies with a high energy demand usually reach step four, the internal usage of energy. These companies could increase their energy efficiency by identification of the waste heat flows and thus developing concepts for utilization of the waste heat flow, with the goal to reduce the primary energy demand.

In the steel industry waste heat is a result during the production process. The billets produced in strand casting are heated and processed in rotary hearth furnaces or walking-beam furnaces. Other furnace types which are used in the production process to prepare the desired structure are patenting furnaces, curing ovens, drying furnaces as well as annealing furnaces. In spite of using regenerative or recuperative preheating of the combustion air, these furnaces dispose of the exhaust gases at around 300 ° C. In the production process the milling products are cooled down by air (cooling beds) or by water (quench cooling).

For the identification of heat sinks and the integration of the recovered energy in the company's specific energy supply unit it is essential to know the processes in detail. From the present point of view the following steps have to be taken:

- Creation of a data base (e.g. measurement data)
- Process- and energy analyses (Pinch-analyses[3], Sankey diagrams[4])
- Simulation of the possibilities for utilization of the waste heat flows
- Risk analysis of identified measurements
- Cost effective analyses (payback period)

An example for a waste heat flow at the voestalpine Austria Draht GmbH is shown in figure 1. The example shows the energy demand at the walking beam furnace and the losses in the course of the production process.

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[2] (1) Insertion of low-loss technologies, (2) Process optimisation, (3) Energy refeeding , (4) Internal usage of energy, (5) External usage of energy

[3] The Pinch-analyses is a thermodynamic method to find out the best energy supply unit system for a process. The process flows are described by their beginning- and final temperatures, by the product between specific heat and their mass flow or their evaporation- or condensate cable and their heat transfer rate. The process flows are diagrammed in the temperature-energy flow chart.

[4] The Sankey diagram is a graphic representation of flows (amount per time) e.g. energy, material, waste heat flows through a system. Usually the flows are diagrammed as arrowheads and the amplitude of the arrowheads is proportional to the largeness of the presentable flow.

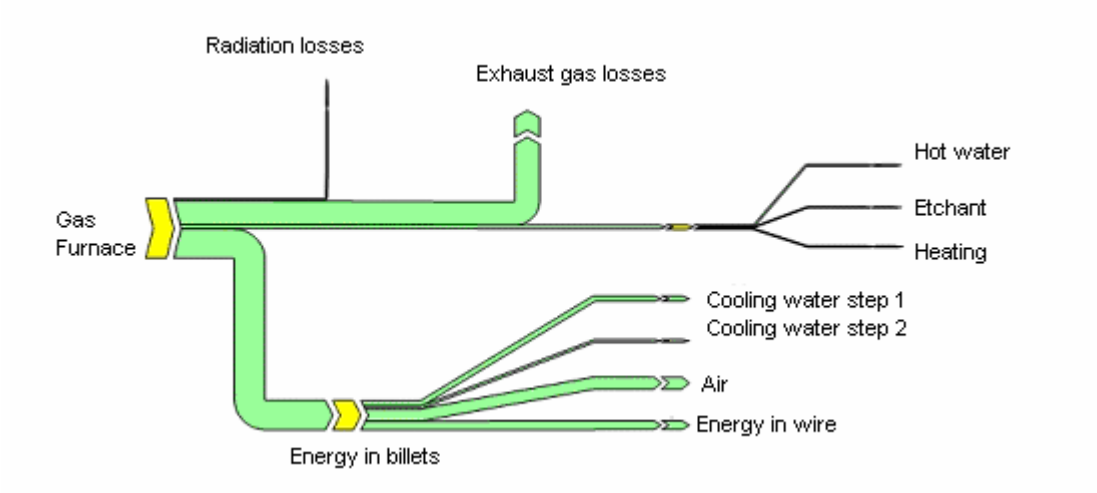

Figure 1: Sankey diagram voestalpine Austria Draht GmbH

The Sankey diagram illustrates that about 40 % of the primary energy is in the exhaust gas. The exhaust gases of the walking beam furnace disposes at about 300 °C. From that point of view and from the fact of the high energy demand for the walking beam furnace it is a great potential to use an ORC-equipment for electrical power generation out of the exhaust gas.

Another heat source is the water cooling circulation. At present about 14 % of the primary energy of the furnace is contained in the cooling water. The temperature of the cooling water is to low for using in side processes.

The utilization of waste heat from furnace exhaust can be realized on the one hand with application of ORC plant (Organic Rankine Cycles) for electrical power generation and on the other hand by the usage of waste heat boilers for heat extraction. Another heat source is the cooling water circulation. In that coherency it is possible to separate the warmer flows and bring them on a useful level, e.g. with absorption heat pump, to use this gained energy in other processes (for example: heating systems, pickling tanks, hydraulic fluid heating).

In the last year studies by the authors have shown that the steel companies can produce about 5 % of their electricity demand out of waste heat und that they can reduce the primary energy demand about 10 % by using waste heat. Using the waste heat flow contains a big potential for the future.

For the companies it is important that the integration of new technologies is corresponding to the general company specific conditions, that they don't have any negative effects on the product quality and that they have an optimum mix of measures for reusing the waste heat flow, taking into account the necessary investments during the amortization period.