RELOTEMP – Reuse of Low Temperature heat (<350°C) for the reduction of CO₂-impact of the steel industry – A case of SSAB EMEA Luleå

Swerea MEFOS
General information and objectives

**Objectives:** The aim of the project is to reduce energy use and CO₂-emissions of the steel industry by the reuse of low temperature excess heat (LTH) with T<350°C in typical production processes (coke plant, BF, steelmaking, rolling mill and coating). Target for saving is 250 GWh per year.

**Scope:** SSAB EMEA at Luleå and Borlänge

**Funding:** Co-funded by Swedish Energy Agency and Research Fund for Coal and Steel (RFCS)
SSAB EMEA

- Iron ore based steel production
  - Production sites at Luleå, Oxelösund, and Borlänge
  - Total production 2.9 Mton hot metal (2013)
  - Production at Luleå site 2.0 Mton hot metal (2013)

- Production sites at Luleå and Borlänge included in the study
  - Process route in Luleå: coke plant, blast furnace, steel plant, continuous casting, power plant
  - Process route in Borlänge: hot & cold rolling mill, coating, painting, and other finishing processes

- Modelling results only for SSAB EMEA at Luleå site
Work process and description
- Inventory of low temperature heat

- Total amount of occurring low temperature heat: flue gases, cooling water and fluids, radiation
- Reference temperature: 5 °C during winter and 15 °C during summer

![Graph showing the different sources of low temperature heat](image)
Work process and description
- Inventory of low temperature heat

Average low temperature heat flow for whole year, unit: /year

- Gas/Vapor: 755 GWh
- Water/Liquid: 1778 GWh
- Radiation/Solid: 386 GWh

- 50-100 °C: 35.2 %
- 100-200 °C: 37.1 %
- 200-350 °C: 27.7 %
- Solid, 0-50 °C: 0.9 %
- Radiation: 99.1 %
Work process and description
- Identification of utilization options

Waste heat export for district heating/cooling or to other industries.
Direct waste heat reuse in the production processes for combustion air/gas, bath or material preheating.
Improvement of working conditions (air-conditioning).
Resources savings and waste minimisation (wastewater treatment, sludge drying).
Production of mechanical energy (to drive air compressors, fans, pumps...)
Process steam production.
Production of electrical energy.

Coking plant
Sinter plant
BF
BOF
SM
CC
HRM
CRM
Finishing
Power plant

Gas/vapor
(e.g. sensible heat in flue gas, process gas, vapor/steam)
**Water/liquid**
Sensible heat in cooling water, process liquid, sludge, etc.
**Solid**
Radiation heat from hot equipment, vessel, product and by-product, etc.

**HEX**
(to produce hot/superheated water, steam, hot air, preheated thermal oil, ...)

Parabolic collector, etc

Heat pump
Kalina cycle
ORC
Heat storage
Peltier-element
Rotary screw compressor
...

Direct use:
(e.g. combustion air, slab/scrap reheating, coal, sludge drying ...)

- Blower driving
- Process steam
- Process hot water
- Combustion air preheating
- Feed water preheating
- Office/district heating
- Electricity
- Air condition

Process units
LTH identified
Heat transformation
Heat reuse Technologies
Final users/products
Work process and description
- Identification of utilization options

- Internal utilization
- Best Available Technologies (BATs): ORC, Kalina, heat pipe exchanger for air and gas preheating, heat pump, WST (wet steam turbine), CMC (coal moisture control)

Source: CMC system from Nippon Steel
Work process and description
- Process integration approach

• A process integration approach is applied for evaluation of recovery options and techniques

• Mathematical programming is used to create a system model of studied site

• Optimization is performed on basis of energy saving
Conclusions for Luleå site
- Energy saving potential

• The majority of the energy saving is attributed to saving of coke oven gas, which can be used for replacing fossil fuels at the power plant or reductant materials (pulverized coal and coke) in the blast furnace.

• The saving of coke oven gas is a result of utilizing flue gases for drying of material and preheating of combustion air and gases.
Conclusions for Luleå site
- Economic conditions and incentives

- Recovery of waste heat for internal utilization (drying of material, preheating of combustion air, steam production, etc.) most cost efficient

- Electricity production is the least favorable option with low energy saving potential and poor economic feasibility

Alternative no. 1-4: Drying of material and preheating of combustion air & gases
Alternative no. 5 & 7: Electricity production (WST and ORC)
Alternative no. 6: Steam production from BOF
Conclusions

- Waste heat recovery in steel plants

- Steel production is an energy intensive industry with significant amounts of waste heat occurring, but:
  - A large part of the waste heat is at low temperature (cooling water etc.), reducing the possibilities for utilization
  - Harvesting heat from radiation is hindered by infrastructure at the site and batch wise processes

- The available utilization options at the specific site highly affect the potential for waste heat recovery

- Utilizing flue gases for internal recovery and reduction of primary material and fuel consumption is the most energy- and cost efficient utilization option

- External heat-to-power technologies such as ORC and Kalina should be viewed as a last option due to high investment costs and low efficiency
We work on a scientific foundation to create industrial benefit.
www.swerea.se