VALORIZATION OF INDUSTRIAL WASTE HEAT BY HEAT PUMPS

based on case studies of the project EnPro

INDUSTRIAL WASTE HEAT

• 12 case studies in Austrian industrial companies

• energy efficiency and renewable process heat

• heat pumps to reintegrate waste heat

• humid exhaust gases carry a significant amount of energy
CASE STUDIES

- Analysis of energy supply and consumption
- Process optimization
- Potential for heat pumps (and solar thermal heat)
- Techno-economic analysis

Paper mill
Laundry
Production of foams

22.05.17
TISSUE PAPER MILL

C HP plant with two gas turbines for steam and electricity generation steam grid at 17 bar and 3.5 bar
TISSUE PAPER MILL

Recovering paper and recycling it in a paper machine to create tissue paper.

Process heat demand and exhaust gas:

- Process heat demand
- Exhaust gas

CHP plant with two gas turbines for steam and electricity generation:
  - Steam grid at 17 bar and 3.5 bar
HEAT PUMP INTEGRATION

- Measured process data
- Flow sheet simulation
- Process screening with a simple heat pump model

Diagram:
- Recovered paper
- Paper recycling
- Heat recovery
- Paper machine
- Converting
- Tissue

Heat pump:
- 160 °C
- Steam
- 50-80 °C
- Exhaust gas
values referred to the energy demand of tissue production

three cases:
- exhaust gas temperature after conventional heat recovery
  - 80° ... summer
  - 50° ... winter
thresholds for reductions

$\text{CO}_2$, primary energy:
Austrian electricity mix, natural gas

prices:
different price ratios
… medium ratio applies
how to improve?

integration example for steam with 160°C

steam with lower temperature?
LAUNDRY

🔥🔥 process heat demand ⚠️ exhaust gas ⚠️ waste water

dirty laundry → washing machine

washing machine → tumble dryer

tumble dryer → finisher

finisher → pressing

pressing → clean laundry
LAUNDRY

Heat source: Finisher exhaust gas: 60°C, dew point 49°C
LAUNDRY: HEAT PUMP INTEGRATION

heat sinks:
- hot water feed water preheating
- steam
  low pressure steam for finisher

high price ratio
- requires COP > 3.3
- only hot water production favourable
- not much need for hot water

exhaust gas 60°C

hot water, 80°C
steam, 142°C
PRODUCTION OF FOAMS

raw Material ➔ pre-expansion ➔ maturation ➔ final foaming ➔ EPS product

process heat demand

exhaust gas
PRODUCTION OF FOAMS

- humid exhaust gas from the filling pump, 90°C
- humid exhaust gas from the vacuum pump, 57°C
- condenser of the vacuum tank, 60°C
PRODUCTION OF FOAMS: HEAT PUMP INTEGRATION

heat sink:
- steam, 1.8 bar

low price ratio
- COP > 1.5

positive evaluation
- heat pump for condenser and exhaust gases
- heat supply > demand
- further investigation

steam, 118°C

condenser exhaust gases 57-90°C
CONCLUSIONS

• humid exhaust gas as a heat source with a significant amount of energy
• condensation usually only possible with heat pumps
• environmental benefits: CO₂ reduction and primary energy reduction

• assessment of heat pump potential allows for stop or go decisions
• steam generation allows for larger field of application
• careful matching of sinks and sources to increase efficiency
INVITATION

EnPro Symposium

12th June 2017
in Vienna (in German)

The project EnPro is an R&D service on behalf of the Austrian Climate and Energy Fund, financed by the Energy Research Programme 2014.
THANK YOU!

Veronika Wilk, veronika.wilk@ait.ac.at