Transforming our Approach to Waste Heat

Thermal systems of the future

Ammonia-Salt Resorption for Thermal Transformations

23rd January 2020
Overview

• The Problem or Opportunity?
• Why do we have waste heat?
• Resorption technology
• My research project
Government reports identify 48 TWh/yr of waste heat sources from industry. Equivalent to a 1/6th of industrial energy use. Element Energy (2014) Imperial College London for DECC.
• 78% more than total energy generated by offshore wind in 2017[1]

• Equating to around 10 MtCO2, which is similar to driving 25 billion miles in an average car

Why are we losing so much?

Heat is Work is Energy is Heat is Work

Energy most often required as: Heating, Ventilation, Air conditioning, mechanical and electric power

Often produced by a heat engine using High Temperature Heat

Second Law of Thermodynamics and Carnot
The Universe’s tax on heat exchange

Do we want to pay more tax?

What has the universe ever done for us?
Resorption
Resorption & Thermal Transformers

• Simple concept and design, no pump, no evaporator or condenser

• Components can be cheap to manufacture

• Recovers waste heat by upgrading to useful temperature

• Or Better integration of heat in district heating

• Or provisions for refrigeration for district cooling

• Use of solid salts enables an endless list of possible operations and alternative applications
Resorption Transformer

- Low Temperature Heat Sink
- Waste Heat Source

Useful Heat
2-Salt resorption cycle thermal transformer

Phase 1
- High pressure
- Endothermic desorption at medium temperature
- Exothermic adsorption at high temperature

Phase 2
- Low pressure
- Exothermic adsorption at low temperature
- Endothermic desorption at medium temperature

Temperature:
- LT Salt: 30°C
- HT Salt: 80°C
- Ammonia: 120°C
- 80°C

Reaction:
- LT Salt CaCl₂
- HT Salt MnCl₂

Graph:
- ln(P)
- P_{high}
- P_{low}
- T_{low}
- T_{mid}
- T_{high}
- \(-1000/T\)
Material Testing

- Reactive Sample
- PTFE
- ½ inch pipe centre
- 1 inch pipe jacket
- PTFE to fill heated volume
- O-ring Swagelok face seal fitting
To Conclude

- Waste Heat must be reduced
- Fiscal incentives
- District heating and heat recovery
- Sorption and Resorption
- Further integration better returns

Thank you for listening

Samhinmers@warwick.ac.uk
Results, full LTJ cycle

LTJ Experimental Cycle Result

- LTJ wall top T
- Exp V T
- ENG T
- Inside Pipe
- LTJ Wall Bottom T

Ba45 7bar d Xstart = 8, gap = 0.2, kENG = 16

Temperatures (°C)

Time (s)

Ba45 7bar a Xstart = 0, gap = 0.2, kENG = 16

Temperature (°C)

Time (s)
Objectives

- Test different salts in a conductive material
- Model and build a resorption transformer
- Produce a Coefficient of Performance of 0.4
- Highlight the efficacy of the technology/write thesis