GLOBAL SECURE

Sustainable Energy through China-UK Research Engagement (SECURE)

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http://research.ncl.ac.uk/globalsecure/
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Theme 6 ‘Thermal energy management in processing industries’

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1. Introduction

• Background

The project is highly relevant to the priority areas of Energy and Environmental Change issues.

Fossil fuels are the main sources of energy we use today.
• **Background**

Large amount of low grade heat wasted from industries.

Thermal Power Plant efficiency < 40%;

> 60% of energy wasted as low grade heat.
• **Objective:** Investigation of the opportunities to improve thermal energy utilisation within processes of processing industries and ‘over-the-fence’ options to reduce overall energy demand.
• Project partners:

(1) Institute of Engineering Thermophysics of Chinese Academy of Sciences

(working on a soy sauce plant)
• Project partners:

(2) Jishou University, Hunan
(working on spirit plant)
• Project partners:

(3) Guizhou Institute of New Technology, Guizhou University (working on thermal power plant)
• Project partners:

(4) Guangxi University
(working on paper and sugar plant)
2. Principle of Thermal energy management in processing industries

- Process analysis
- Energy consumption evaluation
- Waste heat identification
- Renewable integration
- Waste utilisation
- Process optimisation
3. Case studies

- Beijing: Soy Source Plant
- Hunan Province: Spirit Plant
- Guizhou Province: Coal Power Plant
- Guangxi Province: Paper Plant
- Guangxi Province: Sugar Plant
(1) Beijing: Soy Source Plant
Beijing: Soy Sauce Plant
(2) Hunan Province: Spirit Plant
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(3) Guizhou Province: Coal Power Plant
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(4) Guangxi Province: Paper Plant
(5) Guangxi Province : Sugar Plant
Guangxi Province : Sugar Plant
4. Results and outcomes
(1) Soy Sauce Production System Set Up
Changes Required

• **Space heating**
  – New hot water radiator system
  – Reduction of the volume heated (currently 7 m high)
  – Consideration of covering the fermentation vats

• **Vat heating**
  – Replacement of the open steam distribution system by close loop water system

• **Insulation**
  – Production halls
  – Cooker

• **Heat store**
(2) Process flow diagram of the spirit plant

- Open tank
- Fermentation bed
  - Ambient temperature (22°C)
- Air cooling to 22°C
- Manually transferred
- Manually transferred

- Distiller waste
  - Manual transfered

- Raw materials 4000 kg total

- Water 22°C

- Condenser
  - Cooling water in 18°C
  - Cooling water out 55°C

- Steam 127°C

- Distiller tank
  - Reception tank
  - 75 kg approx. (x5)

- 1 hour preparation 1 hour distillation (x 5)

- 1 hour

- 60 days
(4) Paper Plant PFD
Plant Energy Use

KWh per shift (8 hours)

- Cookers (165deg.C)
- Heating white liquor (95deg.C)
- 4-stage wash water (85deg.C)
- Drop flow tower #1 heating (50deg.C)
- Drop flow tower #2 heating (60deg.C)
- Total
- BL Boiler Flue (140deg.C)
- Waste Flash Steam (120deg.C)
Waste heat recovery opportunities

• Flash steam:
  – Condense and use as wash water
  – Difficult to use directly due to batch-to-continuous scheduling

• BLB flue gas:
  – Conversion to electricity (organic Rankine cycle)
  – Difficult to recover for heating
    • If use the flue gas to replace a steam heating duty then less steam is required by the plant, therefore less flue gas available
Outcomes

• A report of a plant energy and process evaluation has been produced. It is found that there are some processes may be improved to increase the thermal efficiency of the plant and reduce emissions.

• It is possible and intended to produce joint-papers
5. Conclusions

• It is found that there are huge potential to reduce thermal energy consumptions with improvement of management

• Optimisation of thermal energy management is necessary

• Further studies with relevant industries required – if funding available
6. Future work - project roadmap report and 5 year engagement plan

- Project roadmap:
  - Further study by simulation and experiment will be carried on
  - Economic evaluation or Life cycle analysis
  - Optimisation and integration
  - Application to different processing industries
5 year engagement plan:

• **Further study by simulation and experiment** will be carried on – work with Institute of Engineering Thermophysics (IET), Jishou University (JU); Guangxi University (GXU), Guizhou Institute of New Technology (GINT), Guizhou University (GZU)

• **Economic evaluation or Life cycle analysis**: work with IET, JU, GXU, GINT and GZU

• **Optimisation and integration**: work with IET, JU, GXU, GINT and GZU

• **Application to different processing industries**: work with IET, JU, GXU, GINT and GZU