Reuse of waste heat & water in soy protein powder making

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Industrial energy consumption in China

Industrial energy consumption

Energy consumption of industrial divisions in 2014

- Industrial energy consumption increases during last 10 years, reaches 2.96 billion tce in 2014
- Energy consumption of manufacturing industry accounts for 82.88% of total industrial energy consumption.

Industrial water consumption in China

- Waste water in industry keeps ~20 billion tons in the last 10 years
- Water water is quite weak solution
- Reuse of waste heat and waste resource is of vital importance!

Manufacturing process of soy protein powder—"alkali-solution and acid-isolation" method

**Principle:**

- Protein dissolves in weak alkaline solution
- Protein denaturation happens in acid solution, precipitated and separated

**Diagram:**

1. Soy bean meal
2. Extracted from alkaline solution
3. Extract liquor
4. Precipitated from acid solution
5. Protein condensation product
6. Washing
7. Strong solution
8. Spray drying
9. Protein powder
Waste heat and water: case study

The largest soy protein manufacturer in China:

- **Waste heat: exhaust air with high temperature**
  - Feature: high temperature (70-73 °C), high latent heat (65% of total heat), mixed with small quantity of protein powder (160-260 mg/Nm³)
  - Air volume: 180700 m³/h

- **Waste water: soy whey waste water**
  - Feature: content of protein: 1.5%-2%
  - Amount of waste water: 2.5 million m³/year
Traditional spray drying process
Proposed waste heat recovery system

Diagram showing the integration of various components such as pumps, heat exchangers, spray chambers, and other systems involved in the waste heat recovery process.
Heating season:

- average quantity of heat recovery reaches 13287 GJ per month
- average power consumption reaches 765003 kWh per month

Heat recovery performance during heating season is much better than that during non-heating season.
Waste heat recovery system

☆ Energy saving rate reaches 43.9% during heating season, 21.8% during non-heating season

☆ Statistic payback period is 2.4 years
Waste water recovery system

Soy bean meal

Extracted from alkaline solution

Extract liquor

Precipitated from acid solution

Protein condensation product

Washing

Strong solution

Spray drying

Protein powder

Waste soy whey water
Waste water recovery system

Mechanical vapor recompression system (MVR)

- Tube side: solution
- Shell side: high temperature steam, as heating source
MVR plant

Evaporator
Compressor
Electric control cabin
Electric heater
Solution inlet
Circulated pump
Vacuum pump

Diagram showing the layout of the MVR plant with labeled components.
Waste water recovery system: tested performance

- Energy consumption of compressor reaches **23 kWh to evaporate per ton of water**
- Per ton of soy protein strong solution could be sold as **10000 yuan**
- Per liter of condensed water could be sold as **1.5 yuan**
- Annual earning from waste resource recovery could reach **0.8 billion yuan**
Conclusion

- Waste heat and waste water exist in manufacturing processes such as soy protein powder, milk powder, and similar industries.
- Energy input with high grade can be decreased significantly by waste heat recovery.
- MVR could be utilized meantime for waste water recovery, to realize zero discharge of waste.
Thanks for your attention!