Experience from Thailand

- A Case Study of Cassava Starch Industry -

INVENT – Final Meetings
Content

1) Cassava Starch Industry
2) Waste Avoidance and Reduction
3) Biogas Technology
4) Environmental Awareness
A Case Study in Cassava Starch Industry

- A top five agro-industry
- Import/Export
- Waste Minimization
- Energy
Cassava Starch Production Process
Thai Cassava Starch Industry

- **Production capacity:**
  - < 100 tons/day = 9 factories
  - 100 – 200 tons/day = 46 factories
  - 200 tons/day = 6 factories

- **Cost of water**: 50-165 baht/ton dry starch (5 baht/m³)
- **Electricity consumption**: 15-20 KWh/ton starch
- **Cost of electricity**: 34 baht/ton dry starch (2 baht/KWh)
- **Wastewater**: 12 – 35 m³/ton starch
- **Biogas**: 300 million m³ (150 million liters of fuel oil)
- **Environment & Energy**
Waste Avoidance and Reduction

Starch loss

Production process

Starch: 72%

Pee: 2%

Extra: 17%

Separ: 4%

Dry: 5%

Starch loss
Waste Avoidance and Reduction

- **Waste Audit**
  - starch loss
  - product yield 66 - 90%
  - Cassava Pulp

- **Water**
  - water 9.4–15.8 m³/ton
  - water reuse

- **Chemical use**
  - alum
  - sulphur
Integrated Waste Management to Academic Curriculum
Starch Engineering and Process Optimization (SEPO)

Production Process Optimization

Clean and Green Manufacturing Practice

- Engineering Skills
- Knowledge
- Industrial Needs

Industrial Linkage

Starch Engineering and Process Optimization Program (SEPO)

BIOTEC

King Mongkut’s University of Technology Thonburi (KMUTT)

Research & Human Resource Development
A Case Study in Cassava Starch Industry

Extractor

starch  pulp
Biogas Technology - Anaerobic Fixed Film Reactor

A Biogas Plant at Chonchareon, Co.Ltd. in Chonburi Province
Reactor Size                12,000  m³
Organic Loading Rate       55,200  kg COD/day
Biogas Production Rate     17,600  m³/day
Fuel Oil Replacement       8,300   L/day

Start up                  Since November 2005
COD Removal               85-95%
Biogas Utilization
                         Since December 13, 2005
                         January 2006  13,050 L  (176,000 baht)
                         February 2006 56,420 L  (761,000 baht)
Waste Utilization and Management

- Open Pond System
- Phase I
  - Anaerobic Fixed Film Reactor
- Phase II
  - Anaerobic Hybrid Reactor
- Starch Production Process
Financial Support

- Energy Policy and Planning Office (EPPO) supports 20% of capital investment (~9 million baht)
- Soft loan from Company Directed Technology Development Program (CD), NSTDA
- Investment  40 million baht ($US 1 million)
- IRR 30%
Governmental Support for Biogas Technologies

2003 ENCON Fund
12 biogas demonstration plants for tapioca starch factories
166 million baht (30% of capital cost)
Wastewaters 25 million m³
4 agencies with different technologies
- Department of Energy Development and Promotion (DEDP) (4 factories – UASB)
- Department of Factory (3 factories – UASB)
- BAU, Chiang Mai University (2 factories – H-UASB)
- KMUTT (3 factories – Anaerobic Fixed Film Reactor)

Biogas generated 36 million m³
Electricity 44 MkWh/year
Fuel oil 22 million liters (174 million baht)
Anaerobic Digestion

Biological treatment/stabilization systems applicable to liquid, slurry, and semi-solid waste that collect and combust off-gases

1. hydrolysis
2. fermentation
3. acetogenesis
4. methanogenesis

complex organic matter
- carbohydrates, proteins, fats

soluble organic molecules
- sugars, amino acids, fatty acids

volatile fatty acids

acetic acid

H₂, CO₂

CH₄ + CO₂
Anaerobic Fixed Film Technology
Transfer of Anaerobic Fixed Film Reactor
INVENT – Integrated Waste Management modules for different courses of graduate studies

Impact

% starch produced

1 ton

72%

1.04 tons/ton starch
8 tons/200 tons

75%

5.5 million baht/day
1,100 million baht/year

Timeline
### Rice Flour Factory

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Capacity</td>
<td>350 ton/d</td>
</tr>
<tr>
<td>Wastewater</td>
<td>1,000 m³/d</td>
</tr>
<tr>
<td>Biogas Production</td>
<td>2,400-3,000 m³/d</td>
</tr>
<tr>
<td>or Electricity Production</td>
<td>3,000-3,500 KWh</td>
</tr>
<tr>
<td>COD reduction</td>
<td>4,560 kg/d</td>
</tr>
<tr>
<td>Reduce chemical cost</td>
<td>0.3 M.B/month</td>
</tr>
</tbody>
</table>

### Tapioca Starch Factory

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Capacity</td>
<td>200 ton/d</td>
</tr>
<tr>
<td>Wastewater</td>
<td>3,000 m³/d</td>
</tr>
<tr>
<td>Biogas Production</td>
<td>3.84 M.m³/y</td>
</tr>
<tr>
<td>Save fuel oil</td>
<td>1.8 M.Liter/y</td>
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<tr>
<td>Electricity Production</td>
<td>4.8 M.KWh/y</td>
</tr>
<tr>
<td>Reduce Pollution (COD)</td>
<td>7,680 ton/y</td>
</tr>
</tbody>
</table>
Cassava Starch Industry

Outcome

- Environment
- Energy
- Process Optimization
- Water Utilization
- Chemical Reduction
- Cost Reduction
Summary
- An Eco-Efficient Cassava Starch Industry -

- Efficient Production Process
- Efficient Natural Resource Utilization
- Good Product Quality
- Knowledge Transfer to the Whole Industry
- Strengthening the Industrial Competitiveness
- Profits to Industry
- Benefit Returns to the Farmers

ECONOMICS, ECOLOGY, AND ENVIRONMENT
Thank you for your attention!