Waste to Energy Technology for Clean & Recycle Society

21st March 2013

JFE Engineering Corporation
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2. Waste to Energy (WTE) Technology
   ● WTE in Japan
   ● WTE Technologies
   ● Pollution Control
   ● Excellent Combustion Control
   ● Latest Update
3. Recycle Business
Corporate Profile

JFE Engineering Corporation
JFE Group

Data in FY2011

since 1912

Merged in 2003

JFE Holdings

45.93%

NKK

Since 1951

JFE Engineering

Net Sales (million $)
3,600

Employees
7,400

JFE Steel

Net Sales (million $)
34,000

Employees
42,600

Japan Marine United

Net Sales (million $)
2,800

Employees
3,600

JFE Shoji Trade

Net Sales (million $)
27,000

Employees
1,300

Merged in 2003

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Global Network of JFE Engineering

Europe / Middle East
Frankfurt (Germany)
Rome (Italy)
Al Khobar (KSA)

China
Shanghai
Beijing
Hong Kong

South East Asia & Oceania
Singapore
Kuala Lumpur (Malaysia)
Jakarta (Indonesia)
Hanoi (Vietnam)
Ho Chi Minh (Vietnam)
Yangon (Myanmar)
Manila (Philippines)
Mumbai (India)
Brisbane (Australia)

Underline shows “Regional Head Office”
JFE Engineering
Experiences & Capabilities
on
Waste Thermal Treatment
<table>
<thead>
<tr>
<th></th>
<th>Stoker Furnace</th>
<th>Fluidized Bed Furnace</th>
<th>Gasifying and Direct Melting Furnace</th>
<th>hermoselect System</th>
<th>Stoker-Kilo Furnace</th>
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<tbody>
<tr>
<td>Continuous Operation</td>
<td>No marks</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Daily start-up and shutdown Operation</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
</tbody>
</table>
International Recognition

Prime Minister Mr. Najib (Malaysia)

Deputy Prime Minister Mr. Suwankiri (Thailand)

President Mr. Hu Jintao (China)

Director Gen. of MODON, Alrabiah (Saudi Arabia)

US Navy / UCLA (USA)
Waste To Energy Technology

JFE Engineering Corporation
Part 1.

WTE in Japan
World Waste Treatment

Source: CEWEP
60 million ton/y - MSW With 420 plants

Source: USEPA
29 million ton/y - MSW With 85 plants

33 million tons of MSW per year Goes To
1,243 Thermal Treatment plants

Source: Ministry of Environment
Japanese Waste Management Development

START WASTE MANAGEMENT
+ 1900 WASTE CLEANSING LAW
  > LOCAL GOVERNMENT RESPONSIBILITY
  > Controlled INCINERATION AS PRIORITY
+ 1903 Mechanical INCINERATOR Start


MODERN WASTE MANAGEMENT
+ 1970 WASTE MANAGEMENT AND PUBLIC CLEANSING LAW
+ Waste-to-Energy Plant START
  + 1990 DIOXIN Guideline
  + 1999 DIOXIN Law

THERMAL RECYCLING EMISSION CONTROL

RECYCLE
+ 1991 Promotion Law
+ 1995 Container/Packaging
+ 1998 Home Appliance
+ 2000 Recycle Basic Law
+ 2000 Construction/Food/Car

START WASTE MANAGEMENT

NO WASTE MANAGEMENT
+ 1880s~ PANDEMIC (CHOLERA, PEST, etc.)
+ OPEN BURNING
+ UNSANITARY ENVIRONMENT

PROTECT HUMAN HEALTH from UNSANITARY ENVIRONMENT

RAPID ECONOMY GROWTH brought
More Waste generation
Higher Waste Calorific Value
Improper Treatment

To SUSTAINABLE SOCIETY
Trend of MSW Generation and Treatment

MSW Generation (million t/year)

Percentage of incineration

Percentage of recycle

Fiscal Year

Source: Ministry of Environment (Japan)
Part 2.

WTE Technologies
Benefit from WTE

Power Generation

Heat Utilization

Material Recovery

Go to Landfill

Greenhouse Effect

Odor

CH4

$\frac{1}{30}$

(in volume)

$\frac{1}{21}$

CO2

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WtE Technology Trend (Japan)


▲ Modern Mechanical Incinerator

▲ Waste-to-Energy start

▲ Guideline to Melting Furnace

▲ Dioxin Laws & Regulations (98% Reduction achieved from ’97 to ‘03)

▲ Dioxins issue & RDF emerged

Stoker Furnace

Gasifying & Melting Furnace

Stoker + Ash Melting

Fluidized Bed
(1) **Proven Track Record**
130 plants since 1968

(2) **Advantages:**

1) **Minimum Discharge**
   Advanced Combustion Control
   High standard Air Pollution Control
   Prevention of Dioxins emission

2) **Large Capacity**
   Many track records of Large capacity

3) **Safe and Easy operation**
   Highly Developed Control System
   Stable combustion
(1) **Proven Track Record**
   10 plants (20 furnaces) since 2003

(2) **Advantages:**
1) **Applicable to Various Wastes**
   MSW, RDF, Sewage Sludge, ASR, Hazardous (medical) wastes, Excavated landfill wastes, etc.

2) **Minimum Discharge**
   - extended life of landfills
   - prevention of dioxin emission

3) **Safe and Easy operation**
   - no explosion/gas leakage risk
   - continuous slag extraction
Typical Flow of Stoker Plant

- Waste Pit
- Furnace
- Boiler
- Economizer
- Gas Cooling Tower
- Bag Filter
- Power Generation
- IDF
- Stack
- Fly Ash Silo
- LANDFILL

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Structure of JFE Hyper Grate System

- Waste feeder
- Stoker Grate
- Bottom ash
- Boiler
JFE Gasification: Advantages

Various Type of Waste

- MSW
- Waste tire
- RDF
- Hazardous waste
- Sewage sludge
- Landfilled Waste

Volume Reduction $\geq 97\%$

Power

- Boiler
- FGC

Fly Ash to Landfills (less than 3%)

Recyclables

- Slag
- Metal

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**Slag & Metal Recycle**

**Slag Leaching Test**

<table>
<thead>
<tr>
<th>Items</th>
<th>Standard</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Pb (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Cr^+6 (mg/l)</td>
<td>≤ 0.05</td>
<td>&lt; 0.04</td>
</tr>
<tr>
<td>As (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Hg (mg/l)</td>
<td>≤ 0.0005</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>Se (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

**Metal Leaching Test**

<table>
<thead>
<tr>
<th>Items</th>
<th>Standard</th>
<th>Test Result</th>
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</thead>
<tbody>
<tr>
<td>Cd (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
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<tr>
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<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Cr^+6 (mg/l)</td>
<td>≤ 0.05</td>
<td>&lt; 0.04</td>
</tr>
<tr>
<td>As (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>T-Hg (mg/l)</td>
<td>≤ 0.0005</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>Se (mg/l)</td>
<td>≤ 0.01</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

**Back-filling Material**

**Concrete Product**

**Asphalt Aggregate**

**Recycle**

**Counter Weight**

**Copper Recovery**
Part 3.
Pollution Control
Reducing DIOXINs

1. LOW Dioxin Generation
   - Homogenizing wastes by crane
   - Good Mixture of various waste characteristics

2. Inhibit Dioxin re-generation
   - Dust Removal in boiler
   - 3Ts
   - Sufficient capacity of waste pit
   - Stable Feeding
   - Flue gas Temp = Above 850 deg.C
   - Residence Time = more than 2 sec.
   - Turbulence

3. Dioxin REDUCTION
   - Quick Quench Of flue gas
   - Avoiding Dioxin re-generation temperature
   - Absorption by Activated Carbon
   - Dioxin conc. 0.1ng-TEQ/mN^3
   - Destruction by SCR
   - Stack

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## Dioxin Measurement

<table>
<thead>
<tr>
<th>No.</th>
<th>Facility</th>
<th>DXN Reduction Technology</th>
<th>Emission Standard ng-TEQ/Nm³ (Standard 0.1000)</th>
<th>Measured Result ng-TEQ/Nm³</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Two-way Flue Gas Furnace</td>
<td></td>
<td>0.000043</td>
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<tr>
<td></td>
<td></td>
<td>Hybrid ACC</td>
<td></td>
<td>0.000043</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boiler + Gas Cooling Tower</td>
<td></td>
<td>0.00270</td>
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<tr>
<td></td>
<td></td>
<td>Activated Carbon Injection</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>SCR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>S-City 90 t/d × 3</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2</td>
<td>K-City 140 t/d × 2</td>
<td>○</td>
<td>○</td>
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<tr>
<td>3</td>
<td>O-City 450 t/d × 2</td>
<td>○</td>
<td>○</td>
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<tr>
<td>4</td>
<td>K-City 150 t/d × 1</td>
<td>○</td>
<td>○</td>
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<tr>
<td>5</td>
<td>R-City 90 t/d × 2</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>6</td>
<td>Y-City 400 t/d × 3</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>7</td>
<td>M-City 135 t/d × 3</td>
<td>○</td>
<td>○</td>
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</tr>
</tbody>
</table>
WTE Plant Harmony with Town

M-plant

Completion: March 1991
Capacity: 300ton/day x 2 lines
Power Output: 11,000 kW

WtE Plant
Hospital
School
Train Station

500m

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**WTE Plant Harmony with Town**

**E-plant**

- Completion: January 1997
- Capacity: 300ton/day x 2 lines
- Power Output: 12,300 kW

Diagram showing the location of the WTE Plant relative to the hospital, school, and train station within a 300m radius.
Realizing Low DXNs/CO and NOx

Achieves “3T” for Dioxins Reduction
- T1: High temperature (850-950 deg C)
- T2: Retention time (2 sec)
- T3: Turbulence

Secondary Combustion Zone
- For unburned gas: Oxidation reaction
  \[2 \text{CO} + \text{O}_2 \rightarrow 2 \text{CO}_2\]
- For combustion gas: Reduction reaction
  \[\text{NOx} + \text{NH}_3 \rightarrow \text{N}_2 + \text{H}_2\text{O}\]

Unburned gas
- CO, H\(_2\), NH\(_3\)

Intermediate ceiling

Combustion gas
- O\(_2\), NOx, CO\(_2\)

Low CO(DXN)

Low NOx
Part 4.

Excellent Combustion Control

Maintain Performance even for LOW calorie MSW
LOW Calorie Waste Combustion
Stable Combustion

Waste Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>50～60</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>18～23</td>
</tr>
<tr>
<td>Burnable (%)</td>
<td>22～27</td>
</tr>
<tr>
<td>Lower Heat Value (MJ/kg)</td>
<td>4.7～5.8</td>
</tr>
</tbody>
</table>

Data / Photo from Qingdao(China) plant

GOOD STABLE COMBUSTION

- Combustion completes before end of combustion stage
- No outstanding flare

In this stage...
LOW Calorie Waste Combustion
Better Bottom Ash Quality

Effective Radiation
Better Bottom Ash Quality!

Less Unburnt
Less Organics to Final Landfill

Intermediate ceiling

Ash with Unburnt
Enough Experience of Wide Range Waste Heat Value

- Y-city (900tpd)
- F-city (600tpd)
- T-city (600tpd)
- Y-city (1,200tpd)
- O-city (900tpd)

LHV of Waste (kJ/kg)

LHV history of MSW in Design condition

- Hu=max
- Hu=ave
- Hu=min

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Part 5.

Latest Updates
Biomass briquette can replace Coke

CO₂ Reduction: 50%
(comparison with using coke only)
WtE : Integrated Approach

Wastes
- E-Wastes
- Plastics
- Industrial Wastes
- C & D
- MSW
- Organics (Kitchen Wastes)
- Sewage Sludge

Pre-Treatment
- MRF
- RDF Plant

Conversion
- Stoker
- Gasification
- Digestion

Utilization
- Recycling
- Power
- Recycling
- Gas Fuel
- Solid Fuel

Recycling

Solidification Plant

Power
Recycling Business

JFE Engineering Corporation
**Recycling Business Sector**

- Refuse Treatment & Recycling
- Waste Collection/Transportation
- Refuse-Derived Fuel (RDF) Power-generation

**Areas of Focus**

- **Fukuyama - Kurashiki area**
  - RDF Power-generation
  - Biomass Carbonization

- **Sendai area**
  - Plastic/Fluorescent Lamp/Wood waste Recycling

- **Yokohama-Kawasaki - Chiba area**
  - Fluorescent Lamp Recycling
  - E-Waste Recycling
  - Food Recycling

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Recycling Business Sector

- Home Electric Apparatus Recycling
- Pet Bottle Recycling
- Fluorescent Light Recycling
- Plastic Waste Recycling
Thank you

Further info. Available in

http://www.jfe-eng.co.jp/en/