Benefits of the self-heat two stage biomass gasification facility

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Today’s morning news show

Take Proper Treatment!!
Current Status of Energy Production in Japan

Source: Japan Ministry of Economy, Trade and Industry

- Coal
- Oil, LPG
- LNG
- Nuclear Power
- Hydro Power
- Renewable Energy
- Other fossil fuel

The Great East Japan Earthquake

Japan Ministry of Economy, Trade and Industry
Forest land = Japan land

Forest Cover Ratio = 251,000km² / 378,000km²

66%

HP: Learning museum of the Forest and Forestry
Each Country’s Forest Cover Ratio

FAO 「Global Forest Resources Assessment 2010」
Natural Forest vs Planted Forest

Natural Forest, ~50%

More than 80% are Broad leaf forest.
e.g. Quercus, Fagus crenata, Betulaceae

Planted Forest, ~40%

More than 90% are Conifer forest.
e.g. Cedar, Cypress, Larch trees

HP: Learning museum of the Forest and Forestry
Before and After Forest Thinning Operation

Role of thinning operation
Public function of Forest
/ Water Source
/ Purify water
/ CO2 absorption
/ Prevention of landslide disasters
Timber from forest thinning

Much of Unused Woody Biomass

- e.g. Saitama District
- Very low availability

Discarded timber

Strip road for timber collection
Reconstructing of Regional Forestry

Regional Economy

Intermediate work field

Biomass

Row Lumber

External Economy

Wood chip yard

Wood Distribution

Lumber

Forest Management

Biomass power generation

Hydrogen Production

Society’s needs are not just for regional area, but for Urban area
Large scale biomass power plant, Steam Boiler Type

e.g. Hitachi Company, Japan
Supply for 12,000 households
Initial cost: 25,000,000 Euro
Running cost: 2,083,000 Euro

(Yomiuri 17 Jan, 2016)

Small scale biomass power plant, Gasification Type

Many trials were carried out
But, stopped by Tar Removal
Running cost: ??? (not opened)
Self-heat two stage biomass gasification facility
Power Plant

Water vapor boiler

Gasification furnace

Heat Source

Carbonizing furnace

Power generation + Hydrogen production

$H_2, CO, CO_2$
Woody biomass chips (water content: 55%)

Drying

Carbonizing furnace

Gasification furnace

Exhaust gas treatment

Atmosphere

Dried chips

Heat source

Carbon content > 90%

Unreacted char

Around 2% of input

Power generation

Power generation + Hydrogen production

Hydrogen production

Water gas

H₂O

60% H₂, 20% CO, 20% CO₂

60% H₂, 20% CO, 20% CO₂

TEMP 400°C 700°C 1000°C

PROCESS for CARBONIZATION THERMAL DEGRADATION THERMAL DECOMPOSITION CARBONIZATION : Bincho-tan

PERCENTAGE OF CARBON 56% 72% 92% 95%
Japan Traditional Technique

- **White Char Production**

  - Control air to burn wood.
  - Temperature inside the Kiln reaches 1,000°C.

  **Stop burning by Ash covering White Char**

  Temperature control, material.
**Carbon, Nitrogen, and Hydrogen content of Char**

**4 days continuous trial**

<table>
<thead>
<tr>
<th></th>
<th>Carbon</th>
<th>Nitrogen</th>
<th>Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>White char</td>
<td>92.1%</td>
<td>0.23%</td>
<td>0.45%</td>
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**Graphs showing the time variation of carbon, nitrogen, and hydrogen contents over 4 days.**
Impurity-free, Hydrogen rich gas production

Gasification reaction at 700 C
C + H₂O → CO + H₂

Shift reaction
CO + H₂O → CO₂ + H₂

(H₂, 57.99%)
(CO₂, 18.83%)
(CO, 16.69%)
(N₂, 5.6%)

水性ガス組成（ガスクロ測定）
Comparison with lower temperature treated Char

**Graph**

- **Surface Area**
- **Total Pore volume rate**
- **Meso-pore Volume rate**

**Axes**
- **Surface Area m²/g**
- **Carbonized Temperature, C**

**Data Points**
- 700°C: Surface Area, 70°C, Total Pore volume rate, 50°C, Meso-pore Volume rate, 0°C
- 900°C: Surface Area, 100°C, Total Pore volume rate, 70°C, Meso-pore Volume rate, 0°C
- 1100°C: Surface Area, 150°C, Total Pore volume rate, 100°C, Meso-pore Volume rate, 0°C
Land use map of Ara-river Basin
Saitama-Tokyo district

Population: 930 million
Economic damage: 78 trillion Yen
Policy Recommendation

Independent power supply for evacuation

- Financial support for Conservation of Forest environment
- Woody Chip Supply
- Stock of Chip for emergency
- Promote of Urban Greenery
summary

The two-stage gasification facility that makes it possible to keep temperature of each stage was constructed.

Stable supply of the aqueous gas and the homogenization of the quality has been demonstrated.

Future Plan

Unreacted Char can be used to produce “Activate Charcoal” using released CO2 gas.

Reaction by CO2 can be done at 850 C. The facility can supply for 850 C air.

Net balance CO2 will be decreased !!