

Case study

Production of Fuels from Waste & Biomass by the EDDITH Thermolysis Process Recent Industrial Developments

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Who We Are

- **Institut Français du Pétrole**

The Institut Français du Pétrole (IFP) is an independent RTD, education, training, and information center active in the fields of oil, natural gas, biofuels, automobile, and energy.

IFP is in charge of the technical development of the EDDITH process.

Visit the internet site : www.ifp.fr



- **Thide Environnement**

SME active in the field of waste/biomass treatment and in charge of the commercialisation of the EDDITH Process all over the world.

Visit the internet site : www.thide.com



Waste Disposal : key factors

- **Regulation factor**

- ↳ Landfill suppression
- ↳ Priority for material recycling and valorisation

- **Mediatic factor**

- ↳ The « NIMBY » syndrome : Not in My Back Yard
- ↳ Dioxin and furan emissions
- ↳ Incineration health impact
- ↳ Climate change

- **Economical factor**

- ↳ Waste quantities are growing
- ↳ The number of waste fields are growing



The waste market needs new solutions



EDDITh Thermolysis Process

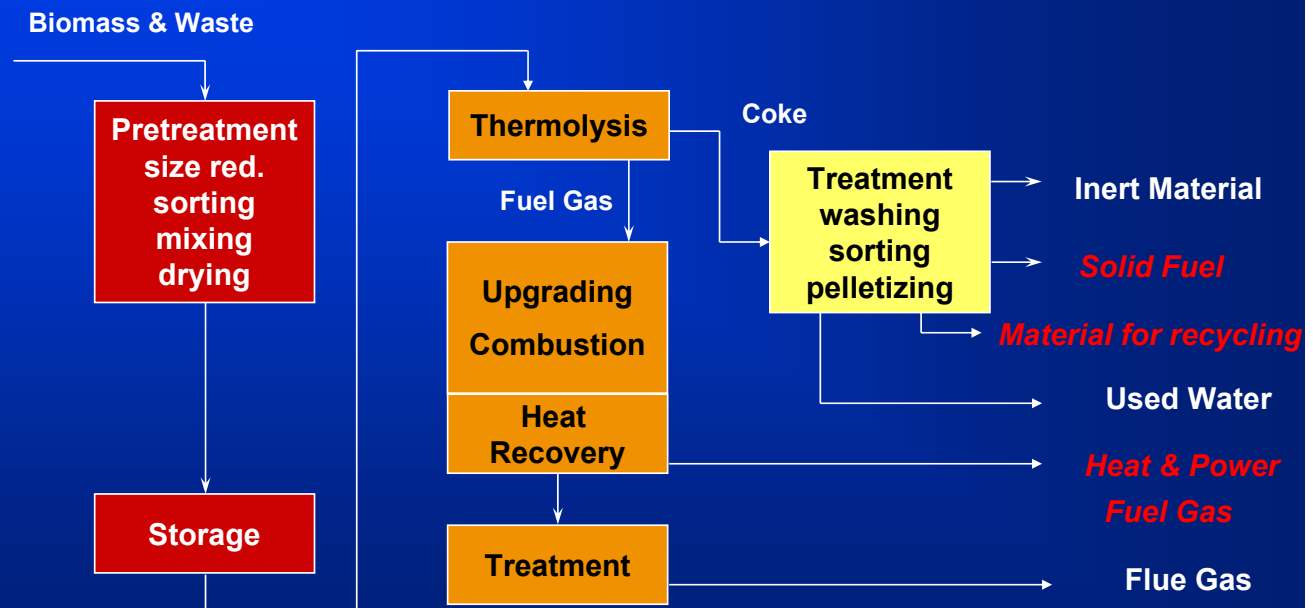
Objective : Energy and/or fuels production from biomass & waste with a clean, efficient and flexible thermal technology.

- Fuel gas
- Solid fuel (Carbor®)
- Heat
- Power
- CHP (Combined Heat & Power)

↑ **Development of the EDDITh Thermolysis (pyrolysis) process**



EDDITh Process : Block Flow Diagram



Slow or conventional pyrolysis process

- ≈ 10 % moisture feedstock
- Limited size requirements
- Indirectly heated rotary kiln
- Heating rate : 10-50 K/min.
- Final temperature between 400 and 700°C
- Residence time between 45 et 60 minutes
- Atmospheric pressure
- Absence of oxygen

- Pollutants abatement is performed inside the kiln

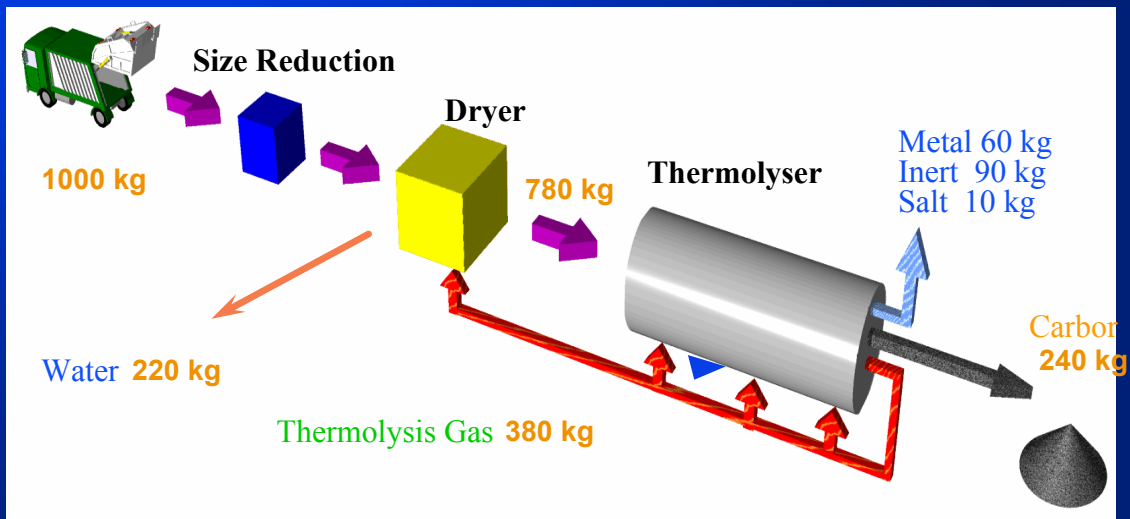
- **Waste**
 - MSW (sorted, raw, dry, RDF...)
 - Auto Shredder Residue
 - Industrial Waste (papers, plastic, tires...)
 - Electronic Waste
 - Sewage Sludge
 - Refuse from Recycling Processes
 - Refuse from Methanisation & Composting
- **Biomass**
 - Wood Chips, Forestry Residue...
 - Treated Wood
 - Farming Waste

Process developments have been made using a 0,5 t/h pilot plant located in Vernouillet (France)



Simplified Mass & Energy Balance

Case of the Arthelyse Plant : MSW / IW / Sludge



Solid fuel = 45 % of the waste energy content

Gas composition - MSW 10% H₂O

Thermolysis products

Raw Gas		49%
%W	H ₂ O	23 %
%W	tars	6%
%W	gas	20%

Gas composition (dry basis)

	H ₂	CH ₄	CO	CO ₂	C ₂ H ₄	C ₂ H ₆	C ₃ +	LHV
% Vol	12,7	16,0	19,1	28,8	5,5	4,9	13,0	23,1 MJ/kg

Fuel gas valorisation

- **Burner combustion**
 - process heating
 - heat
 - power
- **Gas conditioning**
 - scrubbing
 - thermal and/or catalytic cracking
 - engine or gas turbine

Solid fuel valorisation

- **Combustion**
 - process heating
 - heat
 - power
- **Solid fuel conditioning**
 - remove ash and metals
 - leaching, washing, flotation
 - sorting, decanting
 - blending & pelletizing

The process requires ~ 20% incoming energy for drying and thermolysis (MSW. Arthelyse plant)

- Homogeneous composition
- Easy to handle and store
- No evolution upon storage
- Excellent combustion behaviour
- Characteristic and grade of that fuel may be adapted to its final use



Custom-made grade for specific applications :
From raw fuel to high grade quality fuel (no ash, no metals)



Comparison Carbor - Solid fuel - Waste

	M.S.W.	Carbor	Coal South Af.	Mixed Wood	A.S.R.
LHV (kcal/kg)	1 900	4 300	6 775	3 865	4 000
Volatile matter (%)	70	15	30,5	78	60
Ash (%)	25	38	11,2	4,9	25
C (%)	37	50	73	46,1	60
H (%)	4	1,6	4,1	6,3	9,2
O (%)	30	-	9,4	40,5	27,7
N (%)	0,5	0,6 -1,6	1,8	2,4	1,3
Cl (%)	1	<0,5	<0,01	0,12	1,2
S (%)	0,5	<0,5	0,8	0,11	0,5
Cd (ppm)	5	14	1	<5	1 000
Cr (ppm)	70	90	30	40	500
Pb (ppm)	300	620	10	405	5 000
Zn (ppm)	650	1 350	-	870	8 000
Hg (ppm)	4	0,2	1	2	4

Raw Carbor from MSW

Pyrolysis & Gasification of Biomass & Waste - 30/09/02



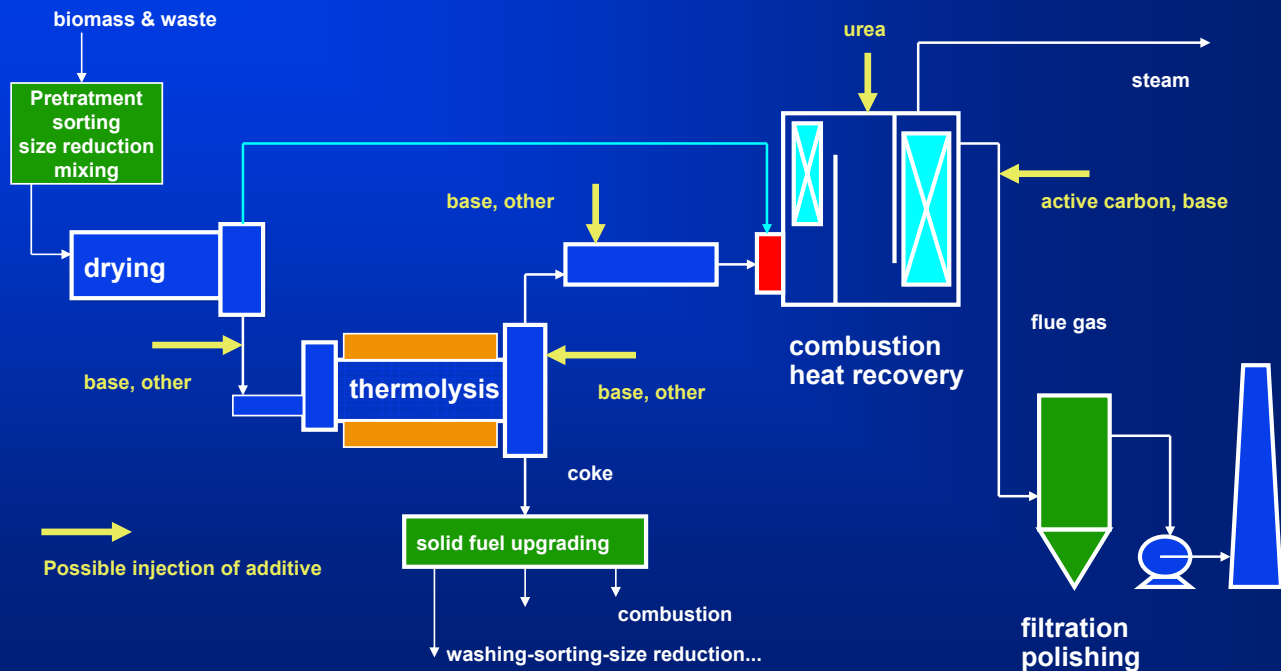
Solid Fuel Use

- Existing facilities in substitution of fossil fuel
 - Cement or lime industry
 - Steel Industry
 - Metal recycling industry
 - Power production
 - Cofiring
- Dedicated facilities for CHP
 - Fluidised bed boiler
 - Slagging boiler

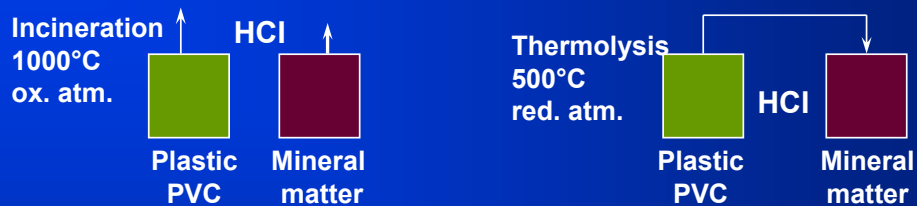
These applications have been demonstrated at industrial scale

Pyrolysis & Gasification of Biomass & Waste - 30/09/02

Pollutants reduction strategy



Acid pollutants capture



- Non-organic chlorine is not volatilised (NaCl, KCl...)
- Chlorine capture by a dry phase mechanism
- Efficiency is a function of :
 - ♦ temperature & gas composition
 - ♦ gaseous flow pattern
 - ♦ initial chlorine content and waste « basicity»
 - ♦ Efficiency may be improved by adding basic additive

↑ 80% to 90% HCl is captured inside the kiln without basic additive



Pollutants reduction strategy

- **Acid Gas : HCl, SO₂, HF**
 - Low emissions due to favourable operating conditions
 - Adding of basic additive inside the kiln
 - Polishing with fabric filter
- **Organic compounds & PCDD/PCDF**
 - Gas combustion in a burner
 - Polishing with fabric filter
- **Heavy metals**
 - Not volatilised (ex. Hg)
 - Polishing with fabric filter
- **Nitrogen Oxides**
 - Low NOx burner
 - Air staging
 - EGR
 - Urea SNCR
- **Particulate**
 - Fabric filter
- **Limited volume of flue gas**



Industrial developments

- A licence of the process has been sold to Hitachi Ltd for the Japanese Market in 1999.
- One 10 000 t/y MSW demo-plant has been successfully erected and operated in Japan since 2000
- **Three commercial plants in Japan**
 - Itoigawa plant : 20 000 t/y MSW
 - Izumo plant : 70 000 t/y MSW under construction
 - a 40 000t/y plant under construction

↑ In 2001 in Japan, 50% of the new MSW treatment plants were pyrolysis & gasification plants !



Demo. plant 10 000 t/y in Japan

Hitachi-Ibaraki prefecture - 10 000 t/y of MSW



↑ PCDD/PCDF emission $\approx 0,01 \text{ ngTEQ/Nm}^3@11\%O_2$

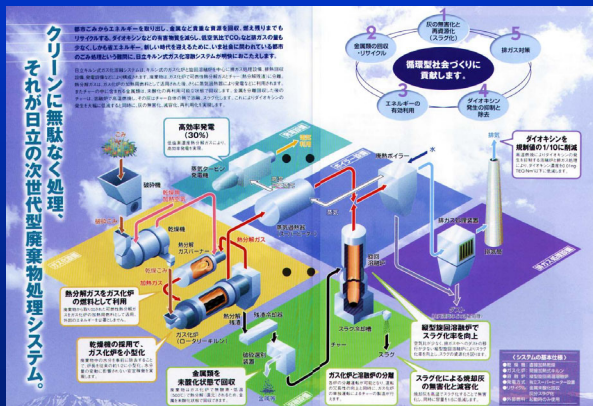


Commercial plants in Japan

ITOIGAWA Plant
20 000 t/y MSW

Fuel gas used for the process heat
Solid fuel used by a cement kiln

Running since mid-2002



Arthelyse Project : Thermolysis Plant of Arras Urban Area

- 50 000 t/year (MSW / Industrial Waste / Sludge)
- Two operating lines
- EU directive 2000/76/CE and NOx 80 mg/Nm³ (IFP' SNCR Process)
- Steam production (chemical plant)
- Solid fuel is used by a metal recycling plant

- Investment : 22 M€
- Treatment cost : 85 €/t
- Construction is running
- Start-up operations : late 2003
- Plant Operated by Thide



- **The process development has been made in France (ADEME funding) but, the demonstration of that European process has been made in Japan : Japanese industry has taken risks that the European industry didn't want to take !**
- **Status of the solid fuel Carbor**
 - waste or fuel or Refuse Derived Fuel
 - renewable ?
- **Process flexibility is a key of success (energy valorisation)**
 - gas upgrading and conditioning
 - solid fuel upgrading and conditioning
 - heat or CHP

Advantages of the process

- Suitable for a large range of waste and biomass feedstock
- Limited feedstock requirements
- Simplified air pollution control
- Excellent environmental performance
- Recycling of materials is facilitated
- Process may be oriented for fuel-gas or solid fuel production
- Flexibility of energy recovery

- Lower investments and operating costs than conventional treatment technologies
- Industrial scale proven technology

↓ **EDDITH Process: the proven Thermolysis Solution**

- Alternative to conventional waste thermal treatment technologies in the range 10 000 to 80 000 t/y
- Excellent acceptance by citizen and local authorities

- Remaining developments
 - Gas upgrading and conditioning for firing in gas turbine or engine
 - Develop the use of the solid fuel as a cofiring fuel
 - Adapt the process to biomass fuels (CHP<10 MWe)

- EDDITH process : a process for the emerging “Carbon Economy”