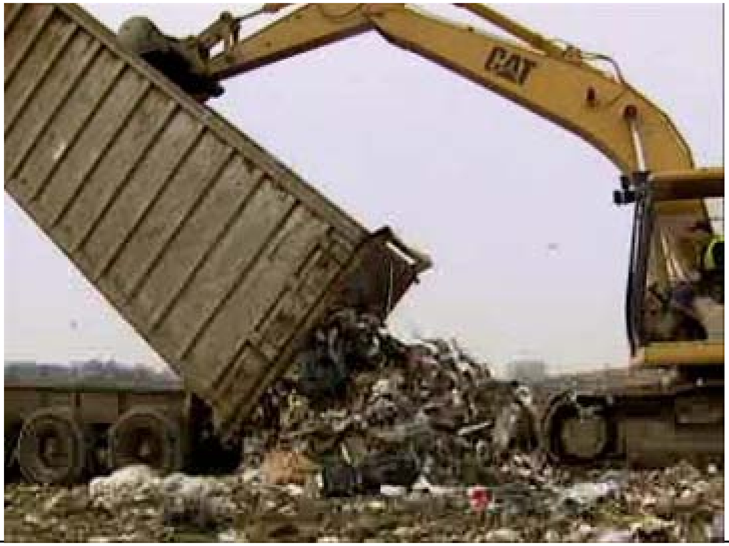
CAGED CATALYST CONVERSION OF WASTE TO PETROLEUM FUELS

Innovator: Sustainable Technologies & Environmental Projects, Ltd.



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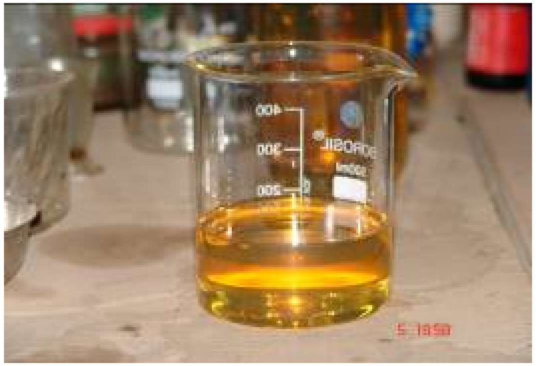
WASTE

COMBUSTIBLE GAS



CLEAN FUEL

Converts most hydrocarbon based materials into liquid, gas and solid fuels including:

- All plastics including hard plastics
- Dirty plastics
- Electronic waste
- Auto fluff
- Bio-medical waste
- Slaughterhouse waste
- Animal fats
- Petroleum sludge
- Sewage
- Organic matter
- Petroleum byproducts

Example of Plastic Waste Conversion to Petroleum

- Converts waste plastics to:
  - liquid fuel (~ 80%) | LP gas (~15%) | solid coker fuel (~5%)
- E.g. 1 kilogram of polypropylene plastic feedstock will yield approximately 1.2 liters of liquid fuel in these approximate proportions:
  - 50% 92-octane gasoline
  - 35% 56-cetane diesel (sulfur free)
  - 10% high grade heating oil
  - 5% naphtha
- Integrated fractional distillation that separates each of these 4 fuel outputs.
- Approximately 15% of fuel production is LP gas (mixture of propane and butane) providing the converter's internal heating fuel.
- Small output of naphtha powers electrical generator providing all required electric energy.
- Plant energy requirement: 1) Self-sufficient and 2) Site location flexibility.
- Cost to convert plastic waste to 1 liter of fuel: ~ $.26
  Inclusive of 5 yr plant capitalization (expected life:10+ yrs), interest, labor & catalyst

Mixing Waste, Emissions & Exposure

- All types of plastics can be used and they need not be pre-cleaned.
  - Accepts electronic waste without having to separate metal or other matter from plastic. Metals collect at bottom of converter.
  - Handles mixes of plastics, plants, waste—separation not required.
- No dioxins or other hazardous emissions produced during conversion process.
- HCL acid from PVC converted to chloride salt by reagent.
- Hydrogen Bromide (HBr) acid from computer plastics absorbed by the catalyst.
- Emissions:
  - Emissions NOx (mg/kWh) < 150
  - Emissions CO (mg/kWh) < 15
  - Sulfur dioxide: no sulfur in fuels production thus no sulfur dioxide emission.
  - Bag filter integrated into chimney captures almost all particulate matter.
- Catalyst exposure can be controlled selectively: Eg: If more LP gas is needed, catalyst can be adjusted automatically to provide more LP & less liquid fuels.

Bio-Fuel Production example: Processed oil palm fruit plant

- **Oil palm fruit: most widely produced vegetable oil.**
  - Fruit put into autoclave: most of plant oil evaporated then condensed into an oil.
  - These oils constitute ~ 20% of the plant weight.
  - The plant remains are typically dumped.
- **Caged catalyst processing of the empty or processed oil palm remains:**
  - Using the processed remains, this process recovers the remaining oil and refines it into fuel grade bio-diesel (56-cetane).
  - 15% of the weight of the processed plant is converted to bio-diesel.
  - 50% of the weight of the processed plant is converted to olefin rich methane gas.
  - The non-esterification process produces no glycerin:
The fuel requires no blending to obtain motor grade specifications for flow & flashpoints.
- **The catalyst is the key component: this 1 catalyst converts a wide array of substances.**
- **Significance:**
  - Malaysia has 300 mills each processing ~ 50 tons/day of oil palm fruit.
  - Indonesia processes 3X that amount.
  - Each mill dumps approximately 40 tons/day of processed oil palm fruit.
  - Besides bio-diesel production, carbon credits from the recovery would be significant.
  - Very efficient bio-diesel conversion for other plants.

Competitive Systems

1. **ALPHAKAT**
   - Uses Nano-Alumina Catalyst.
   - Considerable residue discharge problems.
   - Plant in Germany known to have heavy residue & emissions.
2. **OZMOTECH**
   - Uses catalytic converter.
   - Cannot process all types of plastics.
   - Requires clean plastics
   - High capital cost due to low processing efficiency.
3. **Plas2Fuel**
   - Uses chromatographic separation: absorbant materials such as zeolite & silica gel placed in a column. Contaminants adsorbed forming a molecular film on column.
   - Accumulation of contaminants on columns occurs rapidly requiring frequent cleaning & recharging with a solvent such as methanol otherwise they clog.
   - Cannot retain HCL acid produced by PVC plastics.
4. **Traditional Recyclers**
   - Recycle approximately 5% of total plastic waste generated (EPA)
   - Require clean plastic (dirty plastics not accepted)
   - Process only thermal plastics (thermo-set plastics not accepted)

Development Status

- 3 small prototypes functioning in India, Malaysia and the Netherlands (only 5kgs/hour capacity).
- Testing of Catalyst in November, 2007 by Department of Chemical Engineering, University of Texas at Austin.
- 500 LB/day Prototype completed October, 2007.
- 5 ton/day & 25 ton/day plants scheduled for mid and late-2008.