Energy From Waste
or
Waste-to-Energy

Pyromex

The Solution to Multiple Energy & Environmental Issues

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Agenda

• Who is PowerHouse Energy
• What is Pyromex
• How Does Pyromex Work
• History of Pyromex
• Questions
PowerHouse Energy
Who we are: Energy Specialists

- On-site Power Generation (CHP) - Waste-to-Energy
- Clients are commercial, industrial & institutional & developer markets
- Provide sales and support of turnkey installations
- Bridge between leading commercial technologies and the end-user
- Recognized “CHP Partner” by US EPA
- Offices in California and New Jersey
- Participated in “Fuel”, an Academy Award winning screen documentary film about renewable energy
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Our CHP Experience

Open-technology approach: complete portfolio of equipment to tailor the right solution for each client

Nestle Purina Pet Care, Maricopa, CA

Lean Burn I/C Engines: 85kW-3+MW

Fuel Cells: 300kW-2.4MW

Microturbines: 30kW-250kW

Leading Alternative Energy Solutions
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Our Clients

Constellation Wines

Nestlé PURINA

San José Unified School District

Sempra Energy

Embassy Suites Hotels

We build strong kids, strong families, strong communities.

United States Department of Energy
Oak Ridge Office

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Moving Forward in the Clean Energy Business

As Combined Heat & Power Specialists, We:
- Identify the proper solution, design, permit, construct and service
- Employ highly efficient and clean technologies
- Locate on-site allows for the advantage of heat:
  - Capture electrically generated thermal energy to
  - Further reduce emissions and fuel use

Waste-to-Energy: Capitalize on our power generation experience
- Ultra-high temperature conversion of trash, biomass and biogas into a renewable fuel source
- Logical pairing with generation equipment
- Compelling benefits:
  - Economic savings from reduced energy usage and tipping fees
  - Environmentally responsible “clean” and “green” energy
The Solution

**PYROMEX**

A Carbon Neutral Waste-to-Energy Process

Ultra-High Temperature Gasification

- Ultra-high temperature (>1100°C) gasification is the destructive distillation of organic materials.
- This distillation process involves the application of intense, indirect thermal energy in the absence of oxygen which reduces the material to a combustible gas and a hazard-free, non-leachable inorganic recyclable material.
Gasification System

Pyromex Ultra High Temperature Gasification Reactor Technology
Typical Material Flow

Project Specific
- Pretreatment
- Storage

Pyromex Standard
- Infeed
  - GASIFICATION
    - Inert Material
    - Syngas
    - Off-Heat
      - Gas Motor
      - Heat Exchanger
      - Electricity Generator
      - Heating / Cooling
      - Electricity
        - Market
        - Own Consumption

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The Pyromex System
1. Waste material (feedstock) such as tires, plastics, woody biomass, municipal solid waste, hospital waste etc. is placed in the processing hopper bin.
2. The feedstock is run through the primary shredder to break the material down into 6-12” chunks.
3. The shredded feedstock and recyclable material is conveyed to the secondary re-shredder where it is further shredded into pieces of 1” minus in size.
4. As the material is being shredded here, it separates and sorts out the recyclable materials such as glass, ferrous and non-ferrous metals. The remaining material is referred to as a refuse derived fuel (RDF).
5. The RDF is conveyed to a storage bin prior to entering the Pyromex gasification feed tank system.
1. The RDF is conveyed from the storage bin to an oxygen purge feed tank system. Nitrogen is used to displace oxygen in the feed tanks to attain an oxygen free environment so that the oxidation level is controlled in the gasification phase. The only oxygen utilized in the system is the O2 molecule in water that is in the feedstock material (moisture content between 20%-30%).

2. RDF is conveyed into the water-cooled, reformer tube that operates at ~1150º C.

3. The chamber rotates RDF while heated by an electrical resistance element. The RDF converts (gasifies) into a syngas in a combustion free environment.

4. The syngas and any remaining solids are passed forward for gas clean up.

5. The remaining solids, a benign, inert residue, are dropped out into a collection bin for reuse as a recyclable material such as aggregate for cement.
1. The syngas is sent to a combination water quench and scrubbing process where the syngas is quenched, cleaned and cooled to ~100°C.

2. The resulting syngas typically has an energy content in the range of 350-500 BTU/SCF. The BTU content of the syngas may be adjusted down-stream by a steam shift reaction to increase hydrogen and then increasing the methane content by a methanization process.

3. The syngas can be pressurized and stored, if needed, for the customer’s application.

4. The syngas is delivered to the intended application such as power generation, boiler fuel or other uses.
1. The syngas is fed into the gas train of the generators.
2. The generator(s) provide electricity to the client site or for export to the grid.
3. The thermal heat of the generators (exhaust and jacket) may be used to provide hot water, steam or chilled water (via an absorption chiller).
Standard 25 tpd Unit
25 tpd Reformer

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Typical Waste to Gas Results

Output gas concentrations depend on input materials
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Advantages of WTE Solution

• **Ecological Recycle of Waste:**
  – No harmful emissions to the atmosphere (closed loop-no smoke stack)
  – No dangerous residues to dispose of after treatment
  – Treatment of waste/biomass, incl. hazardous and toxic material
  – Meeting the highest environmental regulations - permitted in Germany

• **Efficient:**
  – Optimum recovery of energy contained in the waste/biomass
  – Total conversion of the organic waste content to fuel gas
  – Highest energy recovery (power output per ton)
  – Simple operation- only a few moving parts

• **Economical:**
  – Lower investment, operating and maintenance costs than digesters
  – Valuable renewable energy produced as a product
  – Customer oriented modular, adjustable setup with small footprint
  – Very low energy requirement
Uses for Output Syngas

**Syngas**

- Direct Use
- Liquefaction (Future Development)
- Gas Engine
- Gas Turbine
- Fuel Cell
- Dryer

PowerHouse ENERGY
Leading Alternative Energy Solutions
100 tpd Pyromex
WTE Facility
150’ x 150’

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Pyromex History to Commercialization

  - Result: Proof of concept that temperatures of 1150°C or higher can fully destroy all organics in the waste and produce ultra clean syngas.
  - Industrial size 25 tpd Pyromex system, applied for first patents.
  - Established proof of concept for commercial application for processing Bio-solids or sludge to an efficient way to process sludge into a energy source; while producing a non-leachable benign solid residue from the inorganic waste.
  - Plant operated for one year 3-5 days a week.
  - 3,600 hours of plant operation with 11 days continuous
  - 300 thermal cycles that determined proper metals and coatings of choice for the Pyromex technology.
  - Program completed. Commercial viability established.
• 2002-2005: Pyromex Sludge Processing Plant 25 tpd in Neustadt, Germany
  – Industrial size 25 tpd Pyromex system for commercial use.
  – Implemented new metals and coatings in the design of the reformer
  – Demonstrated the use of syngas for drying of sludge waste and boiler use.
  – Plant permitted for 3 years on using municipal waste water sludge from a local sanitary sewer system.
  – Began to test other carbonaceous materials to be processed and utilized in the Pyromex UHT gasifier.
  – Poor site location: the waste water facility did not maintain the proper standards for German government and the waste water treatment facility was closed.
  – The site operated for 6 months, 90 days of continuous 24 hour operation with 7 days between shutdowns. Over 50 thermal cycles.
Pyromex History to Commercialization (cont)

• 2006-2007: Pyromex moved operations to Munich, Germany. Built and operated a 1 tpd testing facility where a variety of different feedstocks were gasified into syngas that was used in a variety of energy systems.
• 2008-2010: Contracted with Kompostwerk (MSW transfer station) Am 1 Eitting 85462 Germany to gasify 25 tpd of post sorted RDF (Refuse Derived Fuel) to electricity. Fully permitted by local government and supported by the EU.
• 2010: PHE executes international license for manufacture, sales and service and made equity investment in Pyromex for 30% share.
• 2011: Pyromex AG accepts first commercial orders.
• 2012: PHE will manufacture systems in Carson City, NV and set this site up as a demonstration and testing site (early 2013).
Thank you for your time and consideration

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