

Emerging Technology Forum

“European Experience”

Pyromex Ultra-High Temperature Gasification
Implementation in Germany

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Presented by
Rick Diederich
ILS-Partners
1 Como Circle
Palm Desert, CA 92211
Tel 760-568-9369 info@ils-partners.com

Project Description

- Develop a commercial scale Pyromex Waste-to-Energy facility to gasify waste water sludge in Emmerich, Germany
- In-feed material consists of the waste water treatment solid residue
- In-feed material composition is 80% moisture and 20% solids
- Process consists of drying material 20% to 30% moisture content
- Pyromex Ultra-High Temperature was permitted for operation by the German Ministry of the Environment in late in 1999
- Facility was operational for over 3 years and met all environmental and emission regulations
- Equipment moved to a waste water treatment facility in Neustadt, Germany for commercial operation

Permitting and Regulations Considerations

- EU differentiates gasification from incineration
- Permitting is stringent but acceptant of scientifically advanced technology
- Permitting did not allow any air emissions from the Pyromex gasification process
- Local regulators reviewed total project and offered a few recommendations for safety improvements
- Regulators monitored system startup and approved full scale operation
- System participated in two year EU study
- System operated significantly below EU and German emission standards

Emmerich Germany 25 ton/day facility



Exhaust Gas Emissions

Component /Pollutant	Unit of Measure	Pyromex ultrahigh Temp. gasification	17 th BimSchV Limit	Pyromex below limit by factor
Dust	(mg/Nm ³)	1	10	10
Total Organic	(mg/Nm ³)	0.5	10	20
Chlorine (as HCl)	(mg/Nm ³)	1	10	10
Fluoride (as HF)	(mg/Nm ³)	0.03	1	33
Sulfur oxide (as SO ₂)	(mg/Nm ³)	20	50	2.5
Nitrogen oxide (as NO ₂)	(mg/Nm ³)	135	200	1.4
Carbon monoxide (as CO)	(mg/Nm ³)	38	50	1.3
Mercury (as Hg)	(mg/Nm ³)	0.002	0.05	25
Cd, Tl	(mg/Nm ³)	0.002	0.05	25
Other heavy metals	(mg/Nm ³)	0.07	0.5	7
PCDD / PCDF	(TEq mg/Nm ³)	0.0005	0.1	20

Pyromex Ultra-High Temperature Gasification

- What is it?
 - The Pyromex Technology is a gasification process that causes the “*thermal decomposition*” of the waste material and converts it into a hydrogen-rich synthetic gas through the application of ultra-high temperature in an oxygen free environment
- Terminology
 - *Gasification* is the process of subjecting a feedstock to chemical reactions that produce gas
 - *Thermal Decomposition* is the process of splitting a compound by applying ultra-high temperature

Why is Pyromex UHT Gasification unique?

- Operational temperatures between 1200 and 1700 C
- Effective for a wide range of waste streams
- Energy efficient induction heating, direct not indirect
- Thermal decomposition in oxygen free environment
- Minimal amount of inert, non-leachable residue
- Process does not include an oxygenation stage
- No ash, no char, no tar, no emissions and no stack
- Small footprint, approx 12,000 sq feet for 25 ton/day
- Delivers energy in the form of heat, steam, electricity or hydrogen
- Most efficient and cost effective means of converting waste to energy

Emmerich Germany 25 ton/day facilities



In-feed storage and auger feed



Internal view of rotary kiln & induction coils

Emmerich Germany 25 ton/day facility

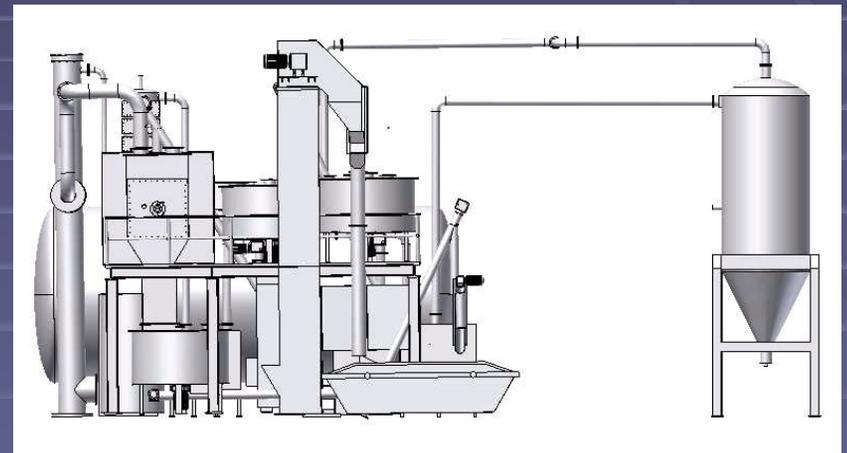


Rotary Kiln & Induction Coil Construction

Emmerich Germany 25 ton/day facility

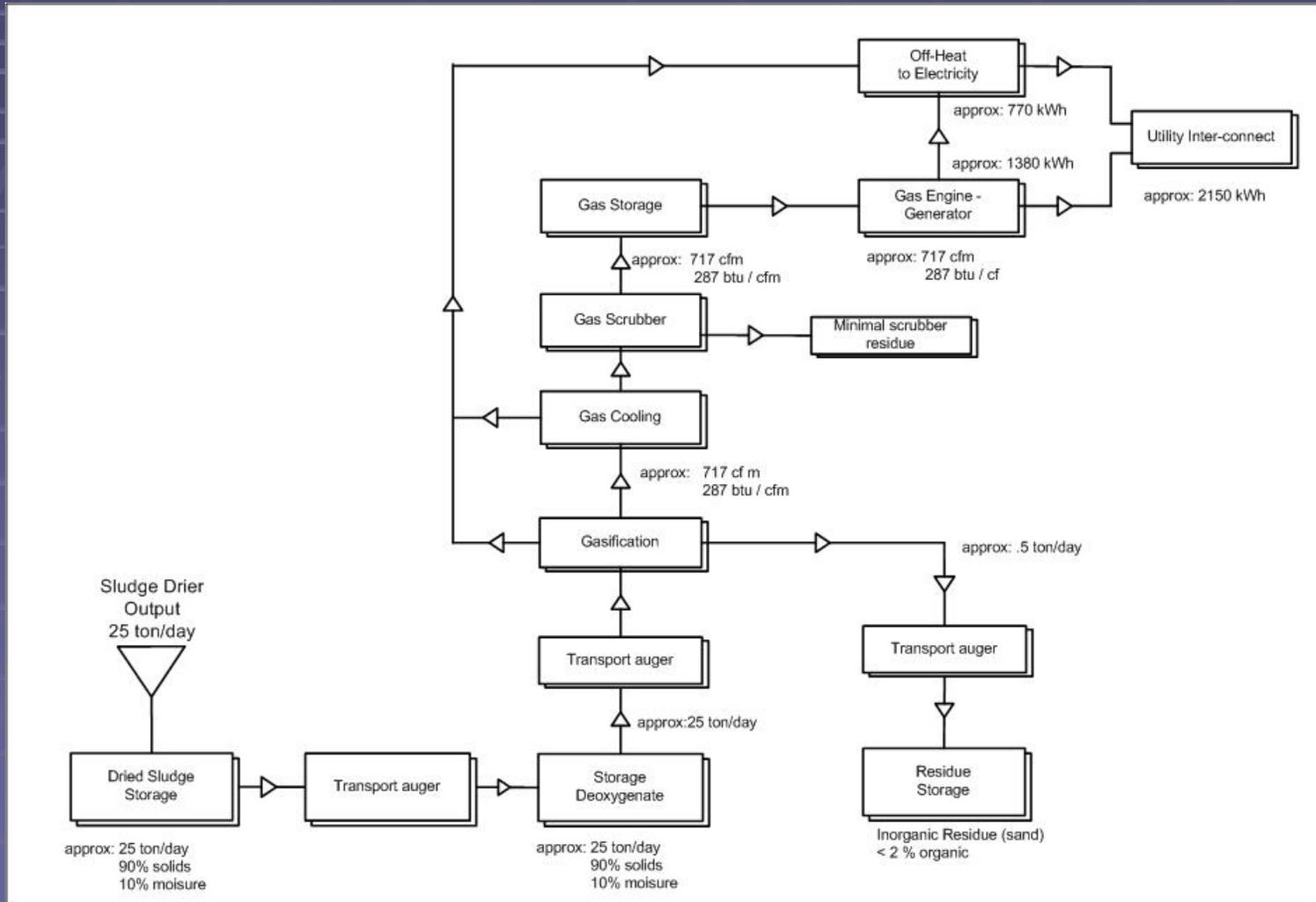


Inert, non-leachable solid residue discharge



System diagram

Sample Mass Balance



European Committee Study

- Funded by Energy, Environment and Sustainable Development Committee in Brussels
- Two year study focused on hard-to-treat, non-recyclable organic waste
- Concentrated on Pyromex Ultra-High Temperature gasification technology
- Concluded that Pyromex UHT gasification met all environmental standards and is well suited for waste elimination and generation of clean energy from non-recyclable organic waste
- Study also concluded that, due to the high amount of hydrogen in the gas, the technology has the potential to become a major contributor to the Hydrogen Economy
- Full study results available, on request

Current German Permitting

Farming & Animal Waste, including dairy, chickens & hogs

Natural Fiber

Plastic Waste, including chlorinated plastics

Wood chips

Waste from leather and fur industry, including chrome contaminated

Fly-ash from Power Plants, including, slag, dust, rust from incinerators

Packaging material, including paper, cardboard, plastic & wood

Waste from car recycling, including ASR, oils & tires

Medical waste, including hospital waste category A

Sewer sludge, including sludge from waste water works

Shredder waste, including light fractions & dust

Residue from mechanical treatment, sorting, shredding & pelletizing

Pyromex European Activity

- Commercial scale Industrial Waste facility in Munich fully permitted and under construction
- Munich will also include a Renewable Waste-to-Energy Demonstration Center
- Projects in planning stage:
 - Hospital waste
 - Paper and Waste Sludge
 - Auto Shredder Residue
 - Waste paint and manufacturing residue
 - Animal waste and farine

California and U.S. Activity

- Introduced technology to U.S. market 30 months ago
- Participated in UC-Riverside CE-CERT study
- Developed U.S. based operational business unit
 - Developed a pipeline of multiple opportunities
 - Created a development JV with ARES Corporation
 - Created a partnership with a Renewable Energy funding company
 - Reviewed technology with SCAQMD to understand permitting issues
- Projects in Planning Stage:
 - Waste-to-Energy (electricity or steam)
 - Animal waste
 - Auto shredder residue
 - Waste water sludge
 - Waste-to-Hydrogen
 - Animal waste
 - Industrial waste
 - Manufacturing waste

Regulatory Challenges

- Implementation challenges are not related to technology
- The current California regulations consider gasification a form of incineration
- Current regulations inhibit the application of scientifically proven advanced technology to be implemented for waste-to-energy projects
- Zero emission technology is not addressed in any regulations
- Waste elimination and energy generation are viewed as separate processes, not complementary or compatible
- California could significantly benefit from and should encourage and support, proven European Waste-to-Energy technology that addresses two significant challenges
- Waste-to-Hydrogen technology could be a driving force to the California Hydrogen vision