Wastewater Treatment, Energy, and Water Re-Use via Catalytic Hydrothermal Gasification

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Overview of Gasification Process

- **Catalytic Hydrothermal Gasification (CHG) is a wet process (up to 95% water) which produces natural gas in a single step**
- **Feedstock is any organic material made into slurry**
- **Reactions are fast (minutes) and complete (>99%)**
- **Process developed over 30-year period at Pacific Northwest National Laboratory (PNNL), a DOE National Lab**
- **Genifuel has licensed and improved the process**

Energy from CHG Gas Production

- **Gas produced is mostly methane and CO_2**
- **Gas can be burned directly as medium-BTU fuel, or can remove CO_2 for Renewable Natural Gas (RNG)**
  - Medium-BTU is app. 620 BTU/cubic foot
  - RNG is app. 1020 BTU/cubic foot
- **RNG can be inserted into pipeline and removed at a generator site to get renewable electricity credits**
- **Can use with existing natural gas generators**

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Wastewater Treatment

- **Can locate at a municipal wastewater facility and gasify the waste solids**
  - Can also locate at source of waste (e.g. food processor)
- **Almost completely eliminates wastewater solids—gasifies >99% of organics, leaving only inorganics (typically around 13% of wastewater solids)**
- **Can simplify the wastewater treatment process and reduce the footprint of facilities**
- **Can handle sludge with solids content from 4% to 25%**

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Skid-Mounted Gasifier Unit

CHG Gasifier Is Simple and Economical

- **Feedstock is heated and pumped to 350°C (660°F) and 21MPa (3,000 psi)**
- **Output goes through heat exchanger to recapture energy by heating incoming feedstock**
- **Outputs are fuel gas, warm water, and a small amount of sterile sludge (like wet clay)**
- **System built with straightforward industrial construction--standard codes using stainless steel**
- **Catalyst is readily available**

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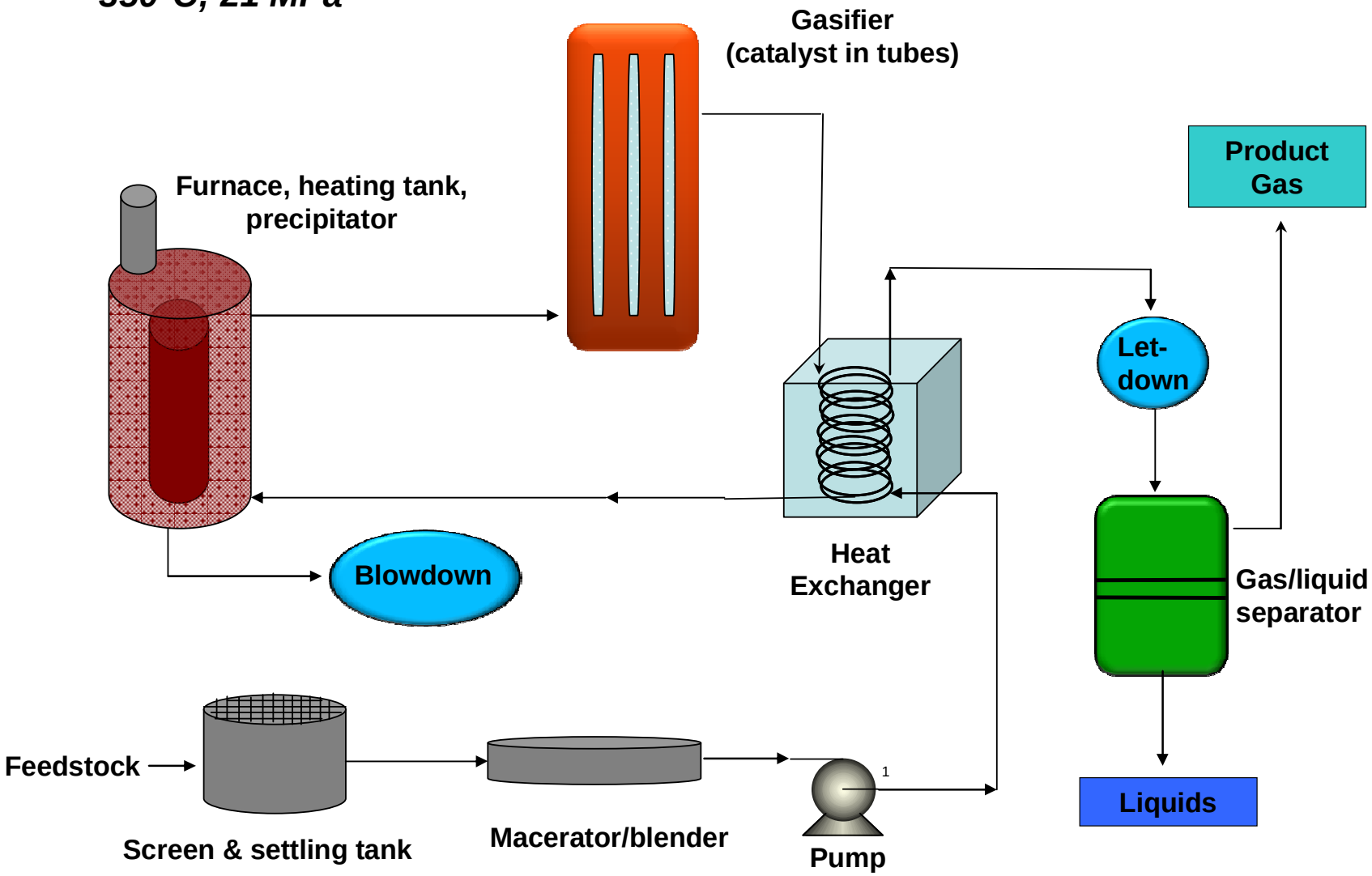
Simplified Process Diagram

Genifuel Gasifier Block Diagram

350°C; 21 MPa



Water Re-Use

- **Water is completely sterile (has been heated under pressure to 660°F before cooling)**
- **Water will contain plant nutrients—fertilizer**
  - Primarily nitrogen and potassium
- **Perfect for re-use as irrigation water**

Options for Wastewater Treatment

- **Gasifier can be installed in a wastewater treatment facility in several ways:**
  - To install instead of digesters (aerobic or anaerobic) in facilities which are currently contemplating digesters
  - To process sludge coming from existing digesters and reduce remaining solids
  - To start an alternative path for a portion of solids which would otherwise go to existing digesters, providing faster, more complete digestion, eventually replacing existing digesters

Table 1: Comparison of CHG to Anaerobic Digestion

	CHG	AD
Dwell time	Minutes	4 to 6 Weeks
Digestion of Organics	>99%	~50%
Cost	Medium	Medium+
Size	Small	Large
Effluent Water	Sterile, Reusable	Hard to Recapture
Water in Sludge	10%	75-80%

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Example: A Mid-Size Utility, 2008

Influent flow, daily average	32.9	MGD	SLC Data, million gallons per day
Solids sent to digesters	6,527	t/y	SLC Data, dry metric tonnes
Solids after digesters	3,223	t/y	SLC Data, dry metric tonnes
Solids removed by digestion	50.6%		Calculation
Total Volatile Suspended Solids	86.15%		SLC Data
Non-volatile Solids (Inorganics/Ash)	13.85%		Calculation
Cost of natural gas	6.00	$/MCF	From Variables worksheet
Cost of electricity	0.08	$/kWh	From Variables worksheet
Cost to operate digesters inc. capital	500,000	$/y	Estimate
Total profit from electricity production	392,357	$/y	From P&L
Avoided cost to remove solids	182,230	$/y	From above
Avoided cost to operate digesters	500,000	$/y	From above
Capital cost for gasifier	1,932,656	$	Does not include site engineering
Payback period	1.8	y	Calculation
Total annual savings from gasification	1,074,587	$/y	Calculation

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Benefits and Conclusion

- **Several important wastewater treatment benefits**
  - Waste management—almost eliminate solids
  - Re-use gasifier water for irrigation
  - In long term, can reduce footprint of treatment facility
- **Proven at a skid-mount scale**
- **Output gas can be used as medium-BTU fuel to generate electricity**
- **Capital cost payback in less than two years, with large annual savings thereafter**
- ***Conclusion:*** **CHG gives significant financial and environmental benefits in wastewater treatment**

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