Energy, Water, and Waste Management via Gasification of Wet Organics

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Overview of Gasification Process

- **Catalytic Hydrothermal Gasification (CHG) is a wet process (up to 90% 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 carbon dioxide (can remove CO_2, but not necessary)**
- **Gas can be used directly as a medium-BTU fuel in an engine or turbine designed for this gas**
- **With slight modification, can co-fire a diesel engine with a mix of this gas plus JP-8 or diesel fuel**
  - Engine can still run on straight JP-8 or diesel
- **Engine can drive generator for electricity**
- **Hot water from gasifier can be re-used**

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Practical Methane Substitution

- **Direct fuel offset with energy from methane up to 70% of fuel requirements**
- **Engine can revert to JP-8/diesel without modification**
- **Primarily controls modifications**
- **Been done before, but needs test with specific engines**

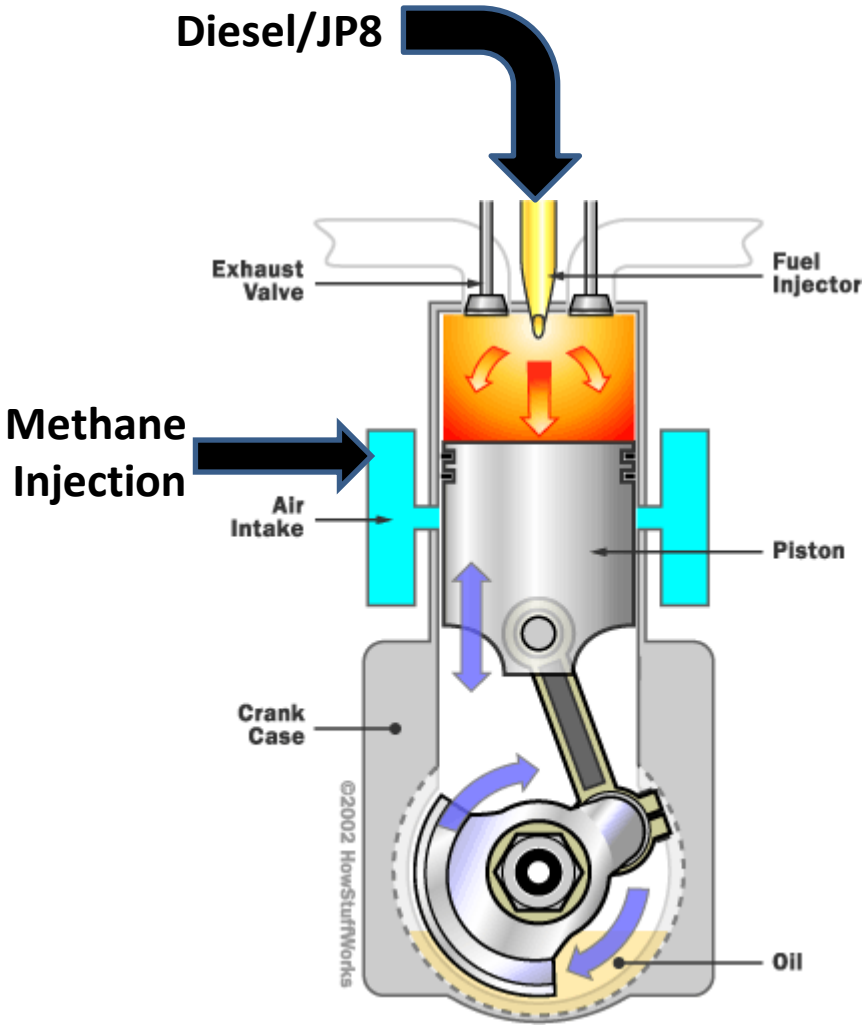

Diagram courtesy of Colorado State Engines Lab

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Feedstocks

- **Capture all food waste and latrine waste from base--a typical base yields a useful amount of engine fuel**
- **To get more engine fuel, augment the base waste by using locally-sourced biomass**
  - Grass, straw, weeds
  - Rice waste, food processing waste
  - Aquatic material—algae, river lettuce, water hyacinths
- **Prefer no woody material—too hard to make into slurry**

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What A 10% Slurry Looks Like

Skid-Mounted Gasifier Unit

Trailer-Mounted Gasifier

Interior of Trailer-Mounted Gasifier

Algae in Large Quantities as Feedstock

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, hot 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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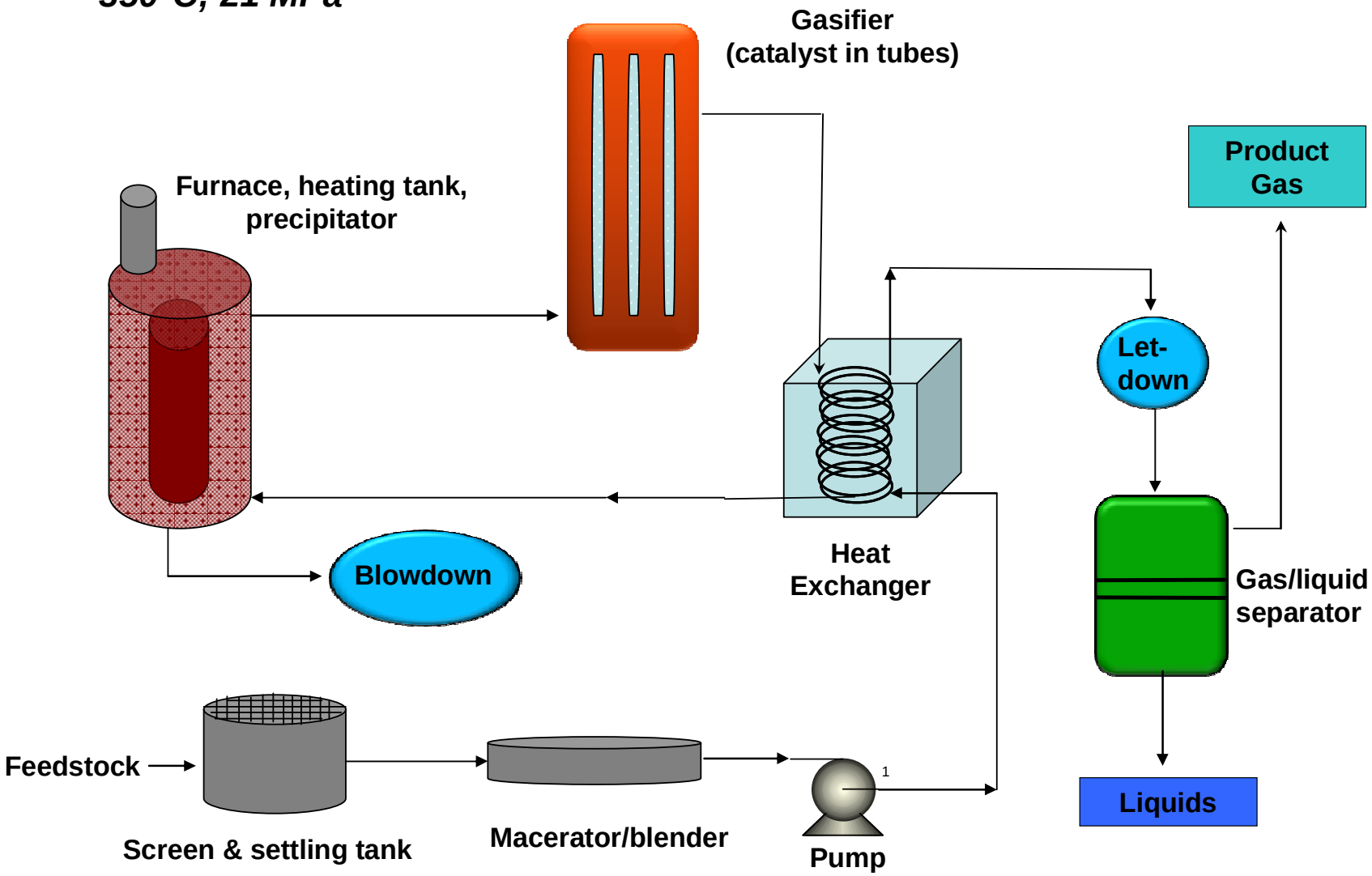
Simplified Process Diagram

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 some salt (primarily sodium and potassium chlorides—table salts) and some ammonia**
- **Could easily be re-used for laundry or wash water**
- **Could also be used as potable water after running through a carbon filter, but probably not worth the "PR effect" from doing this**

Energy Storage

- **System can provide short-term energy storage**
  - Feedstocks can be accumulated for short time (days) to gasify when fuel is needed
  - Gas produced can be stored in tanks (with slight compression for more economical storage)
- **Longer-term energy "storage" can be achieved by scheduling local feedstock harvesting**
  - Higher harvest when surge in fuel supply is needed
  - Slower harvesting at other times

Energy Cost for Renewable Natural Gas Compared to Biodiesel (Q4 2009)

	RNG	Algae B100	Soy B100
COST	**$12/MCF**	**$30/gal**	**$3/gal**
BTU Content	**1,020,000**	**118,300**	**118,300**
COST/ 100,000 BTU	**$1.18**	**$25.36**	**$2.54**

Note: 100,000 BTU is slightly less than 1 gallon equivalent

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Benefits and Conclusion

- **Four important benefits**
  - Produce electricity from wet waste
  - Waste management--essentially eliminate wet waste
  - Extend water supply by re-using water for washing
  - Provide capability for energy storage
- **Use local biomass to greatly increase fuel production to generate electricity**
- **Quick to set up and get into operation**
- **Co-fuel gas with JP-8 or diesel; can still run engines with straight JP-8 or diesel if needed**
- **Suggest small-scale demonstration be set up**

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