Steam Hydrogasification Based Conversion of Carbonaceous Feedstocks using the Viresco Technology

Jim Guthrie, Arun SK Raju, Chan S Park, Joseph M Norbeck
Viresco Energy LLC
1451 Research Park Drive
Riverside, California 92507
Presentation sections

Introduction to Viresco Energy
  1. Mission, strategies, vision
  2. Timeline: Conception to commercialization
  3. Technical consortium

Viresco process
  1. Process features
  2. Economics
  3. Pilot plant
Introduction to Viresco Energy

Mission
To become a global leader in the production of clean synthetic fuels

Strategies
1. Use proprietary breakthrough technology
2. Develop appropriately sized, cost-effective, modular and standardized plant designs
3. Strategically locate production facilities near source materials (feedstock)

Vision
1. Provide highly valued products at low cost
2. Minimize environmental impact
3. Promote use of renewable and domestic energy resources
4. Reduce global climate change emissions

www.virescoenergy.com
Technology Description

Simplified process flow diagram

Recycle excess $H_2$

$H_2$

Carbon

$H_2O$

SHR 750C 400 psi

Steam Reformer 850C 400 psi

Fischer-Tropsch 220C 400 psi

CH$_4$, H$_2$O, etc

H$_2$, CO

H$_2$/CO = 2.1

Clean Synthetic Diesel Fuel

www.virescoenergy.com
Steam Hydrogasification Process

\[ C + \text{H}_2\text{O} + 2\text{H}_2 \rightarrow \text{CH}_4 + \text{H}_2\text{O} + \text{CO}, \text{CO}_2, \text{C}_2+ \]

- Can handle wet feedstock w/o drying.
  - High pressure slurry pump
- Less C\textsubscript{2+} fraction. Less precursor for the formation of tar
- No oxygen required
  - Oxygen production is an expensive process
  - Suitable for smaller scale, distributed facilities
- Reducing Environment
  - \text{H}_2\text{S}, \text{NH}_3 formation (No COS, SO\textsubscript{2} or NO\textsubscript{2} formation)
- Control feedstock for desired product distribution
  - Carbon, Water, Hydrogen ratio
Water makes the Viresco process unique.

1. Carries the feedstock
   High pressure slurry pump
   moves wet feedstock

2. Speeds the reaction rate
   Reduce reactor size/cost

3. Feeds the Steam Methane Reformer
Any carbonaceous material can be converted by the Viresco process into synthetic fuel.

Biomass Organic
1. Wood, forest clearings
2. Crop waste, agricultural residues
3. Energy crops (switchgrass, corn stover)
4. Animal, municipal solid waste, food waste, biosolids

Petroleum Organic
1. Plastic (PVC, PUF)
2. Polymers (rubber, tires)
3. Paint residues

Fossil Organic
1. Coal, mine tailings

www.virescoenergy.com
The Viresco process creates synthesis gas, which can be converted to a variety of transportation fuels:

1. Fischer-Tropsch diesel
2. Jet fuel
3. Gasoline
4. DME (Dimethyl Ether)
5. Methanol
Pilot plant launch

- 2008 Pilot plant design initiated

- 2009 Pilot plant design will be finalized; permits filed to build in Utah

- Pilot plant to use wood and coal as dominant feedstocks
CRADA between DOE/NETL & UCR established since Nov. 2007

1. Independent Review of the Process
   • Validate the gasifier equilibrium model
   • Setup flow-sheet for the several different cases
   • Estimate TPC (Total Project Cost) and perform economic analysis

2. Support the Design of the Gasifier Reactor
   • Using CFD code developed by NETL
## Major CRADA results

<table>
<thead>
<tr>
<th></th>
<th>Viresco (CE-CERT) Process (Steam Hydrogasification)</th>
<th>Conventional Entrained flow gasifier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>input</strong></td>
<td>4000 TPD CTL Plant 400 TPD CTL Plant</td>
<td>3707 TPD CTL Plant</td>
</tr>
<tr>
<td><strong>output</strong></td>
<td>107 MW electricity 7143 BPD, (2.8 BPD/mT) 10.8 MW, 679 BPD</td>
<td>10.3 MW electricity 7143 BPD</td>
</tr>
<tr>
<td><strong>HHV η</strong></td>
<td>53.4% 51.1%</td>
<td>47.6%</td>
</tr>
<tr>
<td><strong>TPC/ TCR</strong></td>
<td>$1,026 MM/$1,512 MM (Jan. 2008 $) $250.8 MM / $323 MM</td>
<td>$1215 MM/$1,764 MM</td>
</tr>
<tr>
<td><strong>IRR</strong>*</td>
<td>17% (@ $38/T) 20% (@ $18/T) 4% (@ $8/T)</td>
<td>7% (@ $38/T) 12% (@ $18/T)</td>
</tr>
</tbody>
</table>

*Debit/equity = 70%/30%, with 15% interest financing, product sales @ $2.7/gal*
15% interest financing, $2.7/gal sales, $38/ton feedstock, 1,026 MM capital
0.1 TPD PDU

Indoor Unit, Biomass + Biosolids Feedstock, Gasifier + Cleanup + SMR

- Design by Technip Inc.
- Will also account for coal feedstock
- Development of Hydrothermal Pretreatment system


Will be funded by the California Energy Commission, Viresco, City of Riverside and UCR on a cost-share basis
Pilot Plant Projects

2~5 TPD @ City of Riverside waste water facility
1. For Comingled Biomass + Biosolids
2. Complete System to produce FTD
3. City will provide the Land and Utilities
4. Potential Funding from CEC, Federal Earmark
5. Accelergy FT + RTI Regenerable WGC

20TPD @ Utah
1. For Coal
2. Funding from Viresco, and others
Timeline

2002
University of California (UC) began developing gasification technology & applying for patents

2003
Viresco Energy LLC (VE) established; began funding UC research

2006
VE & UC signed global option for technology transfer

2007
VE formed technical consortium

2010
Initiate pilot plant in UT

2012
Commercial plant design

www.virescoenergy.com