Successful Conversion of Carpet Into Clean Energy

2015 CARE Conference – New Orleans, LA

Chuck Ludwig
Henry W. Brandhorst, Jr., Ph.D.
CHZ Technologies, LLC

May 13, 2015
Background

• In mid-2014, we became aware of an emerging problem in the carpet industry
  – Spreading impact of California AB 2398
  – Limits on landfilling post-consumer carpet (PCC)
    • Polyester carpet is difficult to economically recycle, nylon not so limited
  – ~2 million tons of post-consumer carpet is landfilled annually in the U.S.
    • ~40% is polyester
  – Landfills are reaching their capacity
    • New landfills are costly and time consuming

• We had technical discussions with nearby Interface, Inc.
  – Presented the capability of the Thermolyzer technology
  – Interface offered to **fully fund** a test of carpet shreds
    • They supplied nylon shreds, CRI supplied polyester shreds (no backing)
  – The tests of both materials were conducted in Germany in Sept. 2014
Why Is Thermolyzer Different?

• Thermolyzer system has undergone development over the last 17+ years
  - Two pilot plants, one 44 TPD commercial plant

• Thermolyzer system overcomes deficiencies of other gasification approaches
  - Continuous, oxygen-free process
  - Tars and oils recycled to make more clean Fuel gas (VOCs < 1ppm)
  - No dioxins or furans formed
  - Has processed many types of waste
    • Tires, plastics, carpet, auto shredder residue (ASR), MSW, wood…
    • Meets the most rigid environmental standards

• Economically viable technology, but:
  - Dependent on location, plant size, feedstock and offtake choices
  - Costs have been worked out, but details are critical
Results of Carpet Test September, 2014

• Test of PET and PA carpet shreds at the 4 ton/day research facility
  – Eric Nelson, Interface and Carter Hallock, Rethink Green, witnessed the test
  – Bob Peoples and Joe Yarborough have also reviewed the data

• Tests covered two days (one day for each type)
  – Both PET and PA samples processed easily and quickly
    • The resulting Fuel gas was clean with no VOCs or other contamination
    • Mass balances were determined plus analyses of all gases
      • Chlorine content in one sample was 1.6% - process is tolerant to 7% Cl

• Thermal content of the carpet was similar for both:
  – PET: 7158 Btu/lb.; PA: 6762 Btu/lb.; (PP estimated at ~14,000 Btu/ft³)
  – Heating value of the generated Fuel gas: PET 438 Btu/ft³, PA 567 Btu/ft³
  – Fuel gas output met EPA (& German) emissions requirements

• These results established the feasibility of using Thermolyzer technology to process PCC and provide clean Fuel gas and/or other outputs
  – Would need similar tests to confirm thermal value of different feedstock
Examples of Other Thermolyzer Test Results

Note: Solid blue bars are literature values
Key Factors in Determining Thermolyzer Economics

- **Type of carpet input**
  - Selvage (~16,800 Btu/lb.)
  - Mixed carpet (PET, PA, backing - ~7,000 Btu/lb.)
  - Shredded to ≤2” - # of shredders? (e.g. 2 for mixed carpet)
  - Windsifter, magnetic separators likely needed for bulk carpet
  - Tipping fees impact economics

- **Estimated Fuel gas output from 44 TPD plant**
  - Selvage: 39,000,000 Btu/hr.; Mixed PET/PA: 16,000,000 Btu/hr.
  - Fuel gas can be used for: burners, or steam and electricity production/distribution
  - Each has different economics; point of use dependent

- **If making electricity**
  - PPA required from power company
  - Price significantly impacts economics (>6¢/kWhr.)
  - With selvage: 36,000 MWhrs./yr.; mixed carpet: 14,000 MWhrs./yr.

- **Char sales**
  - Quality of char and point of sale impact economics (est. $20/ton)

- **Avoided landfill costs also enter in to economics (est. $30/ton)**

- **Plant cost tbd (~$10 million or so depending on above factors)**
  - Labor (24 hr./day operation), permitting, waste water, safety standards, etc.
What Does This Mean for You?

• The Thermolyzer Technology has processed PET (and PA) carpet successfully
  - Produced a clean, environmentally acceptable Fuel gas
    • That can be sold, used to make/sell steam, or make/sell electricity
  - Produces a char which can also be sold
    • Or potentially be recycled into carpet process
  - We’re seeking to build a plant at any location in the U.S.
    • Carpet, tires, ASR as feedstocks (even in a single facility)

• The economics are dependent upon numerous factors
  - Size of plant: 44 TPD to 88 TPD and multiples; feedstock type(s)
  - Customer for Fuel gas or steam: e.g. a refinery (paid on energy content)
  - Electricity value depends on location and securing a PPA with the utility
  - Tipping fees, char sales…

• Without a detailed analysis of a given location, costs are ROMs
  - The devil is in the details but:
    - $10 million for a 44 TPD facility is in the ballpark
      • With an approximate payback time of 4-5 years, depending on the exact details

• We’d look forward to detailed discussions if you’re interested