

Analytic Power Corp

1109 Sangre De Cristo, Santa Fe NM 87501
505-216-0825 Voice, 617-249-0310 FAX, www.analytic-power.com

On Board Storage Technology Hurdles & Actions

October 9, 2006



Since
1959

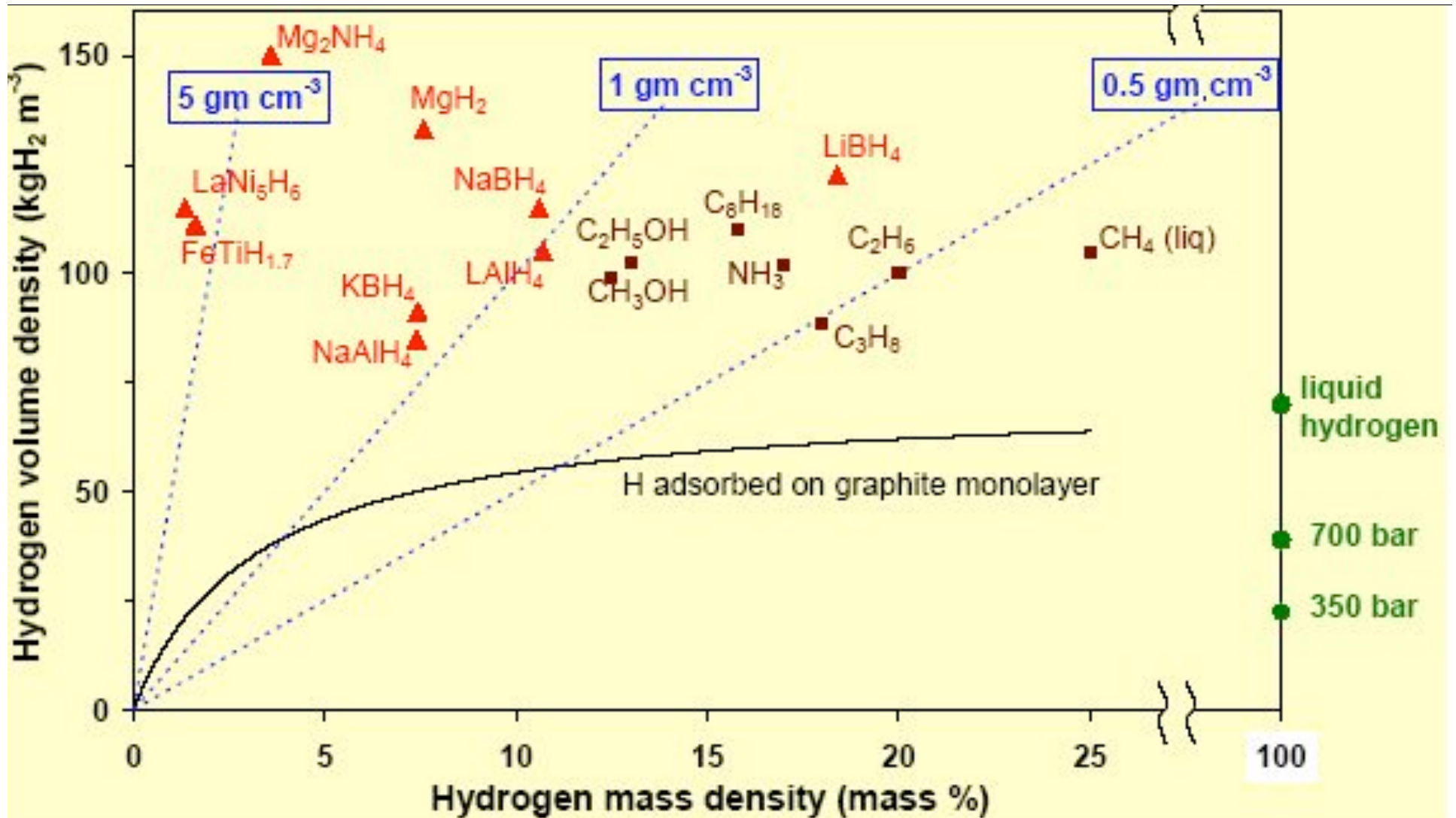
Ammonia
Met
Today's
DOE
Hydrogen
Fuel
Spec's

The Biggest Hurdle

Alternative fuels that:

- Work with your engine now.
- Competitively priced
- Don't have to be widely available
- Plug in Hybrid's, not shown, work in your home.





Basic Research Needs for the Hydrogen Economy, Report on the Basic Energy Sciences Workshop on Hydrogen Production, Storage, and Use (DOE May 2003)

Infrastructure –Problem Scale

- Domestic Gas Stations ~100,000 declining (Exxon 45,000 worldwide)
- Deliver >250,000 gallons gasoline per month*. ~41 Ton NH₃/day
- US gasoline consumption is ~6x world NH₃ Capacity (KBR).
- US NH₃ Pipeline Capacity 1MMTon/yr could supply 66 gas stations.

Well to Wheels Efficiency

- Fuel Production efficiency
 - Refineries – 90% petroleum to gasoline
 - KAAP NH₃ Production 7GCal/MT >80%
- Electrolysis
 - Power Plant ~40%
 - Cell 56% to 73% (NREL)
- Automotive ICE 25%

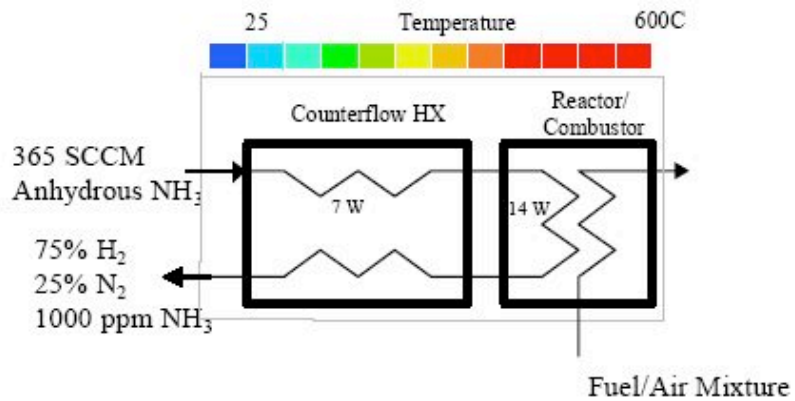
Technology Hurdles

- Multi fuel capacity & ICEs
- Crackers weight, volume and quick start
- On board storage of fuels
- Real On board storage hydrogen density
- Well to Wheels Efficiency.
- Renewables

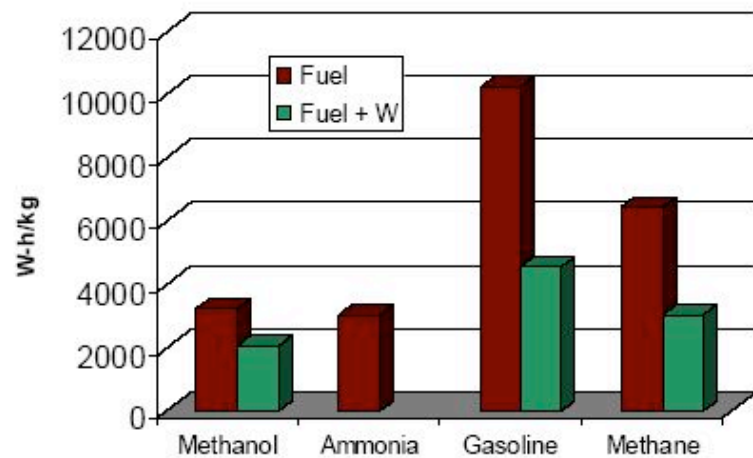
Energy Storage Density

- Package and process weight & volume are important.
- Liquid processing generally simpler than solids.
- Thermolysis of solids generally yields higher energy density than hydrolysis and is easier to regenerate.

Intelligent Energy Information



NH₃ Decomposition Flowsheet



Energy Density of Various Fuels



NH₃-Based Hydrogen Generator



Microreactor
for NH₃
Decomposition

Package & Process weight & volume - crucial issues

Intelligent Energy Information



Fiber-composite tank formed with safe-storage material

Challenges:

Design for Fast Fill

Features:

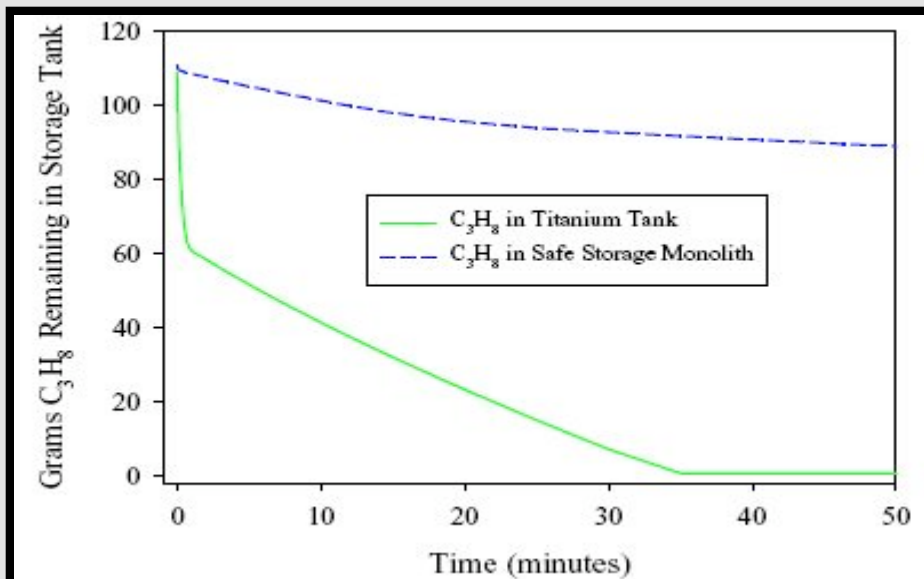
Kevlar foam filled Safe Tank.

120 gm tank stores 500gm NH₃

NH₃ Energy Density 17.5% → 12%.

Withstands 1000 psig

200 kg/m³ & 85% porosity → 75% NH₃ storage density

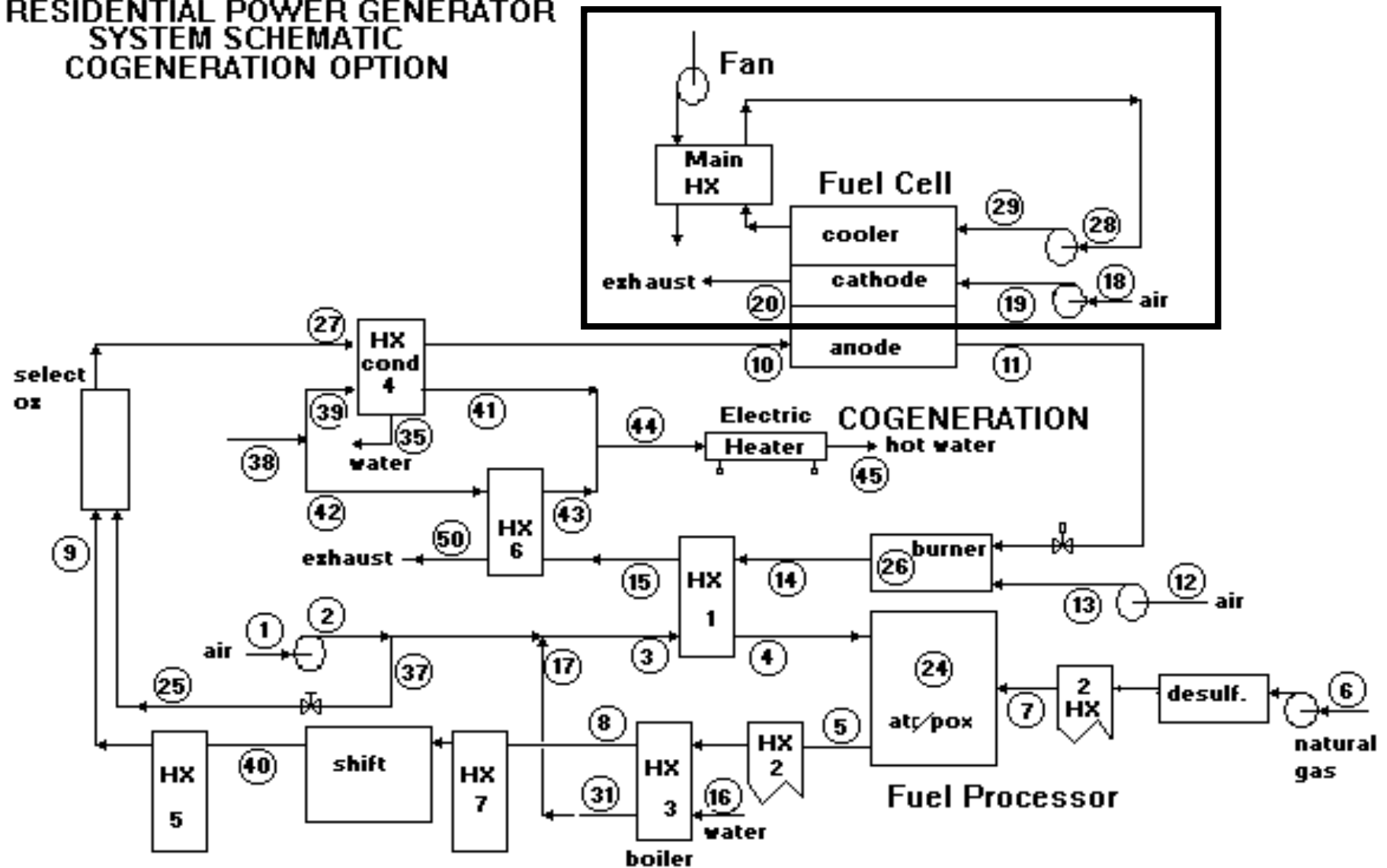


Panel Members

- **Don Hagge**, Oregon Sustainable Energy - Guanidine--A Sustainable, Flexible Fuel and Safe Storage Material
- **Tue Johannessen**, Amminex A/S - “Solidified” ammonia as energy storage material for fuel cell applications
- **Patrick Desrochers**, University of Central Arkansas -Reversible Surface Storage of Ammonia

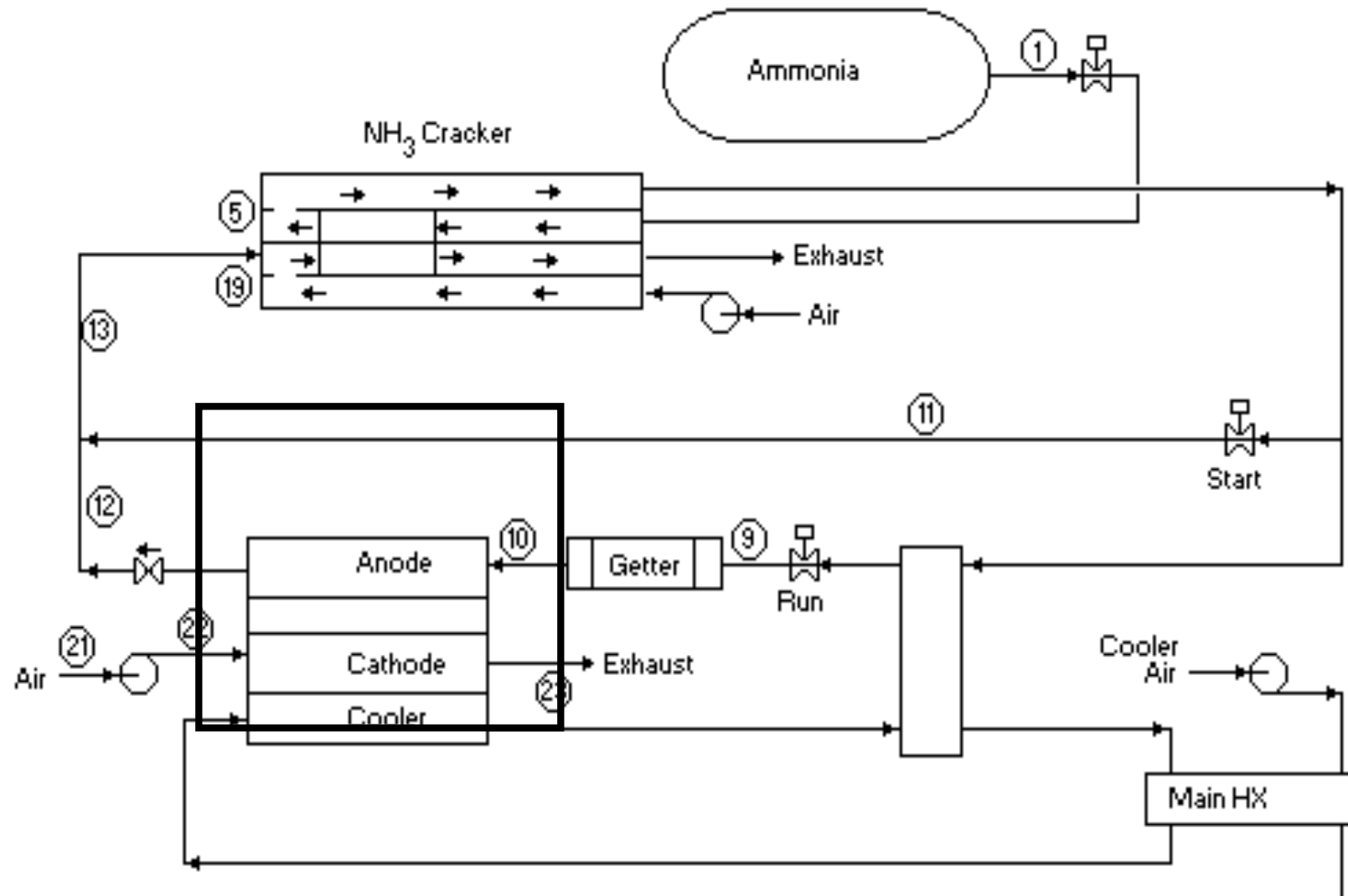
Hydrocarbon Reformers are Complex

Analytic Energy Systems
RESIDENTIAL POWER GENERATOR
SYSTEM SCHEMATIC
COGENERATION OPTION



Crackers are Simple

Ammonia Cracker Fuel Cell Power Plant





Analytic Power -All Brazed, Iron Catalyzed, 5kW Cracker