Gas Generation for the Future

VERDE LLC

Summary

- As the Three-Time “Best of Boston” Award Winner, VERDE LLC has extensive experience in designing, manufacturing, building and installing Gas Generation Plants; especially Hydrogen Generation Plants from Electrolysis, NG Reforming, Methanol or Ammonia Decomposition, and several others.
- VERDE LLC is headquartered in Massachusetts, USA.
- VERDE has numerous partnerships, representatives, and Gas Plant Installations in countries around the world.
- Since 2007, VERDE has moved into Renewable Energy, and established strong relationships with the US Department of Energy, National Renewable Energy Laboratory and a number of Renewable Energy institutions.

Contents

http://www.verdellc.com

VERDE Product Lines

Verde LLC delivers a reputable and highly efficient world accepted Gas Product Lines. With the best rates and a highly trained staff, we guarantee to meet your needs and work with you to obtain your project goals with the highest standard of customer satisfaction. Below are some of our customers:

US Army Research Lab
NASA
Sandia National Laboratories
NIST
NRC-Canada

UC, Berkeley
MIT
UIUC
Duke University
University of Iceland
Los Alamos National Labs

Honeywell
Air Product
CIBA Vision Corporation
Lucent Technologies
Sharp Microelectronics

VERDE LLC. Community

Verde has been bringing forth the latest advancements in all fields of gas generation technology and has recently added the clean energy sector to its industry. Verde was founded by a group of engineers that realized the importance of research and development for the better of mankind. Our dream at Verde is to bring earth to a cleaner, healthier state at rates that everyone can afford.

VERDE Product Lines

- Hydrogen from Electrolysis

H_2 capacity	2 - 500 Nm^3/h
H_2 purity	> 99.9%
Power consumption (DC)	< 4.5 $kw.h/m^3H_2$
Work pressure	0.5 - 3.0MPa

- Electrolysis is the passage of a direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, resulting in chemical reactions at the electrodes and separation of materials.

  The main components required to achieve electrolysis are:

- An electrolyte: a substance containing free ions which are the carriers of electric current in the electrolyte
- A direct current (DC) supply: provides the energy necessary to create or discharge the ions in the electrolyte
- Two electrodes: an electrical conductor which provides the physical interface between the electrical circuit providing the energy and the electrolyte

VERDE Product Lines

- Hydrogen from Natural Gas Reforming

H_2 capacity	50 - 20,000 Nm^3/h
H_2 purity %	99 - 99.999%
Work pressure	1.3-2.0MPa

- Prior to pressurization, desulfurization, and mixing with aqueous vapor, natural gas is passed through a special reformer which is packed with a catalyst for cracking and reforming the effluent mixture of hydrogen, carbon dioxide and carbon monoxide. After part of the heat is recovered, hydrogen will be obtained by removing excess carbon monoxide from the reformed effluent. The shift gas is then purified further through pressure swing adsorption (PSA), to obtain pure hydrogen.

Technical Features

- Low operating costs mean your investment is recovered in a short period of time.
- The desorbed gas from PSA can be burned; which can both reduce the fuel consumption and decrease the ventilation of the waste gas.
- Safe and reliable operation
- Highly automated

VERDE Product Lines

- Hydrogen from Methanol Decomposition

H_2 capacity	5 - 3,000 Nm^3/h
H_2 purity %	99-99.9995%
Work pressure	0.8-2.0MPa

On board methanol reforming has a couple of advantages over other potential fuels:

- Unlike gasoline or diesel fuel, liquid methanol can be readily produced from biomass
- Easily adaptable to the current infrastructure
- Easily transported and stored
- Last but not least, methanol has a high hydrogen density

Technical Features

- Methanol is converted to CO and H_2 with the action of the catalyst
- CO and H_2O are converted to CO_2 and H2 with the action of the catalyst
- CO_2 and trace CO are separated from the decomposed gases by PSA technology and high purity of H_2 is generated

VERDE Product Lines

- Hydrogen from Ammonia Decomposition

H_2 capacity	5 - 500 Nm^3/h
Impurity Oxygen	≤2ppm
Residual Ammonia	≤3ppm
Work pressure	0.05-0.2MPa

- VERDE's Hydrogen Generator by Ammonia Decomposition with Purifying System has a very low cost, long service life, simple operation, compact structure, small coverage, and very simple to installation. Liquid ammonia is used as the source for this hydrogen generator.

Technical Features

- VERDE uses high-quality, heat-resistant, corrosion-resistant, stainless steel alloy as the gall of the decomposition furnace to ensure the long-term stable operation of our Hydrogen Generators
- Great efficiency, all of the metal components are equipped with double-fin heat exchanger material to fully enhance the heat transfer area
- The high temperature nickel catalyst allows for a low content of residual ammonia and highly effective decomposition

VERDE Product Lines

- Nitrogen Generation by Pressure Swing Adsorption

N_2 capacity	1 – 3,000 Nm^3/h
N_2 purity %	95 - 99.999%
Work pressure	≤0.8 MPa

- The PSA Nitrogen generator obtains N_2 by using pressure swing adsorption principles at normal temperatures, along with clean compressed air as raw material and a carbon molecular sieve as the adsorbent. This is achieved due to the different rate of adsorption of oxygen and nitrogen on a carbon molecular sieve's surface as well as different diffusion rates through the open/close of the program control valve

Technical Features

- Rapid response: qualified Nitrogen can be produced in 15-30 minutes
- Efficient molecular sieve filling and long service life along with stable and adjustable pressure, purity and flow allows the product to meet many different customer requirements
- Reasonable structure, advanced process, safe and stable with less consumption
- Fully automatic operation

VERDE Product Lines

- Nitrogen Generation by Membrane Separation

N_2 capacity	1-1,000 Nm^3/h
N_2 purity %	95 - 99.99%
Work pressure	>0.8 MPa

- The compressed air filters through the polymer membrane filters, which separate the gases due to differences in solubility and proliferation rate. According to the characteristics, various gases can be divided into two categories: "rapid gas" and "slow gas." After being compacted and purified (to remove oil, water and dust) the air will enter the membrane separator to obtain nitrogen.
- **Technical Features**
- Simple start-up and shut-down procedure; in less than 2 minutes the system reaches normal and stable gas supply
- No moving parts: minimal maintenance required
- Lightweight, compact structure and small coverage

VERDE Product Lines

- Liquid Nitrogen Generating Plant

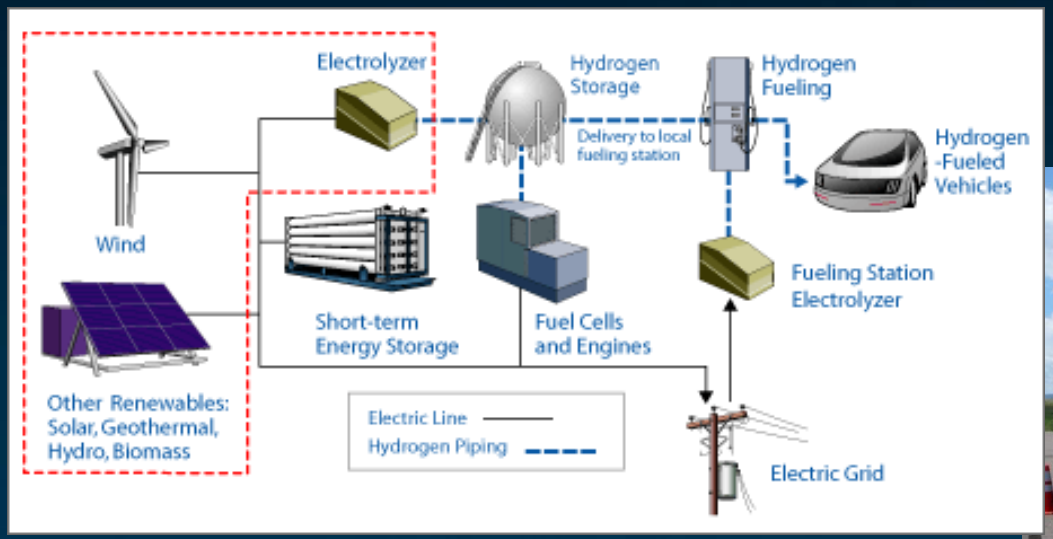
LN_2 capacity	5 – 5,000 liters/hour
LN_2 purity %	95 - 99.999%
Work pressure	0 - 2 MPa

- VERDE Liquid Nitrogen Generators are top of the line systems. Our Generator applications range from 5- 8,000 liters of LN_2 per hour

Cryogenic Engine features:

- Fully Automatic cold head with integral controls
- Includes high efficiency frequency drive with water cooling or optional air cooling
- Fully automatic PLC based controls provide many features and modes including auto start, timed run, auto purge, etc

Looking into The Future



Renewable Energy Market
-Three significant Problems

1. Lack of infrastructure

- In the US, $300 Billion Dollars is needed to connect all potential wind farms

2. Intermittency of renewables

- In NY state, wind farms have to be disconnected frequently in order to protect Grid Network from over-production.
- The same problem occurs throughout the US.

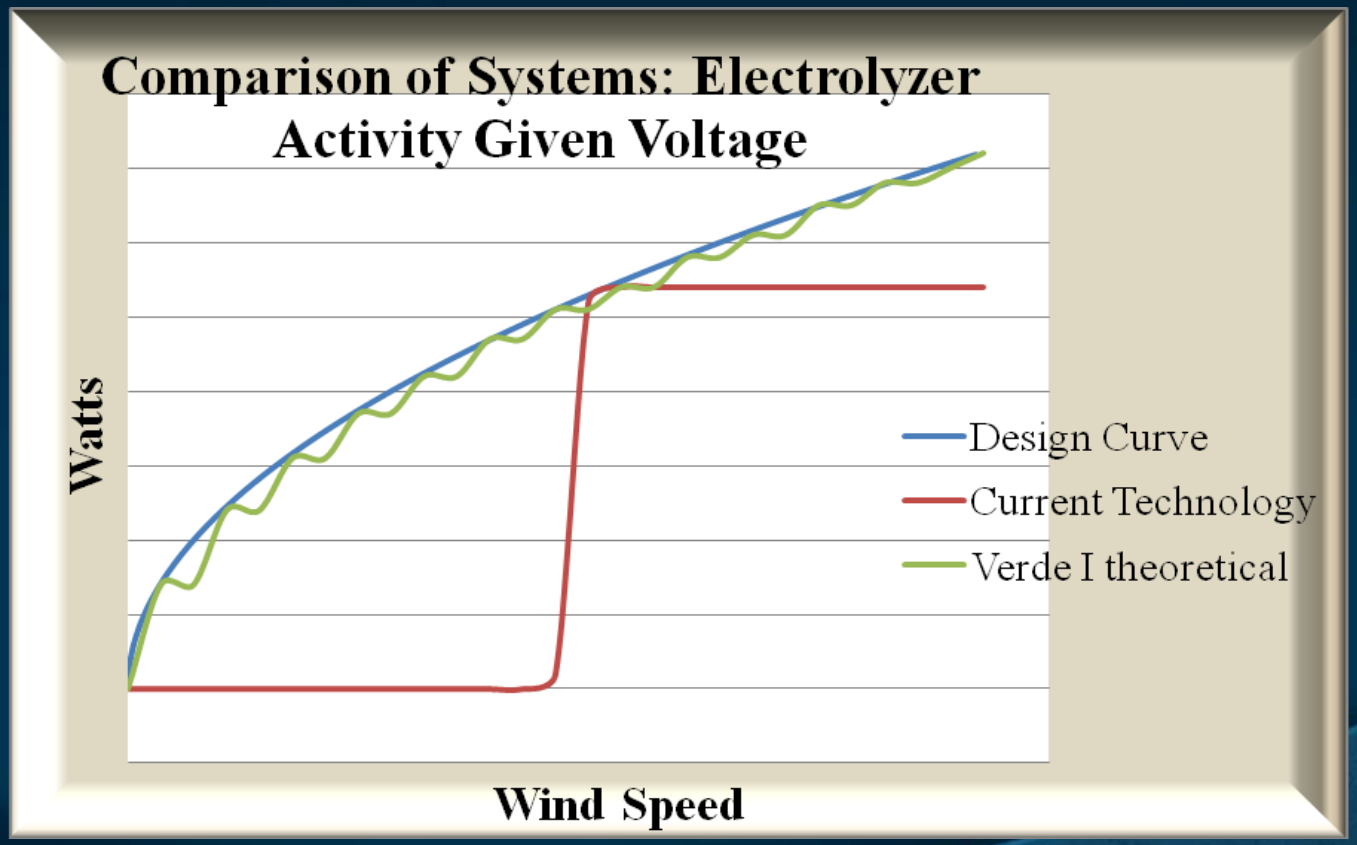
3. Other unnecessary losses

- 8%-15%* loss in the electricity distribution.

* Source: IEC(International Electrical Commission), 2007-2009, “Efficient Electrical Energy Transmission and Distribution”

VERDE Solutions

Our Patent*: The Electrolyzer is the *1st* Hydrogen System in the world that is directly driven by Intermittent Renewable Power.



VERDE Solutions

- Technical Innovation

Power Supply <= Demand

Wind or Solar Energy

Hydrogen Fuel Cell

Power Supply > Demand

Hydrogen Storage

Local Load

Stable & continuous power supply

Transmission

"VERDE"
Hydrogen Generator

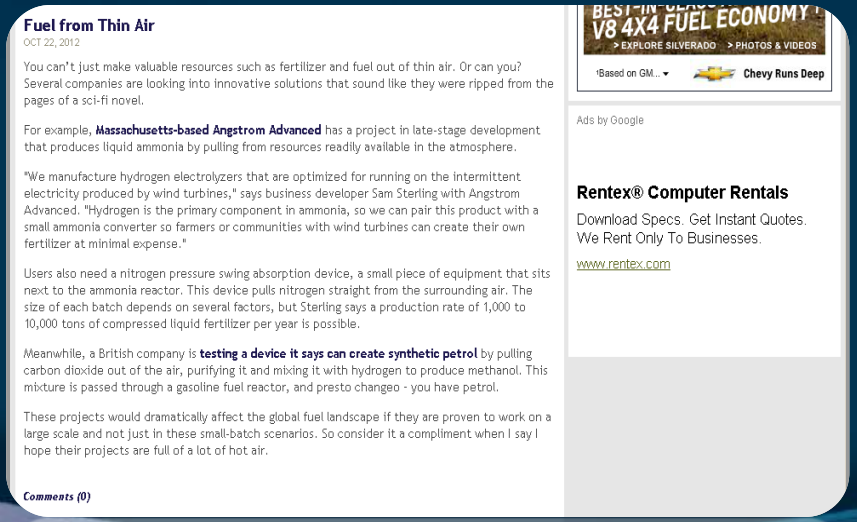
Hydrogen Tube

Nitrogenous Fertilizer

Business Application

- Residential System

Public Acknowledgement



Contact Information

Dear Customers,

At Verde LLC, we are committed to placing our customers first by combining quality products with the latest technology, ensuring top performance and flawless results with every application. Our knowledgeable staff along with our meticulously engineered manufacturing and specifications allow Verde LLC to keep this commitment. As we continue to grow, we look forward to confidently supporting our customers needs and ideas today and throughout the future.

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