

on site H₂ generator

with methanol water



2018

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H2 the future energy

§ The combustion calorific value (Kcal/kg) of hydrogen is 3 X of gasoline, 3.9 X of alcohol and 4.5 X of char coal.

Obviously, as an energy source, hydrogen is very much superior to any existing fuel.

§ Not like oil and char coal, burning H2 will **NOT** produce any chemical material to cause green effect, nor acid rain and smog as well.

§ H2 can be produced from water which is a rich resource on earth.

High energy

No pollution

Applications of H2

§ H2 is applied to industries:

fuel cell- electricity.

power plant- cooling down.

electronics- reduce metal oxides in the process.

metal- thermal spraying, sintering, surface treatment.

medicine- hydrogenation & catalyst.

glass- cutting & polishing, melting / softening, heat treatment.

chemistry- hydrogenation & catalyst regeneration.

steel & copper smelting- reduce metal oxides while smelting.

bio-diesel- oil hydrogenation.

oil refinery- oil hydrogenation.

food- oil hydrogenation.

textile- polyester cotton purification.

§ Mixing H2 (purity 75%) equivalent to 5% of the fuel for combustion of cars, power generators and boilers, may

- save fuel 10 - 20%.

- reduce emissions of CO2 and NOx by 7 - 15% and 65 - 73% respectively.

How is H₂ produced - 1

§ water electrolysis

Decomposing water with an external power source to produce hydrogen. This is the most eco-friendly method, no CO₂ will be produced. However, it needs a lot of electricity. It's not an economical method by now.

§ renewable energy

Water electrolysis combines with solar, wind, hydraulic or geothermal electricity to produce H₂. Currently, solar power is the main method. However, the whole efficiency is only 15%. This method is not applied popularly.

§ thermochemistry

Moisture can be directly transferred into H₂ and O₂ at 1,000 °C - 3,000 °C. However, heating water by using huge fossil fuels is not economical and eco-friendly. Meanwhile, the risk of high temperature and the difficulty of device design are very high.

How is H2 produced - 2

§ biomass energy H2

Biomass & Biological are two main methods.

Biomass method produces H2 by pyrolysis agricultural waste. Biological method H2 production by using special fungi is currently in the research stage and is considered to have considerable economic potential. However, the conversion efficiency of both methods are far lower than solar energy. There is still a long way to go.

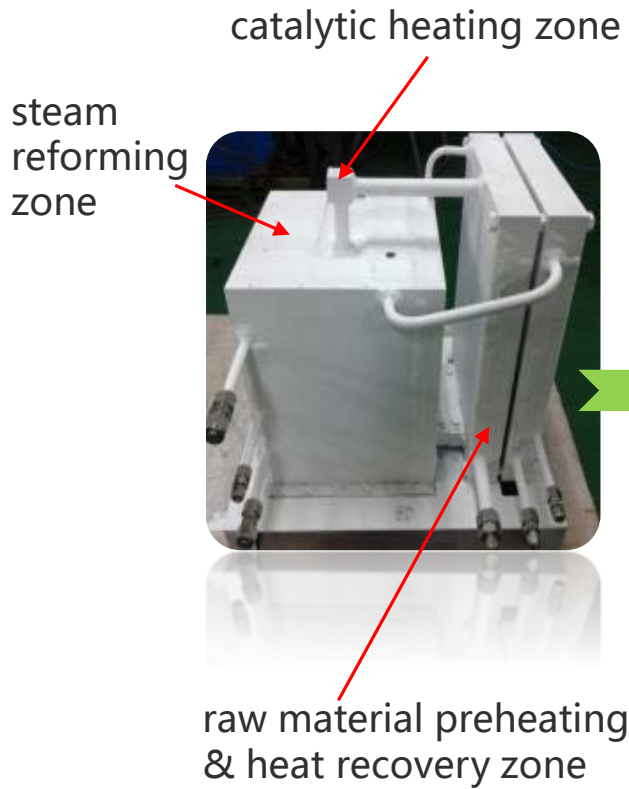
§ fossil fuel reforming

Coal, natural gas and methanol are the main raw material for H2 producing at industrial scale by now. The later 2 are main methods for on site H2 generation.

Natural gas reforming must operate at high temperature (700 - 900 °C), processes are more complicated and need more space (1.5 - 2.0 X) so that the equipment is more expensive (2.0 - 2.4 X). [Methanol reforming](#) is easier and cheaper than natural gas reforming and exhaust pollution is far lower than heavy oil or coal by 30 %.

on site H2 generator – assembly

methanol reformer



methanol reformer assembly



control elements & pipe line

high purity H2 generator



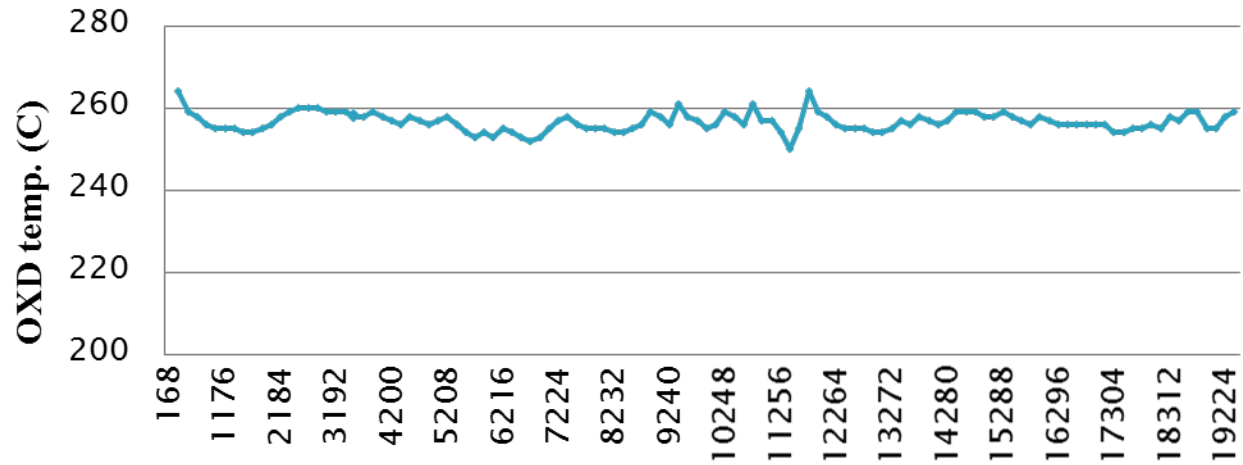
on site H2 generator - advantage 1

catalyst heating

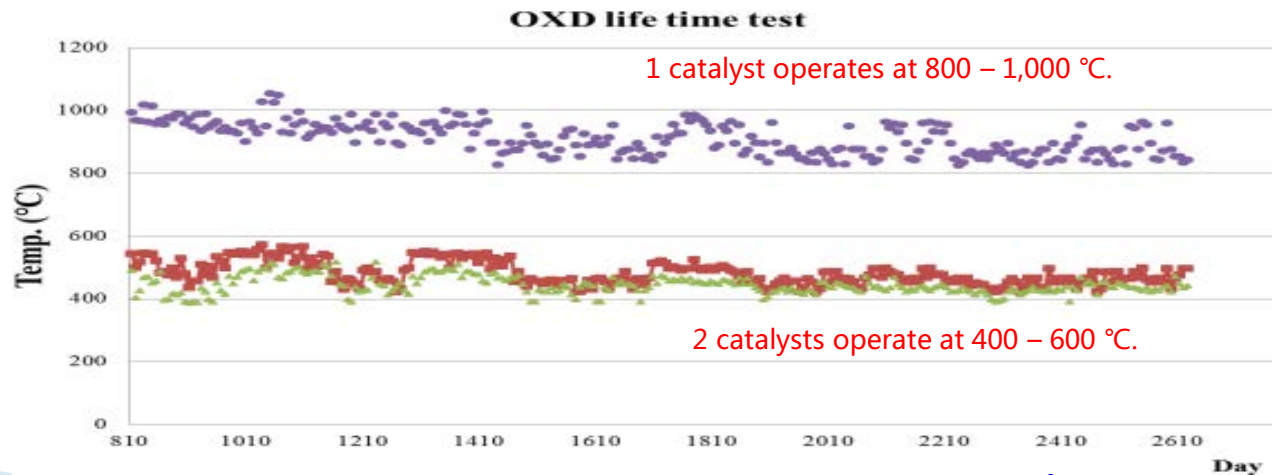
No flame No pollution



catalyst inside



reformer continuous operates > 19,220 hrs



catalyst continuous operates > 63,000 hrs

on site H2 generator – advantage 2

aluminum alloy

*high heat conductivity
homogeneous
temperature*



§ The reformer is made of a whole aluminum alloy not a die casting or an assembly of parts. That's why the reformer has advantages of

- high heat conductivity to start quickly,
- homogeneous temperature to make the conversion more efficient, and
- good structure and compressive strength to bear high pressure.

on site H2 generator – features

high value added

safety

stability & durability

small volume & easy to install



fast cold starting < 50min

high efficiency > 84%

low cost of H2 producing

high purity- H2 > 99.999%

on site H2 generator – feature description 1

§ fast starting

cold start < 50 minutes, hold-temperature start < 10 minutes.

It maintains stability of power supply, eg. solar power and fuel cells combine together can provide stable and low cost power service.

§ high efficiency

The total energy conversion efficiency is more than 84%. It avoids energy waste of H2 from pressurization and transportation.

§ low cost of H2 producing

In Taiwan, the price of high pressured H2 is NT\$30 – 50 / M3 (US\$1.0 – 1.7), while on-site production cost is only about NT\$13.6 / M3 (US\$0.45) at methanol price NT\$15 / kg (US\$0.5). The cost saving is more than 50%. It takes only several quarters to pay back of investment on on site H2 generator.

on site H2 generator – feature description 2

§ high purity

The H2 content is $> 99.9995\%$ and Co < 1 ppm.

§ small volume & easy to install

The cover area of an on site H2 generator is less than 2 m² and only a couple of pipes to be fixed. While a 3,000 M3 tube trailer needs 29.5M² (12.3 x 2.4 m) to lay down. Don't mention it needs more space when exchanging the tube trailer.

** 3,000 M3 tube trailer is standard device by gas traders.*

§ stability & durability

Self-testing run of H2 generator is more than 19,200 hours and still in operation.



on site H2 generator – feature description 3

§ safety

If H2 is provided by tube trailer, a lot of 3,000 M3 high pressure H2 (15 MPa) have to be stored on site. When hydrogen pipeline is replaced, leaking and pollution may be occurred. On site hydrogen generator produce H2 at low pressure (0.7 MPa). No H2 is stored. It's stable and has no such safety concerns.

Our leakage test of H2 generator is 250 °C / 2.0 MPa, much higher than operating pressure (0.7 Mpa).

2 detectors are installed in the generator to monitor the hydrogen leakage must be below 3,000 ppm and ensure the generator does not operate within the range of H2 spontaneous combustion concentration of 4 - 75%.

Under normal operating condition, the PV value of reformer is 0.04 which is far lower than that required (PV > 0.4) by Taiwan High Pressure Vessel Association. On site H2 generator is **NOT** regulated as high pressure vessel.

§ high value added

Generate electricity and provide hot water at the same time.

Performances – hydrogen station, Taiwan



20 NM³/hr, 35 MPa
H₂ > **99.9999 %**, CO < 1 ppm

Performances – stainless steel plant, China

For surface purification of stainless steel



50 NM³/hr

H₂ > 99.999 %, higher than that 99.99% of tube trailer hydrogen.

- **Cost down 75%** from RMB 12 – 15 / m³ (US\$2.0) to RMB 2.8 - 3.1 / m³ (US\$0.43).

Performances – FC CHP, Taiwan

Provide power & heat water for a swimming pool.

4 x 5 kW FC



4 x 5 NM³/hr
H₂ generator

20 kW CHP fuel cell system

* CHP: combined heat & power

Performances – telecom offices & mobile stations



H2 generator with 20 kW FC as UPS for mobile station.



H2 generator @20 NM³/hr with 20 kW FC to back up telecom facilities.

Biz contact

On site H2 generator is sold in Taiwan & China.

More than 130 generators were exported to China in 2015 – 2017.

Start exporting to Japan since Jan. 2018.

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