THERMOTEC TECHNOLOGY

THERMOTEC POWER Technology:

Direct path to efficient hydrogen economy

THERMOTEC Technology a.s.
info@thermotec-technology.com
www.thermotec-technology.com

Comparison of hydrogen production methods

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TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Electrolysis	Electrolysis Commercially available technology with a thoroughly examined process that allows modulation. High purity of the final product, the process is convenient for obtaining hydrogen from renewable energy sources.	High energy costs.
Hydrocarbon conversion	Widespread process and acceptable product cost.	Small-scale devices have no commercial value. The final product contains impurities, which requires expensive gas cleaning. Carbon dioxide emissions.
Gasification of solid combustible raw materials and biomass by pyrolysis	The technology is well studied on a large scale; an acceptable product cost.	Small-scale devices are rare; the final product requires intensive cleaning before use.
Thermochemical and combined cycles	It is possible to produce large volumes at low cost and without emitting greenhouse gases from heavy industry and transport.	It is a complex process; has no commercial significance; needs long-term studies for up to 15-20 years. Requires a high temperature nuclear reactor (HTNR) or solar concentrators.
Flameless gasification by the THERMOTEC POWER technology	**Commercially available technology with an industrially studied process that allows modular use. Significant purity of the final product with high efficiency gasification of raw materials. Lowest cost of product.**	
Biochemical processes	Potentially big resource.	Low rate of hydrogen accumulation. Requires large areas for production.

Estimates of the cost of centralized hydrogen production

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Estimates of the cost of centralized production
of liquefied hydrogen according to its production options US dollars / kg
* *I - optimistic estimates, II - moderate estimates, III – pessimistic estimates*

Production technology	Production cost *			Emissions CO2, kg CO2/kg H2
	I	II	III	
Liquefied H2				
Vapor conversion of methane (natural gas conversion)	2,9	3,7	4,4	17,4
Coal gasification by pyrolysis	3,8	3,9	4,1	30,0
Flameless coal gasification (THERMOTEC POWER)	**0,75**	**1,25**	**1,75**	**--**
Thermochemical decomposition of water in high-temperature gas cooled reactor	5,7	7,9	10,2	9,2
Electrolysis using electricity:				
from power system	5,7	8,6	11,6	48,6
from wind power	6,07	12,3	31,2	--
from solar installation	9,1	21,8	59,1	--

Economic parameters of the use of hydrogen in CHP

The cost of generating electricity, at a cost of obtaining liquid hydrogen using THERMOTEC POWER technology within **1.55 US dollars per 1 kg** and the efficiency of power equipment 0.60, will make:

0.0659 US dollars per 1 kW of electrical energy

or

65.90 US dollars per 1 MW of electrical energy

The use of one ton of liquid hydrogen (priced at $ 155.00 per ton, with THERMOTEC POWER technology), when generating electrical energy at a CHP plant, allows to replace for energy consumption intensity:

4,150 cubic meters of natural gas

3.50 tons of fuel oil

10.00 tons of brown coal

Main indicators of coal gasification processes

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INDICATOR	LURGI	WINKLER	KOPPERS-TOTZEK	THERMOTEC POWER
Type of coal	Brown, non-coking	Brown	All types	**All types**
Capacity of coal, t / h	40-75	20-35	Up to 40	**Any (power ascension by blocks)**
Coal particle size	Large pieces 6-50 mm	<10 mm	Pulverized, <0,1 mm	**Large pieces 50 mm – 100 mm**
Gasification efficiency, %	75-85	65-85	65-85	**99.99**
Temperature in the reaction zone, °C	750-1100	820-1100	1300-1700	**750 - 950**
Consumption:				
coal, кg /1000 m^3 of dry gas	800-650	750-610	660-560	**500 - 600**
oxygen, m^3 / 1000 m^3 (CO + H_2)	210-250	300-350	400-500	**None**
Heat of gas combustion, MJ/m^3	11,9-16,3	7,5-9,4	10,3-11,7	**10 - 13 to get H_2 (aggregate mode 1) or 35-45 – to generate energy (aggregate mode 2)**
Composition of dry gas, % CO_2 + H_2S	25-31	17-22	10-13	**3 - 10 (CO_2) (no formation ofH_2S)**
CH_4				**5 - 30**
CO	17-25	31-35	50-60	**15 - 35**
H_2	40-42	32-43	29-34	**35 - 60**

Competitive advantages.
Production and environmental aspects.

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According to the project concept

- Application of modern technologies of the leading world manufacturers for the production of hydrogen from synthesis gas;
- Flameless recycling occurs without direct combustion of brown coal and without blowing air with oxygen;
- No lining in coal-gasification reactors;
- According to the design, the metal wall has external heating, which creates at least 50-fold improvement in heat transfer, compared to other coal-gasification reactors;
- Operates in atmospheric pressure mode;
- Continuous gasification process with the brown coal gasification efficiency of 99, 99.

Environmental compliance

- Application of and full compliance with environmental standards, the use of world experience in the operation of such facilities in the design of the proposed solutions;
- The application of the UNDP Equator Principles, which excludes the use of hazardous substances or actions that may entail destructive consequences, and exclude forced displacements;
- Deep and complex processing of brown coal without ash and slag and without other hazardous waste that is characteristic of other coal-gasification reactors.

Thank you for your attention!

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