Hydrogen from waste

Thermoselect as part of a modern hydrogen technology

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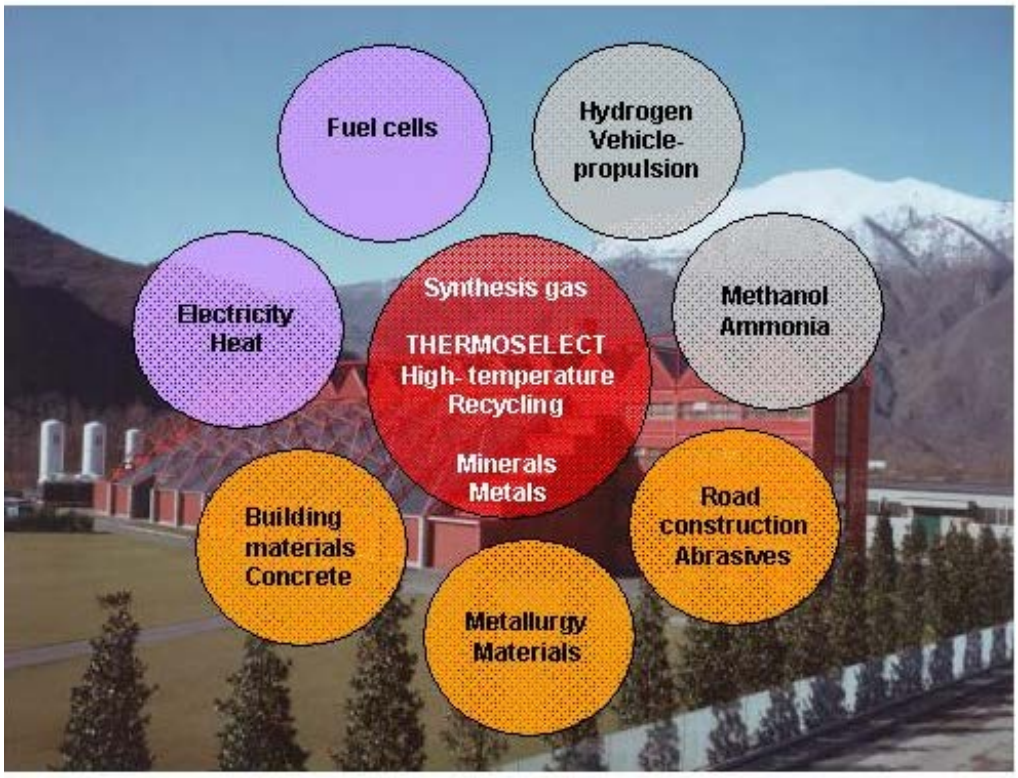

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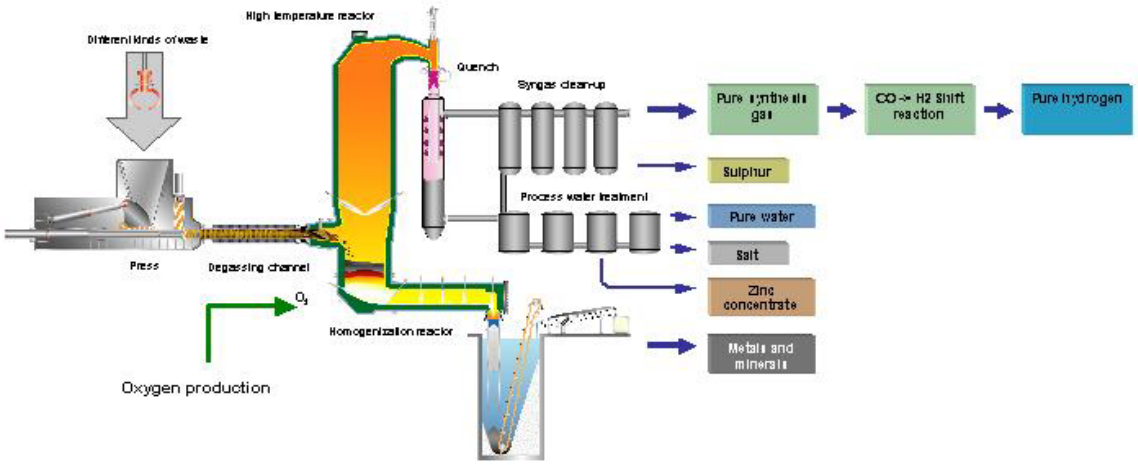
Thermoselect as part of a modern hydrogen industry

A new source for hydrogen production is given by the Thermoselect waste recycling process. Waste is pressed and then decomposited in a high temperature reactor.

The resulting product, profiting from the energy content of the waste, is a synthesis gas, consisting of 30-35 % hydrogen. Hydrogen can be fed into fuel cells, allowing emission free transport systems.

Thermoselect High Temperature Gasification is a continuous process. The technology allows ecological and complete thermal recycling. Hydrogen rich synthesis gas (syngas) is produced by compression and degassing of waste in the degassing channel at temperatures of about 600°C, followed by the conversion of organic compounds in a high temperature reactor at temperatures up to 1200°C. Non-organic compounds are melted at temperatures of 1200–2000°C. They result in recyclable, ecological stable solid products (mineral- and metal granulate).

Beyond the high temperature reactor, a quench is installed, where the synthesis gas is “shock-cooled”, avoiding the formation of toxic organic compounds (like furans and dioxins). Most corrosive material is washed out from the syngas into the quench water. Then the synthesis gas is neutralised in an alkaline scrubber, before entering a desulphurization unit, where the sulphur hydroxide (H_2S) is oxidised to elementary sulphur with an iron-III chelate solution. The cleaned synthesis gas can be utilised for electricity production or for chemical synthesis, e.g. for the production of hydrogen.



In the Thermoselect process the following materials are produced from 1 ton of waste and app. 520 kg oxygen: 900 kg Synthesis gas, 350 kg cleaned water, 230 kg

minerals, 24 kg metals, 3 kg elementary sulphur, 3 kg zinc-hydroxide and 10 kg industrial salt. All products can be used in industry.

Nowadays seven Thermoselect plants are in commercial operation. Fuel cells have been tested in the plant in Chiba, Japan.

Waste as a source of hydrogen

Energy from renewable resources will and has to increase, partly in order to replace nuclear energy. Wind and solar energy production will cover a good portion of the needs, however, energy from waste should not be forgotten and made available in the best future oriented way.

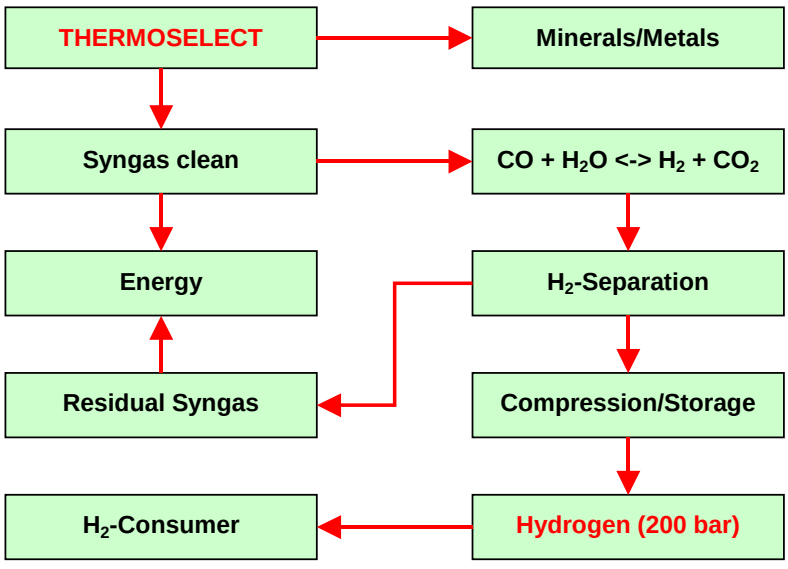
Hydrogen will become more and more important as an energy-carrier and storage and has the potential to replace fossil energy, while avoiding emissions to the air. The cost of hydrogen production is relatively high, if it is produced from fossil resources like natural gas. If hydrogen could be produced economically viable, it could be the best vehicle to keep air clean in huge cities.

The Thermoselect waste recycling process is an economical an ecological interesting solution for hydrogen production. The synthesis gas produced from waste, contains 30–35 % hydrogen and 30–35 % carbon monoxide. The hydrogen concentration in the synthesis gas can be increased by catalytic CO-Shift reaction:

$$CO + H2O \Leftrightarrow CO2 + H2$$

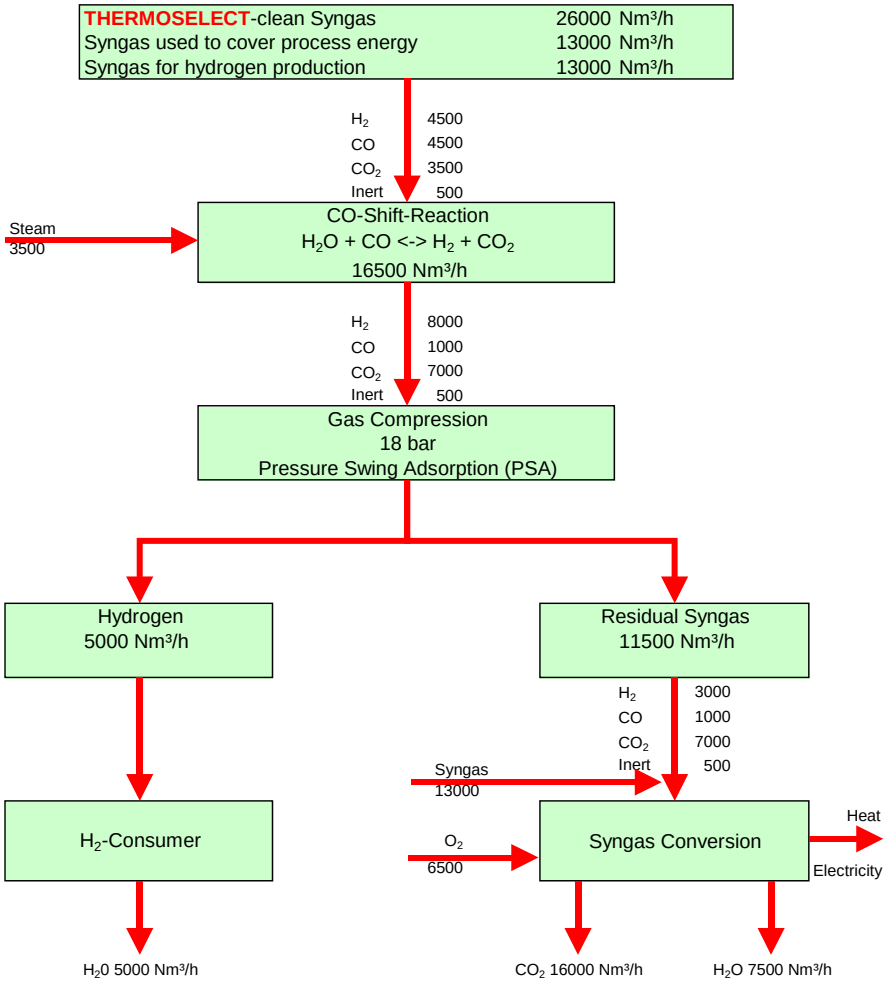
In this process the carbon monoxide reacts with water (steam) to yield hydrogen and carbon dioxide (CO2).

In the following process step, hydrogen can be separated by pressure swing adsorption (PSA). PSA uses the different adsorption characteristics of hydrogen and the other syngas compounds for separation. Pure hydrogen (>99%) and a remaining amount of synthesis gas are the resulting products of the PSA. The remaining synthesis gas can be used for the production of steam or electricity.



If half of the syngas is used for hydrogen production and the other half is used to produce electricity and steam, the Thermoselect plant including the hydrogen production should be able to operate without use of external energy. The exact energy balance depends on the throughput capacity and the heating value of the waste input.

In a plant size of 200,000 Mg waste / year app. 4,000 Mg hydrogen at 200 bar pressure can be produced (20 kg hydrogen / Mg waste) as shown in the following figure. The costs for the additional steps for the production of hydrogen form syngas are app. 0.10 €/Nm3 hydrogen.



Future

Hydrogen production from synthesis gas can be an important possibility to make use of the energy content in waste. A main advantage is that hydrogen can be produced without fossil energy. Hydrogen produced from waste could cover the needs of waste collecting trucks, taxis and other public transport system. Those have to be equipped with fuel cells, allowing them to drive without air-emissions.

A truck that collects 1 000 kg waste needs app. 10 kg fossil fuel or 3.5 kg hydrogen as energy equivalent. Assuming that 20 kg hydrogen / Mg waste can be produced, there would be 16.5 kg hydrogen / Mg waste available for public transport.

The above described plant has an annual capacity of 200,000 Mg waste. In average there would be 600 Mg waste / day treated in the plant. With this amount of waste there would be a daily production of 2,100 kg hydrogen for the waste collecting system and 9,900 kg hydrogen for the public transport. The annual produced amount of 4,000 Mg hydrogen yields to a CO2 reduction in the city centres of app. 40,000 Mg. This plant could treat the waste of app. 1 million citizens.