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Low Temperature Hydrogenation

Catalytic Depolymerization Process- Conversion of Waste to Diesel or Catalytic hydrogenation with biomass as the hydrogen carrier by low temperature and low pressure

Preamble

As we know, hydrogenation and gasification are competitors since long time in the fuel production. Many combinations are developed for the hydrogenation with hydrogen and the gasification with air, oxygen and steam. In spite of the higher efficiency of the hydrogenation the gasification was more used than the hydrogenation. The reason for was the high pressure of more than 90 bar for the hydrogenation with hydrogen gas and Nickel catalyist.

After the gasification showed many problems with sticky particles, dioxins and furans the competition with the hydrogenation is again discussed.

Discoveries in hydrogenation

Not expected was discovered a new way in the hydrogenation. When hydrogen in the reaction is substituted with biomass, then the necessary pressure for the reaction can be reduced from 90 bars to less than normal pressure. For this process we do not need nickel as the catalyst, we can use the much cheaper minerals of the biomass in form of cation-aluminum-silicate (*Bentonite –Ian Coates*). Also the reaction temperature drops down to less than 300°C. (*no Dioxins/ Furans –icc*).

We have to take into account for this reaction the other energy input in the reaction. This reaction is not possible by heating from outside. This reaction takes place only by friction, by heating in a mixing chamber called a friction turbine. Nobody heated a reaction by friction before. Nobody tried to heat a chemical reaction with a friction turbine. Therefore nobody before ALPHAKAT could find this soft hydrogenation system.

Under the special condition of:

- Energy input in form of a mixing chamber, called friction turbine



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- Catalyst in the circulation medium for the system in form of cation-aluminum-silicate in the range of 5 to 20 %

We have a destruction of the biomass into a fuel molecule on the example of cellulose (1) and sugar (2) in form of

1. $C_6H_{11}O_5 = 2,5 CO_2 + (CH_2)_n (3,5) + H (4)$
2. $C_6H_{12}O_6 = 3 CO_2 + (CH_2)_n (3) + H (6)$

This 4 or 6 hydrogen (in stadium nascent) hydrogenates the input material by normal pressure or under pressure all hydrocarbons including olefins, like plastic, oil, rubber and bitumen, to alkanes and substitute the catalyst in the reaction mass with hydrogen to realize such a low temperature of less than 300°C. This is a pure chemical reaction and has nothing to do with thermal splitting, pyrolysis or thermal destruction.

Therefore the product is a chemical with a high quality, has no smell of pyrolysis and contains no ammonium, dioxins, furans and lighter components. Nobody went (commercially) this way of nature. All the crude oil is produced like this; by lower temperature (14-19°C) and much longer reaction time (thousands of years).

To get to know this reaction was not easy, because all the prejudgments of the chemical engineering show in the other direction. Only the consequences of continuing to look for a 100 % dioxin free process, lead to the scientific discovery of this process. Finally we found this reaction in a special mixing system, with molecule fine powder of the cation-aluminum-silicate, with addition of lime in the reaction, to hold the pH-value higher than 8,5. Then we found an unlimited life time of the catalyst.

Hydrogenation Test using Biomass

We discovered the process and the chemical structure in a special test series. A customer wants to test residues from sun flower residue in the conversion to fuel. We tested several times 5 kg input and got 15 l diesel for each test. Therefore it was demonstrated, that the hydrogen of 5 kg press residue from sun flowers can hydrogenate 15 l waste oil to saturated hydrocarbons in the boiling range of 260°C. This is diesel. With other words, the hydrogen production of 1 kg biomass hydrogenates 3-4 kg mineral residues to diesel. In the case of coal we need another relation of biomass to coal with more biomass.



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What is the efficiency of the biomass in mixing with other hydrocarbons?

- Hydrogenation of the oil and plastic to alkenes and
- Substitution of the catalyst for the CO₂-extraction and Depolymerization with hydrogen to make the product vaporizable, this means the chemical product diesel is not longer covered from catalyst and can evaporate in the product line.

Use of Catalyst

The catalyst which allows this reaction can be added to the process in the following way:

- We add cation-aluminum-silicate produced in the silicate ion of sodium-aluminates or
- We use biomass + lime for the production of diesel fuel and the ash is our catalyst we need for the industrial and municipal waste.

This molecule fine catalyst allows a new catalytic system:

- Not stored in a vessel in form of pellets or honeycomb,
- The catalyst is fine suspended in the circulation oil and goes to the input of hydrocarbon to make the CO₂-extraction and the Depolymerization.

This is a new system with the opposite catalytic reaction, the catalyst coming to the input and not the reaction mass going to the catalyst. This is supported by the high friction in the friction turbine. This system of chemical conversion makes the high product quality of saturated hydrocarbons.

This is new and no other production system in the chemical industry uses the friction turbine for heating and reaction and uses the tanks only for the separation.

Technique improvements

In other words, up to now, on no other place of the technique of chemical plants friction is used to heat and make the process. This is new in the technique and leads the fuel production in the direction of cheap catalytic hydrogenation with biomass and the minerals of the biomass as the catalyst.



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When we compare the level of investment in the old processes with the new low pressure process with the following;

- 90 bar hydrogen Nickel catalyst, higher temperature with heating from outside or
- under pressure, biomass as carrier for the hydrogen and heating with the friction turbine- then;

We can realize that the low pressure hydrogenation with biomass is much cheaper than all the old processes of gasification, pyrolysis and high pressure hydrogenation with hydrogen gas.

The KDV process

This can be applied in the production of fuel, because the KDV-system is completely environmental friendly and the cheaper way to the hydrogenation. The efficiency regarding to the low reaction temperature is very high in the range of 70 - 91 %. All the dangerous materials, like chlorine, flour and molecule fine metals are absorbed by the lime with the high pH-value and the crystalline catalyst.

The hydrogen content of the biomass is about 20 %. This is going in the way of the hydrogenation and in the case of pure biomass in the way to the production water. The hydrogen is consumed in the mixing during the technical production as for coal, transformer oil, PVC, Teflon, rubber, bitumen and refinery residue and less for plastic, waste oil and polymers like PE and PP.

All material, you can burn, you also can convert to diesel in the KDV

In summary we get the following results with the low hydrogenation process KDV:

- As long we have in the mixture enough biomass we get a unique product diesel with saturated hydrocarbons
- We do not need pressure
- The catalyst is coming from the biomass or synthetic from ALPHAKAT and Partners
- We do not get any emissions from the plant
- We use the vacuum system for inherent safety
- We do not form any poison hydrocarbons like Dioxins and Furans.

The KDV is therefore environmental friendly and has the highest efficiency from all known processes.