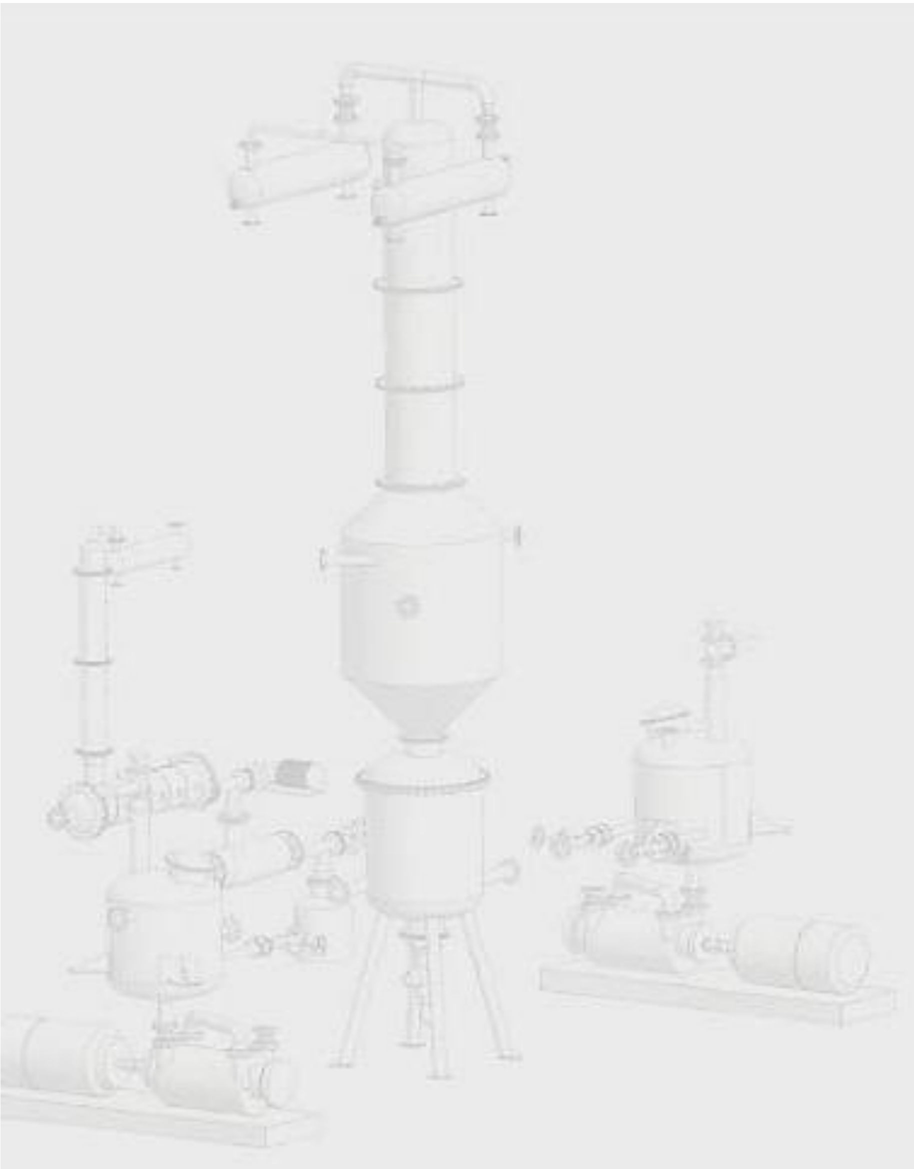
KDV / CPD Plant Diagram & Budget costs: [June 2011]

The KDV system is made up of four basic modules:



1 - **Sludge plant** for the feedstock preparation

2 - **KDV main core** for the sludge conversion

3 - **Ash plant** for the inorganics extraction

4 - **Genset module** (Generators and heat exchangers)

and a fifth optional module:

5 - Desulphurization module for sulphur extraction (required when processing Plastics, Tyres MSW and other synthetic organics)/\.

Comparison table:

Process	Energy efficiency	Yield (t oil/ha/a)	Oil-Equivalent
RME	45% - 54%	1,3	100%
Fischer Trop. Diesel	40% - 47%	1,7	131%
Methanol	40% - 55%	2,0	154%
Ethanol	33% - 50%	2,2	169%
CPD-Diesel	***70% - 75%***	***5,9***	***454%***

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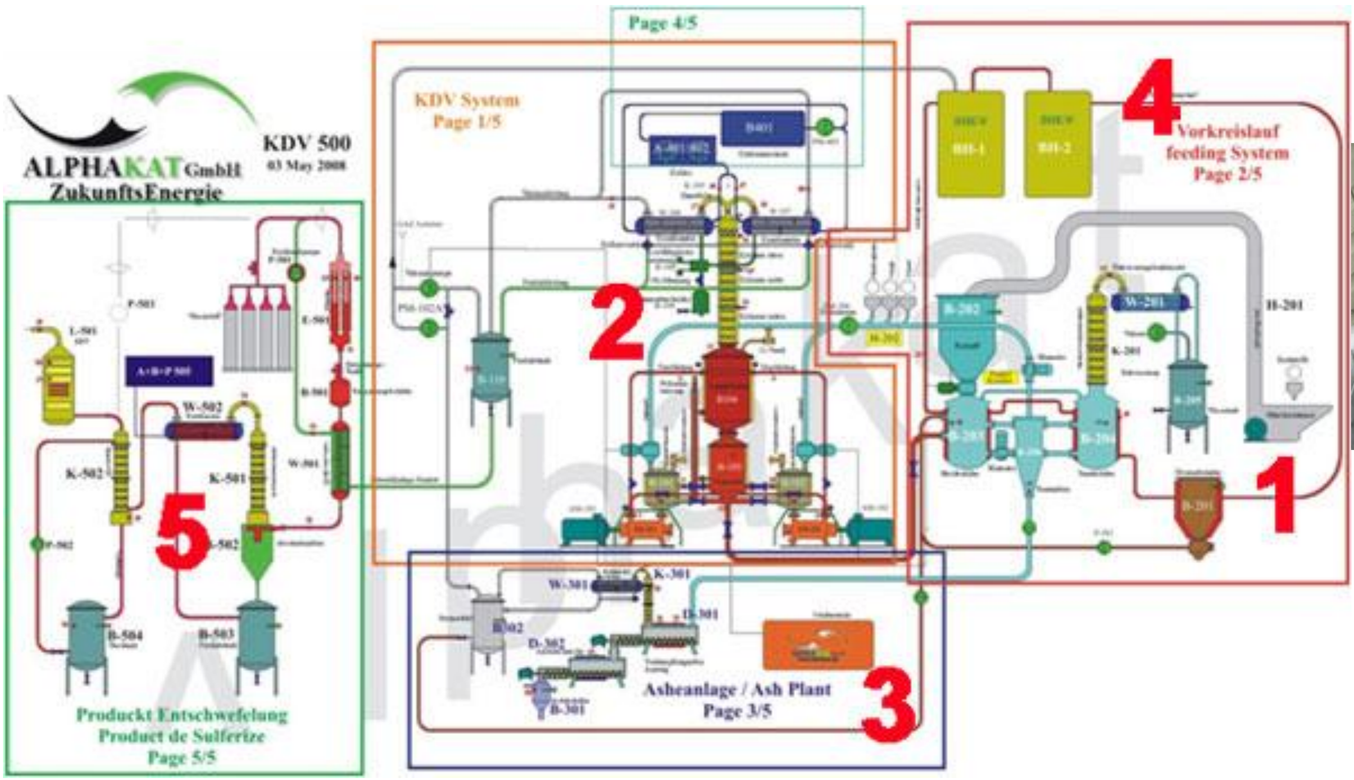

THE PRODUCTION OF SYNTHETIC DIESEL

[KDV METHOD]

The KDV/ CPD - method, from Germany:

Transforming biomass to Diesel-fuel via Low pressure Catalytic Deploymerisation, at low temperature & at low cost.

SYNTHETIC DIESEL FROM BIOMASS:

This paper discusses the potential of biomass utilization available in Thailand and alternative methods of production of synthetic liquid transportation fuel from biomass. This is to replace the conventional biofuel produced by trans-esterification and fermentation processes which has some disadvantages.

References: Krongkaew Laohalidanond*, Jürgen Heil and Christain Wirtgen Coking, Briquetting and Thermal Waste Treatment Group RWTH ***Aachen University, Germany***

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Dioxins and Furans:

Dioxins and furans are some of the most toxic chemicals known to science. Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxin in the environment comes from waste-burning incinerators of various sorts and also from backyard burn-barrels.

The low-temp Catalytic Pressureless Deploymerisation system [CPD] ensures that process temperatures remain well below 350C, ensuring that DIOXINS and FURANS are NOT FORMED!

KDV/CPD - Technical report:

This is a new catalytic hydrogenation of biomass technique and leads to clean synthetic bio-fuel production at low-cost..

Model, Size and Production Volume
Based upon Operations of 8,000 Hours/Year

Alphakat Model	Diesel		MSW etc – 50% Water Content		Install Time & commissioning
	Per Month	Per Year	Per Hour	Per Day	
KDV 1000 *1,000 liters/hr. or 250 gal/hr.*	668,000 Litres	**8,000,000 litres**	2.6 dry tons **5.4 wet tons**	63 dry tons **130 wet tons**	4-5 months
KDV 2000 *2,000 liters/hr. or 500 gal/hr.*	1,333,000 Litres	**16,000,000 Litres**	5.2 dry tons **10.8 wet tons**	125 dry tons **260 wet tons**	6-8 months

SID-com Alphakat includes all of the pre-processing equipment necessary for MSW separation, dehydration and shredding for all feedstock input including plastics (including the desulfurization required when processing plastics). This is a package arrangement also includes technology upgrades as they occur for no additional charge. The units take 4-8 months to deliver and install depending upon the size and type of feedstock to be processed.

Typically set-up costs as follows:
[Estimates valid for RSA – for other countries must add additional transport/ delivery costs and modest add-on for construction personnel during assembly and commissioning]:

Have not added any additional commissions! See comment at end of message.

Model	**Litres/ Year** **[8000 hr.]**	**Turnkey Cost (in RSA) ZAR**	**Diesel Production cost** **ZAR / Litre**	**Add-on Power Plant** [Siemens Turbo-alternator with Grid interface]
KDV 500	4,000,000	R 75,25 m	R 5.50/ litre	1.2 MW R 28 m
KDV 1000	8,000,000	R 113,0 m	R 5.00/ litre	2.5 MW R 42 m
KDV 2500	20,000,000	R 233,0 m	R 4.50/ litre	6.0 MW R 91 m
KDV 5000	40,000,000	R 320,25 m	R 4.10/ Litre	14 MW R 126 m

These plants will require biomass inputs (forestry waste for example) as follows:

Model	**Biomass** **Dry-basis** **Tonne./yr.**	**Biomass ex field: tonne. yr. (35% moisture)**	**Parasitic load in-plant** Litres/ year & MWe required from built-in Genset using own diesel
KDV 500	10,000	15,500	400,000 litres 0.25 MWe
KDV 1000	20,000	31,000	800,000 litres 0.50 MWe
KDV 2500	50,000	77,000	2,000,000 litres 1.0 MWe
KDV 5000	10,000	150,000	4,000,000 litres 2.0 MWe

Customer to supply the following: [i.e. not incl. in budget pricing above].

1. Tank Farm [1 week's diesel output storage is part of AlphaKat plant].
2. Raw Material storage and handling (pre-processing/ chipping could be done at collection site for example) – on-site storage for 2 weeks recommended.
3. Land for the plant ranging from 1.5 Ha to 10 Ha according to plant size.
4. Admin buildings and amenities for plant operating personnel.
5. Accommodation for erection crew for installation and commissioning 12 weeks to 30 weeks for larger plants. [Suggest pre-fab work-camp that can then be converted and used as admin facility for operating plant].
6. Unloading facilities at construction site / craneage, to receive containerised equipment in preparation for installation and assembly by SID-com specialist crew.
7. Port-side clearance documentation and Import taxes SARS documentation and clearance if applicable

Included in these estimates is approx. 5% for Professional & General / supervision fees for Amandla and the local engineering services required for the site establishment and support for the installation crew, local regulatory requirements.

ALPHAKAT
ZukunftsEnergie

Technical explanation:

Gesellschaft für katalytische
Aufbereitungstechnologien mbH

Low Temperature Hydrogenation

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

Preamble

As we know, hydrogenation and gasification are long-since competitors in fuel production. Many combinations are developed for hydrogenation with hydrogen and the gasification with air, oxygen and steam. In spite of the higher efficiency of the hydrogenation, the gasification route was more prevalent than the hydrogenation. The reason for this was the high pressure of more than 90 bars for the hydrogenation with hydrogen gas and Nickel catalyst (Fischer Tropsch).

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

Discoveries in hydrogenation

Unexpectedly, a new way was discovered for 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 much cheaper minerals with the biomass in form of cation-aluminium-silicate (*Bentonite – Ian Coates*) and lime. 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 inputs into 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 as a **friction turbine**. Nobody heated a reaction by friction before now. Nobody tried to heat a chemical reaction with a friction turbine. Therefore nobody before Alphakat was able to sustain this *soft hydrogenation system*.

Under the special condition of:

- Energy input in from a mixing chamber, called ***friction turbine***
- Catalyst in the circulation medium for the system in form of cation-aluminium-silicate in the range of 5% to 20 %

We have a destruction of the biomass into a fuel molecule: -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 substitutes 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 fossil-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 lead 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 molecular-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 costumer wants to test residues from sun flower residue in the conversion to fuel. We tested several times 5 kg input and got 15 litres of diesel for each test. Therefore it was demonstrated, that the hydrogen of 5 kg press-residue from sun flowers (Press-cake) can hydrogenate to 15 l waste oil (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.

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 CO_2-extraction and deploymerisation with hydrogen to make the product vaporizable, this means the chemical product diesel is no longer covered from catalyst and can evaporate in the product line.

<u>Use of Catalyst [Typically Bentonite clay & Lime]:</u>

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 recycled ash is our catalyst that we need for the industrial and municipal waste.

This molecular-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 CO_2-extraction and the depolymerization.

This is a new system with an *<u>opposite catalytic reaction</u>*: the catalyst coming in at 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 ensures a high product quality of the saturated hydrocarbons (NOT a pyrolysis process).

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

<u>Technique improvements</u>

In other words, up to now, the technique of friction to heat and make the process is seen in no other place in chemical plants. This is an entirely new technique and leads us now to diesel-fuel production using cost-effective catalytic hydrogenation with biomass and the recycled ash-minerals of the biomass, as the catalyst.

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

- 90 bar hydrogen Nickel catalyst, higher temperature with heating from outside or

- under low-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 / CPD process

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

The hydrogen content of the biomass is about 20 %. This is going towards hydrogenation and in the case of pure biomass, to the production of water. This hydrogen is consumed in the mixing with technical production better for coal, transformer oil, PVC, Teflon, rubber, bitumen and refinery residue and somewhat 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 emission from the plant!**
- We use the vacuum system for inherent safety (no pressure so no escape gases).
- We do not form any poisonous hydrocarbons like Dioxins and Furans!

The KDV is therefore environmentally friendly and has the highest efficiency from all known fuel-from carbonaceous feedstock processes.

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