



**THE WORLD RESOURCE
FOUNDATION**
FINANCIAL RESOURCES TRUST AND SERVICES

TWRKDV TECHNOLOGY



“Energy Recovery from Waste, we face the future”

2012



1.INTRODUCTION

The composition of municipal waste varies greatly from country to country and changes significantly with time. In countries which have a developed recycling culture, the Municipal Solid Waste (MSW)—more commonly known as trash or garbage—consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses. At the start of the 20th century, the majority of domestic waste in the UK consisted of coal ash from open fires.

In developed countries without significant recycling it predominantly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous wastes from residential, commercial, institutional, and industrial sources. Most definitions of municipal solid waste do not include industrial wastes, agricultural wastes, medical waste, radioactive waste or sewage sludge.

The municipal solid waste industry has four components: recycling, composting, landfilling, and waste-to-energy via incineration. The primary steps are generation, collection, sorting and separation, transfer, and disposal. Activities in which materials are identified as no longer being of value and are either thrown out or gathered together for disposal.

The functional element of collection includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station or a landfill disposal site.

Municipal solid waste can be used to generate energy. Several technologies have been developed that make the processing of MSW for energy generation cleaner and more economical than ever before, including landfill gas capture, combustion, pyrolysis and gasification. While older waste incineration plants emitted high levels of pollutants, recent regulatory changes and new technologies have significantly reduced this concern. United States Environmental Protection Agency (EPA) regulations in 1995 and 2000 under the Clean Air Act have succeeded in reducing emissions of dioxins from waste-to-energy facilities by more than 99 percent below 1990 levels, while mercury emissions have been by over 90 percent. The EPA noted these improvements in 2003, citing waste-to-energy as a power source “with less environmental impact than almost any other source of electricity”.

Energy recovery from waste is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolysis, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE).



The benefits of energy recovery from waste include:

- Recovery of valuable resources that might otherwise be disposed of as a waste
- Generation of electricity and heat from waste, a renewable source of energy
- Reduction of carbon emissions by offsetting the need for energy from fossil sources and reduction of methane generation from landfills.

2.COMPANY

2.1.TWRKDV

KDV is a German company that focuses on:

- Engineering, components production, Research and Development, electric and electronic technologies
- Plants and systems featuring the use of an advanced catalyst
- Plants that convert any organic material to synthetic diesel with a process copied from the natural process of crude oil production (KDV technology)

KDV actually is a synonym of "Catalytic Depolymerization"



2.2.TWRKDV TECHNOLOGY

Since 2003 KDV invented and patented what today is our main product, known as "TWRKDV technology" based on our catalytic low temperature pressureless process.



- The TWRKDV plants use a catalyst with the same structure as what occurs in nature, outputs the same product and with the same environmentally benign process.
- The plant executes this process much faster than in nature since the structure of the catalyst is advanced (fine-molecule, ion-exchange and 100% crystallized) and the process takes place in an oil cycle instead of a water cycle, with a turbine rather than in a sediment.
- The result is that a conversion that took 300,000,000 years in nature happens in just 3 minutes

2.3.OTHER ACTIVITIES

TWRKDV is also active in other sectors of the energy and environmental fields, working with catalytic processes for cleaning combustion, isothermic heat-pipe reactors, low pressure hydrogenation, ash-recycling and development engineering.

TWRKDV partners on projects that can provide a comprehensive solution to the environmental problems of waste recycling. Replacing exhaust gas with fuel produced by our plant also provides a solution to the energy shortage problem. No other fuel has such a high calorific value and is so easy to store than the clean diesel generated by our plant. We offer a solution to environmental problems that is also an excellent means of generating fuel that is readily stored and distributed.

Nature is showing us the way to solve our energy and environmental issues at once.

3.HISTORY

3.1.THE INVENTOR: DR.CHRISTIAN KOCH





Born in 1940 in Werdau (Saxony)

Dr. Koch studied chemical engineering in Dresden and earned his “Diplom-Ingenieur” degree in 1964. At the same time he also studied Engineering Education and earned another “Diplom-Ingenieur”. Several years later in 1973 he earned his Doctors degree in Erlangen.

His first work (1964-1967) was as an associate professor at the engineering school.

Dr. Koch then worked six years (1967-1973) in the Research Center of Siemens Erlangen in the areas of superconducting, fuel cell systems and catalytic reactors for different systems, including submarines.

From 1973 to 1984 Dr. Koch worked in KWU Erlangen V94 (The Siemens Power Generation Group) in special development of systems for chemical plants, the permission system EVA (Brockdorf, Grohnde), and research of fuel conversion-techniques, gasification and catalytic processes with crude oil and coal in Venezuela, Brazil, and Germany. He was also involved in various countries in the field of high temperature nuclear reactor development.

From 1984 to 2003 he worked in the fields of energy techniques, chemical plants, and crystal catalysts with the company Salzgitter.

In 2003 Dr. Koch founded KDV with the "Friktionsturbinen-Verölungstechnik" KDV process for the conversion of organic material to synthetic fuel.

He is also developing a special catalyst (ICR, synthetic platinum) for fuel conversion, cleaning of air emissions, reduction of air pollutants and desulphurization.

Dr.Christian Koch is one of the most recognized scientists in the energy field.

3.2.THE INVENTION: KDV PROCESS

After 30 years of intensive research and development, the German scientist and catalyst-specialist Dr. Christian Koch discovered a spectacular breakthrough in energy conversion.

His process is the first to produce economical and environmentally friendly energy production, using a wide variety of waste products and renewable resources as feedstock.

3.2.1.PROCESS BACKGROUND

Depolymerization is a process for the reduction of complex organic materials (usually waste products of



various sorts, often known as biomass) into hydrocarbons or mineral diesel fuel from crude oil. It mimics the natural geological processes thought to be involved in the production of fossil fuels. Under pressure and heat, long chain polymers of hydrogen, oxygen, and carbon decompose into short-chain petroleum hydrocarbons with a maximum length of around 18 carbons.

The depolymerization process for fuel production from organic materials takes two forms: thermal and catalytic.

The thermal depolymerization process that does not use a catalyst has a variety of limitations. The process only breaks long molecules into shorter ones. Longer molecules are not created, so short molecules such as carbon dioxide or methane cannot be converted to oil through this process. In addition, since the thermal depolymerization approach requires temperatures much greater than 400°C, there is the risk of producing toxic byproducts such as dioxins and furans in addition to carbon dioxide and methane.

Dr. Christian Koch was focused on environment-friendly solutions and decided to move in the direction of the catalytic depolymerization.



3.2.2. CATALYTIC DEPOLYMERIZATION

The catalytic depolymerization process (CDP) is a depolymerization process that occurs at a relatively low temperature and low pressure. Due to the low temperature, a catalyst is required to crack the hydrocarbon molecule. The process requires a temperature above around 270°C and the use of an ion exchange catalyst. However, if the temperature is kept below 400°C, production of carbon



dioxide, dioxins, and furans is avoided.

The catalytic approach is preferable to the thermal approach. The thermal approach latter requires substantial energy input to reach required temperature, a reactor that can withstand high pressures, and further processing to deal with toxic byproducts.

Using the KDV catalyst, the catalytic approach requires only a temperature greater than around 270°C and proper mixing to insure complete reaction of the feedstock with the catalyst.

3.3. INDUSTRIAL DEVELOPMENT

3.3.1. MILESTONES IN THE INDUSTRIAL DEVELOPMENT

We have come a long way to take our KDV chemical process out of the labs and develop full scale industrial plants. In this effort we have been testing all the mechanic components (valves, pumps, sensors, turbine reactors, dosifiers, etc....) just to reach the expected production of our systems

- 1971 Invention of special catalytic converters (cracking carburetors)
- 1972 New environmentally friendly fuels and conversion process (Mobil Oil process)
- 1981 Start of oil conversion development (Orinoco)
- 1998/1999 Pilot plant in Puchan, Korea
- 2000 Pilot Plant at Neuensalz, Germany
- 2004 TWRKDV 500 first industrial plant in Monterrey, Mexico
- 2005 TWRKDV development of the turbine reactor
- 2007 TWRKDV500 plant in Bulgaria
- 2007 TWRKDV500 plant in Ontario, Canada
- 2008 Industrial TWRKDV 500 demo plant for diverse material testing in Hoyerswerda, German.
- 2009 Industrial plant in Tarragona, Spain TWRKDV1000
- 2009 Design of the first KDV large system TWRKDV 5000



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- 2010 Full installation of the TWRKDV500 industrial plant in Massachusetts
- 2010 Development of the MDS (Multiple Dynamic Sealing) turbine reactor
- 2010 Design of the first TWRKDV small system TWRKDV150
- 2010 Startup of the first TWRKDV150 in Eppendorf, Germany
- 2012 Erection of the first TWRKDV150 in Bari, Italy
- 2012 Erection of the first TWRKDV150 in Ethiopia, Africa
- 2012 Erection of the first TWRKDV1000 "Compact" in Poland





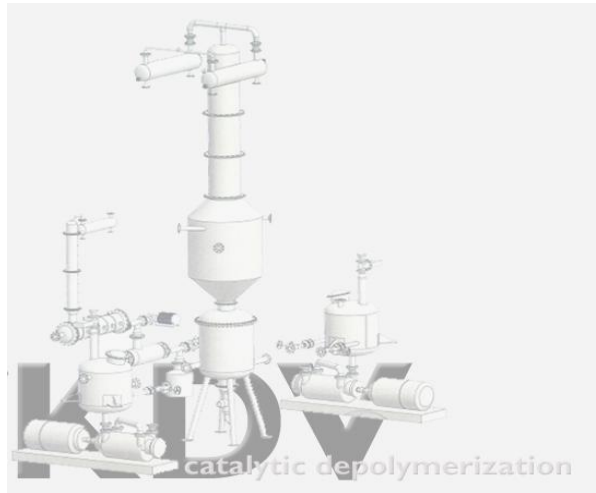
4.PROCESS

4.1.CHARACTERISTICS

4.1.1.CATALYTIC DEPOLYMERIZATION

Depolymerization is a process for the reduction of complex organic materials into light crude oil. It mimics the natural geological processes thought to be involved in the production of fossil fuels.

Under pressure and heat, long chain polymers of hydrogen, oxygen, and carbon decompose into short-chain petroleum hydrocarbons with a maximum length of around 18 carbons.



4.1.2.SELECTIVE CATALYST

In order to get shorter hydrocarbons chains it is used a selective catalyst developed and patented by Dr.Christian Koch. The catalyst crystals used in this process have a double function:

1. To catalyze the reaction, facilitating the formation of valuable products
2. As ion exchanger, retaining the hetero-atoms like halogens, phosphorus, nitrogen and heavy metals present in the raw material, transforming them into inorganic salts.

4.1.3.LOW TEMPERATURE

The catalytic depolymerization process is a reaction process that occurs at relatively low temperature and low pressure. Due to the low temperature, a catalyst is required to crack the hydrocarbon molecule.



The process requires a temperature above 270oC and the use of an ion exchange catalyst. However, if the temperature is kept below 400oC, production of carbon dioxide, dioxins, and furan is avoided. The KDV process is not a pyrolysis reaction, that is why a coke formation can not occur.

4.1.4.PROCESS EFFICIENCY

The efficiency is regarding to the low reaction temperature (250 285°C), and high conversion rates (about 80 % of the Hydrocarbons content of the input materials.)

The process unit is very low maintenance, reliable and safe. Energy demand, heat and power, for processing is supplied by a combined heat and power (CHP) plant, consuming only about 10% of the diesel produced.

4.2.PROCESS DESCRIPTION

4.2.1.THE SITUATION

World supplies of crude oil are running out and their cost is spiraling upward.

The future of civilization and the security of our societies depend on the production of affordable fuels that can substitute for natural crude oil. New approaches using renewable biomass and organic waste are an attractive alternative, especially when fuel can be produced through a low cost zero-emissions process. And when the process is capable of converting huge volumes of biomass and organic wastes which may include toxins, including plastics, municipal waste, sewage, used oils into diesel. Such a process is even more attractive when the conversion process can be used on site where organic wastes are produced and the diesel produced can be used on site to substitute diesel fuel, for process or building heating or to power truck fleets, company cars and industrial equipment.

Consider the huge volumes of biomass and organic wastes generated every day around the world wastes which cause so much damage, degradation and cost to the environment in their disposal.

Consider what it might mean if there were a process capable of cleanly converting all these organic wastes into diesel without any toxic airborne emissions or solid toxic residues?

Well, it has now been proven possible to do this and at a cost considerably cheaper than extracting and converting crude oil to petrol or diesel.

This new KDV patented process uses a purpose-designed reactor to simulate, within minutes, the natural production of oil / hydrocarbons that otherwise has to take place below earth's surface over



millions of years. This process can be scaled from small mobile units to large scale refinery-size designs.

The process mimics the natural crude oil production in the earth and then mimics the oil refinery process to produce diesel all in one convenient contained reactor / refinery.

4.2.2.WASTE IN DIESEL OUT

It sounds too good to be true, but after 25 years of R&D beginning in Siemens laboratories followed by a buy-out of the rights to the technology by the inventor Dr Christian Koch, units are now in operation worldwide and have proven successful producing diesel at a cost as low as € 0.23 per liter!

Basic process parameters:

- ❖ Temperature of 270 °C to 350 °C
- ❖ Ion exchanging catalysts
- ❖ 100% crystalline and extreme active γ -catalysts

Key to this process is the catalyst developed over decades of intense research and optimized for minimal catalyst consumption, resulting in low operational costs.

The process unit is very low maintenance, reliable and safe. Energy demand, heat and power, for processing is supplied by a combined heat and power (CHP) plant, consuming only about 10% of the diesel produced. Apart from the organic waste material there is no need of any other input.

In a closed loop the organic waste / raw materials, mixed with the purpose-designed catalysts, produce the following catalytic reaction:

- ❖ Depolymerization of long hydrocarbons at low temperature (290 °C 350 °C) and low pressure (0.9 bar)
- ❖ Unique high output of more than 80% of the input hydrocarbons
- ❖ Fixation of hazardous halogens into salts
- ❖ Output of standard diesel fuel

4.3.REACTION PROCESS

What takes place in the KDV [Katalytische Drucklose Verölung catalytic low pressure depolymerisation] reaction?

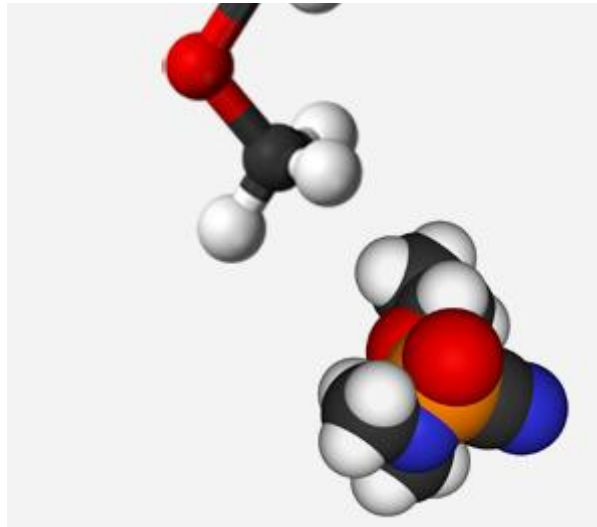
What material conversion occurs in the reaction turbine?



The test plant in Eppendorf [Germany], run by the Institut für Neuwertwirtschaft IFN [Institute for Industrial Sustainability], was recently used for a week-long test on graded waste from Leipzig.

The following results were obtained:

- The reaction temperature at the hottest point in reaction turbine was 282 °C (without any further energy input in the form of heating, microwave energy or flame)
- 89% yield of the hydrocarbons (introduced into the process) in the final product
- Calorific value of the final product 12,000 kcal/kg (alkanes in the C16 group)
- CN number of the product was 63.6
- Approx. 90% degree of desulphurisation compared to the input material
- Density, viscosity, water content and residual material content within the tolerances specified in EN 590.



These are not the results of pyrolysis, or thermal disaggregation set off by the application of external heat, as is repeatedly and mistakenly asserted by Professor Behrendt in Berlin.

These are the results of the catalytic diffusion reaction (at 282 °C), analogous to the reaction of the original creation of Earth's oil.

The increase of the conversion temperature from 15 to 282 °C and the change of the reaction process



from water to oil, i.e. the differences from Earth's oil creation process, have almost no influence here.

What really takes place in the turbine?

The input residual materials, a mixture of

- biomass such as paper, cellulose, constant, fats, wood and organic squeezing residues and
- mineral-based materials, e.g. plastics, oils, bitumen and rubber come into close contact with the reaction carrier (80% oil, 20% catalyst).

In the process of mixing, adsorption of the catalyst by the input material, the reaction, the desorption of the reaction products formed and the evaporation of the reaction products take place in a cycle of approximately three minutes at approx. 280 °C in the reaction turbine.

The individual reactions are significant as they explain how it is that product is high-quality diesel oil.



There are two different reactions, which to all intents and purposes are as follows:

1. "CO₂ extraction", which reduces the oxygen content of the organic components to zero, and thereby produces a hydrogen surplus; and
2. "Depolymerisation", i.e. molecular cracking, which continues until the molecule chains are so short that the reaction temperature enables evaporation.

This is the reason why only hydrocarbons with an evaporation temperature of approximately 280 °C are



generated and that is diesel oil. Apart from diesel oil only three further materials are generated:

- CO₂ resulting from the catalytic extraction reaction,
- water if there is any residual moisture in the input material
- ashes, if there are inorganic materials in the input material, or
- if the surplus hydrogen reacts with oxygen (reaction water) when pure organic material is input.

Hence it is incorrect to assume that products containing oxygen as created in pyrolysis should result from this reaction. It is not a reaction involving thermal disaggregation with the extraction of oxygen in the form of H₂O but rather a catalytic diffusion reaction with the extraction of oxygen in the form of CO₂.

This has of course a very significant effect on the H:C relationship of the product. In the case of pyrolysis, unsaturated hydrocarbons, steam and coke are generated in addition to methane. In the case of KDV, saturated hydrocarbons and CO₂ are generated.

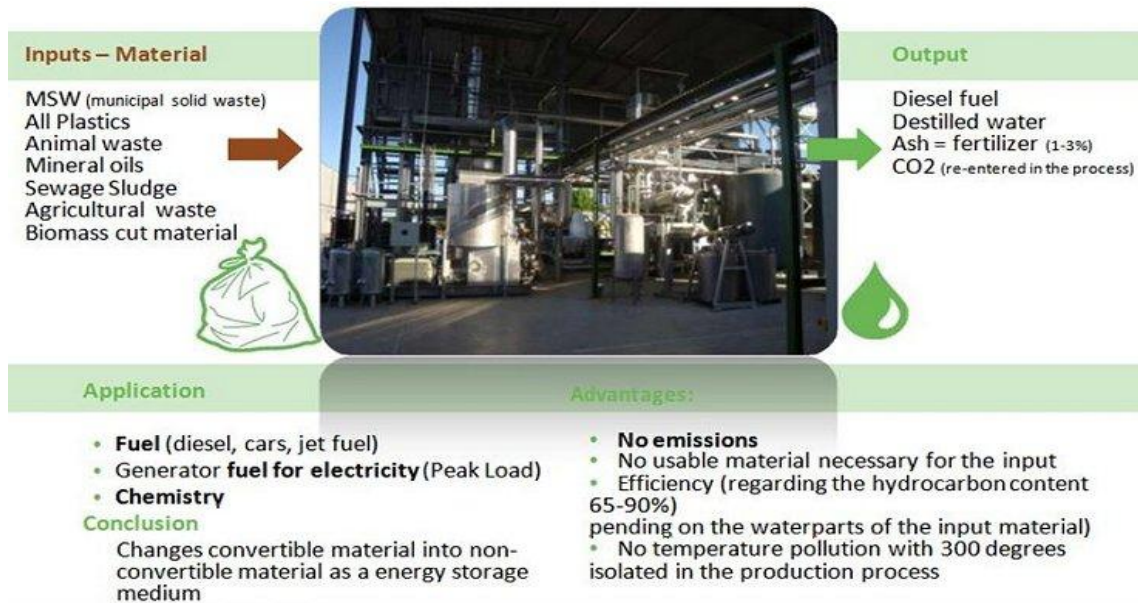
Thus we see that the TWRKDV process is quite different from thermal processes and cannot accurately be characterised as pyrolysis.

One the most important points, however, is not covered in the foregoing description of the reaction process: Binding of acids via the ion-exchange catalysts

The most important task in waste disposal is preventing the formation of dioxins, i.e. aromatic compounds containing acids in particular halogens. KDV ensures by the combination of cation catalysts (crystalline sodium/calcium-aluminium silicates) and their regeneration with added lime that the acid components (PVC, insecticide, bromide) bound in the input materials cannot react with the product (diesel oil) as they are bound as salts (cooking salt, calcium chloride).

The critical value of dioxin is 0.000 000 0001. Dioxin formation bears part of the responsibility for the carcinogenous deterioration of the environment. For this reason the critical value has to be kept as low as possible as halogen aromatics are extremely toxic. Halogens in cooking salts on the other hand are non-toxic. If we want to ensure that our descendants do not die more and more of cancer, then we must desist now with the dioxin production arising from pyrolysis, gasification and incineration. Over a period of 1 billion years Earth has not produced any dioxin. Dioxin is generated upon prior aromatisation, i.e. the thermal treatment of residual materials. This does not occur with TWRKDV.

This means that the TWRKDV technology allows an environmentally responsible treatment of residual material. No carcinogenous toxic waste is produced, and a material is produced that can be directly used as a fuel that, because of the mineral oil substances contained, is comparable to diesel oil.



The TWRKDV technology comprises the following elements:

- Energy technology for pre-treatment and the KDV reaction turbines with approx 10% of the diesel oil produced (efficiency of 90%)
- Pre-process technology for breaking up and drying the input materials and producing a slurry for continuing, non-hazardous input
- Ash plant for the inorganic materials separated from the slurry
- TWRKDV plant for producing diesel oil (alkane) and
- Hydrofiner for subsequent desulphurisation in order to meet EN 590 requirements for sulphur content.

The TWRKDV technology condenses all condensable input materials to form diesel oil and water and during the reaction does not yield any combustible gases or other by-products. There is no chimney on the plant, so the pollution protection ordinances do not apply to this process but are restricted to the input materials and product storage.

4.4.LOW TEMPERATURE PRESSURLESS HYDROGENATION

4.4.1.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 catalyst.

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

4.4.2.DISCOVERIES IN HYDROGENATION

Not expected was discovered a new way in the hydrogenation. When hydrogen in the reaction is substituted with biomass, than 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-aluminium-silicate. Also the reaction temperature drops down to less than 300°C.

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 as 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 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 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 nascenti) 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 chemical with high quality, has no smell of pyrolysis and



contains no ammonium, dioxins, furans and light components. Nobody went this way of the nature. All the crude oil is produced like this by lower temperature (14-19°C) and much longer reaction time.

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 to continue looking for a 100 % dioxin free process lead the scientific activity to this process. Finally we found this reaction in a special mixing system with molecule fine powder of the cation-aluminium-silicate with addition lime in the reaction to hold the pH-value higher than 8,5. Than we found an unlimited life time of the catalyst.

4.4.3.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 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.

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

- Hydrogenation of the oil and plastic to alkanes and
- Substitution of the catalyst for the CO₂-extraction and depolimerization 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.

4.4.4.USE OF CATALYST

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

- We add cation-aluminium-silicate produced in the silicate ion of sodium-aluminate 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 depolimerization.



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.

4.4.5. TECHNIQUE IMPROVEMENTS

In other words, up to now, on no other place of the technique of chemical plants is used the friction 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.

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

- 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

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.

4.4.6. THE TWRKDV PROCESS

This can be applied in the production of fuel, because the TWRKDV-system is complete environmental friendly and the cheaper way to the hydrogenation. The efficiency is regarding to the low reaction temperature 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. This hydrogen is consumed in the mixing with technical production more 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 TWRKDV

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 TWRKDV
- We do not get any emission from the plant
- We use the vacuum system for inherent safety
- We do not form any poison hydrocarbons like Dioxins and Furans

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

5.OUR VISION

At TWRKDV , we are committed to achieving a positive imprint on society, giving as a legacy an environmentally friendly technology able to make employment and source the poorest countries of the world with clean energy ,using renewable resources like biomass.

We are undertaking through our eco-friendly technology the task to change many of the waste management practices that are damaging our environment with nocive emissions.

We are committed to boost our sustainable technology taking organic material and converting it into usable power such as electricity, home heating, and storable diesel but from renewable resources which do not harm the environment.

We will take, at the same time, whatever steps we can to promote “TWRKDV social projects” to facilitate better conditions in the most disadvantaged countries., building social safety nets, creating employment opportunities and maintaining infrastructure. With the introduction of TWRKDV social projects we will support employment by stimulating growth, investing in health education and training, focusing on the most vulnerable.

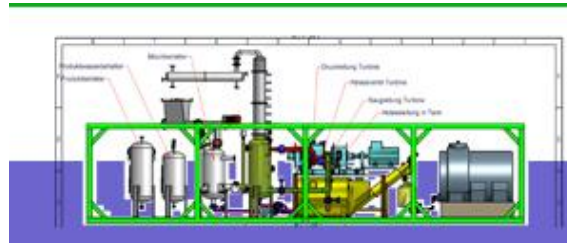




6. TECHNOLOGY

6.1. TWRKDV SYSTEMS

6.1.1. TWRKDV 150 - SMALL SYSTEMS



This plant supports our two small TWRKDV systems of the TWRKDV 150 and the TWRKDV 250. These are small and simple units, with limited electronic sensors, very easy to operate, with auto-cleaning valves and a turbine driven by an electric car motor. A demo TWRKDV 150 plant is now installed in the Eppendorf, Germany.

These units can be mobile units, and are specially designed for biomass applications (energy plants and agricultural residues) to produce storable synthetic diesel or energy.

- ❖ Turbine reactors: driven by an electric car motor
- ❖ Diesel output range:
 - ◆ TWRKDV150 1,000,000 lit/year
 - ◆ TWRKDV250 1,600,000 lit/year

6.1.2. TWRKDV-500 - MEDIUM SIZE SYSTEMS

The TWRKDV500 plant belongs to our Medium Size Systems together with the TWRKDV1000. The medium systems are fully equipped with more than 85 sensors for the automatic operation of the plant.

These systems could have all the TWRKDV Modules (desulphuration module) and are specially designed for all kind of applications including MSW. The best example of this plant (TWRKDV500) was recently



built in Massachusetts by Covanta Energy.

- Turbine Reactors: moved by electric motor
- Diesel output range: 3.000,000 lit/year



6.1.3.TWRKDV-1000 - MEDIUM SIZE SYSTEMS



TWRKDV500 / TWRKDV 1000 / TWRKDV 2000



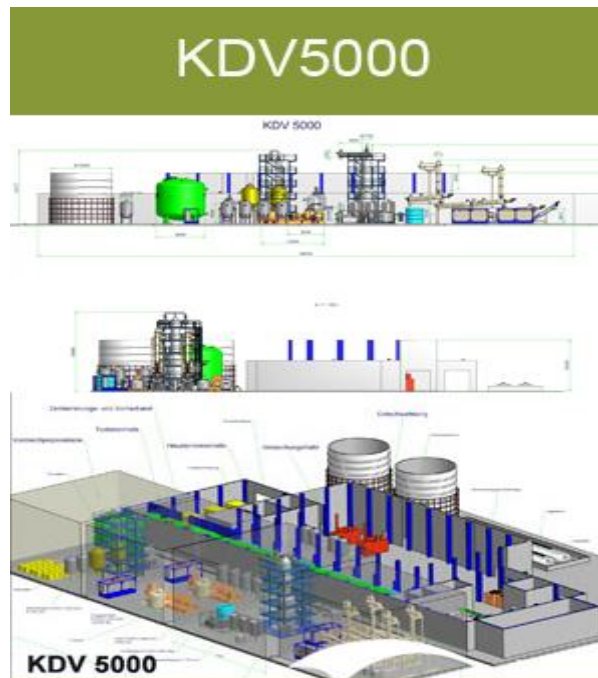
The TWRKDV 1000 as with the other medium size systems is fully equipped with more than 85 sensors for automatic operation of the plant.

These systems could have all the TWRKDV Modules (including the desulphurization module) and are specially designed for all kinds of applications including municipal solid waste.

The best example of these medium size units was recently built in Massachusetts by Covanta Energy.

- Turbine reactors: driven by electric motor
 - Diesel output range:
 - TWRKDV 5003,000,000 lit/year
 - TWRKDV 1000.....6,000,000 lit/year
 - TWRKDV 2000.....12,000,000 lit/year

6.1.4.TWRKDV-5000 - LARGE SYSTEMS



TWRKDV 2500 / TWRKDV 5000

These are large systems, fully equipped with more than 90 sensors for automatic operation of the plant.



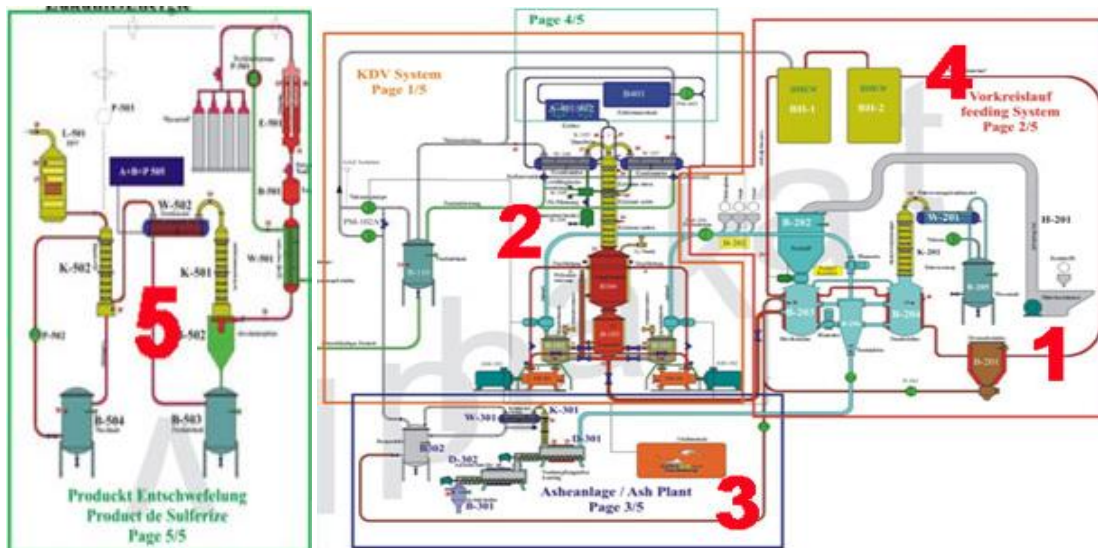
These systems could have all the TWRKDV modules (including the desulphurization module).

These large units are specially designed for all kinds of applications that require the conversion of big input volumes, including refinery waste, municipal solid waste and industrial waste.

With these big systems we can achieve economies of scale, therefore lowering the production cost per liter of diesel.

- Turbine reactors: driven by gas turbine
- Diesel output range:
 - TWRKDV 2500 15,000,000 lit/year
 - TWR-DV 5000 30,000,000 lit/year

6.2. PLANT DIAGRAM



This is the diagram for all the medium and large TWRKDV systems.

The TWRKDV system is made up of four basic modules:

1. Sludge plant for the feedstock preparation
2. TWRKDV 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. The desulphurization module for sulphur extraction

6.3.PLANT MODULES

A TWRKDV system is made up of five basic modules:



6.3.1.SLUDGE PLANT

This is the preparation module. The solid input material is fed into this unit. This module has been designed to convert the solid feedstock into "sludge" before it is taken to the main core of the plant, where the TWR-DV process takes place.

6.3.2.MAIN CORE MODULE

This is the first module designed by TWRKDV. In this unit the "sludge" is heated up with the turbine reactors. The resulting diesel vapors are taken to the main distillation column and then on to the main condensers in order to produce diesel in liquid form.

6.3.3.ASH PLANT

All the remaining inorganics coming in our feedstock come to this unit where the remaining hydrocarbons are removed and the rest remains in the form of ashes.

6.3.4.GENSET UNIT

In this module there is a generator set (genset) that produces the energy needed to drive the process. There are also heat exchangers that take advantage of the heat in the exhaust gases and the resulting heat is used to heat up the thermal oil circuits.



6.3.5.DESULPHURIZATION MODULE

This is an optional module. Depending on the feedstock, the resulting diesel can have a high sulphur content. The desulphurization module is then used to remove the sulphur from the diesel. Some countries have very tough sulphur limit regulations for all fuel for transportation purposes, so this unit reduces the sulphur to the acceptable level.

6.4.APPLICATIONS

6.4.1.BIOMASS

The TWRKDV process is able to process agricultural residues (like sugar cane residue or palm oil residue) or energy plant crops (like jatropha or myscanthus) that grow in many kinds of soil, even desert soil for specific plants.

6.4.2.INDUSTRIAL WASTE AND MSW

The TWRKDV process is able to process all kinds of waste. Some of the preferred applications include mineral oils, municipal solid waste and industrial waste.

6.4.3.PLASTICS

The TWRKDV process is able to convert many kinds of plastics into synthetic diesel. It is also probably the most ecologically friendly way to process all the chloride manufactured plastics (like PVC) because the low temperature TWRKDV process does not produce dioxin emissions.

6.4.4.REFINERY WASTE

The TWRKDV process is able to easily process refinery waste like bitumen. The process is very useful in the field of "oil sands", as the KDV conversion yield is better than the results obtained by the conventional oil sand refineries.





6.5.SAFETY

6.5.1.SAFETY CONSIDERATIONS

The plant is self-supporting in terms of fuel and completely standalone in all process-relevant parameters. Due to the closed-loop design of the plant, gaseous emissions are controlled.

The only emissions of the plant are the exhaust gases of the block heat and power plant (BHKW), including the diesel engine which produces hot water and heat for the system, as well as the waste heat used in running in the plant.

Although the plant is designed for safety, certain additional safety requirements are required. The requirement for the sealing of the plant is ensured by a permanent marginally negative pressure connected with a safety disconnection valve.

Due to the tightness of supply and removal lines, there is only a slight chance of a disturbance. To be prepared in case of this problem occurring, catch pans are provided to make sure no materials can reach the soil.



Unlike with other procedures, there is no danger of discharge of toxic gases such as dioxins or furans. Ion exchange catalysts bind the halogens as salts below the gaseous temperature so that these materials cannot form dioxins, since they are not converted into a gaseous state. Also, prions from organic material are bound just like contained metals by the catalyst, therefore reducing the risk of pollution.

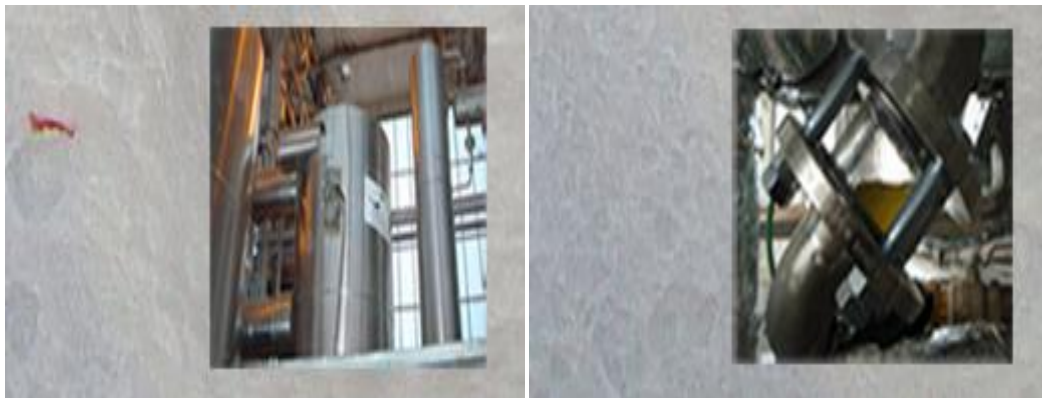


The process reaction takes place in an emulsion consisting of oil and catalyst. The condition of the liquid and the processing loop are constantly monitored so that when levels drop, or if there is an issue with the pumps or turbines, the plant can be immediately shut down as a precaution.

The cut off process and associated cooling take place very quickly, with the energy supply switched off for rapid cooling. When the block heat and power plant (BHKW) is shut down, the plant is automatically rinsed with oil, preventing blockage which could occur if plastic was to cool within the processing loop. In addition, any emergency shutdown initiates an alarm in the central service center and computer log files are simultaneously generated. Once the problem is resolved, the plant can be restarted. Control errors and disturbances that might occur due to inappropriate repair procedures are minimized, protecting the valuable components of the plant.

The restart of the plant takes approximately 45 minutes and is executed in accordance with pre-determined procedures so that further sequence errors are minimized. The monitoring sensors are arranged in a redundant configuration. At least two measured values must correlate at all times; otherwise an emergency is automatically initiated.

6.6.PATENTS



Dr.Christian Koch has more than 70 registered patents (National,European and World) referred to diverse fields:

- Preparation of diesel oil
- Diesel Oil from Waste by Catalytic depolymerization
- Preparation of high speed chambers
- Method and Device for Catalytic Oxidation
- High performance chamber mixer for catalytic oil suspensions



6.7.INDUSTRIAL DEVELOPMENT



6.7.1.TECHNOLOGY UPDATE

The full development of a new technology requires from five to ten years and a lot of financial resources.

In the last years our company has been working in two parallel directions:

- The chemistry process
- The industrial development

6.7.2.CHEMISTRY PROCESS

After many years of testing various materials in our facilities with our demo plants and performing diverse external "due-diligence" testing, we have proven that the TWRKDV chemistry process works quite well. This means that our catalytic depolymerization process is converting organic materials to synthetic diesel as discovered and planned by Dr. Koch some years ago in the laboratory stage.

6.7.3.INDUSTRIAL DEVELOPMENT

The second direction we are working on is the industrial development area. We have been working since 2004 when we built our first large pilot plant on an industrial scale in Mexico to combine the correct mechanical components (valves, sensors, and pumps) with the right turbine reactors. We have also been very active in the last two years in developing three basic modules and components:

- The sludge plant. In this module we are converting all the input material in solid state to something liquid called "sludge". Our process has a larger production yield if we prepare our solid feedstock in the form of slurry or sludge before we send it to our conversion unit.



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- The ash plant. Depending on the feedstock going into the system, the processing residues could contain some inorganics (metals, stones, glass). At the end of the processing we need to remove the resulting ash which contains these inorganics which did not convert into diesel. In the past two years we have been improving this module by testing various materials and seeing how they are processed.
- The turbines. We are also still improving our turbines, because we have to have reliable components, especially for some very corrosive applications such as MSW - municipal solid waste and IW - industrial waste.

We have been advancing in all these important mechanical aspects and only the lack of proper financial resources is causing this to take longer than expected.

We do believe that we are completing the configuration of all the mechanical components in what we are sure it is one of the most exciting inventions the scientific community has ever seen in the energy and environmental field.

6.8.COOPERATION PROGRAM



COVANTA
ENERGY
for a cleaner world



6.8.1.KDV-GLOBAL ENERGY-COVANTA ENERGY

6.8.1.1.TWRKDV500 PLANT

The TWRKDV500 plant built by Covanta Energy this year in Massachusetts has become the best example of the "state of the art" of the TWRKDV technology.

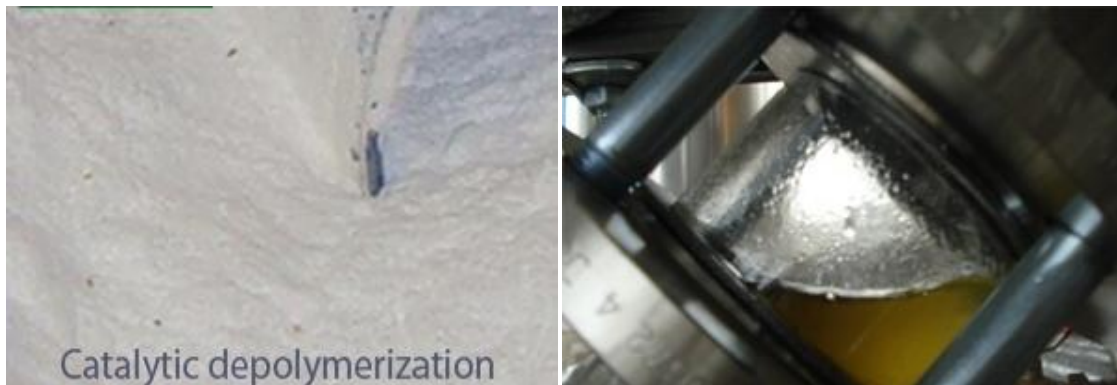
6.8.1.2.Covanta Energy

Covanta Energy is an internationally recognized owner/operator of energy-from-waste facilities and renewable energy projects. Covanta's energy-from-waste facilities convert municipal solid waste and other types of waste material into renewable energy for numerous communities, in the U.S.

7.ORGANIZATION

7.1.ENGINEERING

Our Engineering department works closely with our customers providing the required solutions for the global design and configuration of the TWRKDV project sites.



7.2.ENVIRONMENTAL SOLUTIONS

TWRKDV is also active in other sectors of the energy and environmental fields. The KDV Research and Development Center has been developing in the last years various environmental solutions such as:

- Catalytic processes for cleaning combustion gasses
- Isothermic heat-pipe reactors
- Low pressure hydrogenation
- Ash-recycling



- Desulphurization solutions
- New synthetic catalyst
- Long duration catalyst
- Development engineering

8. INFORMATION

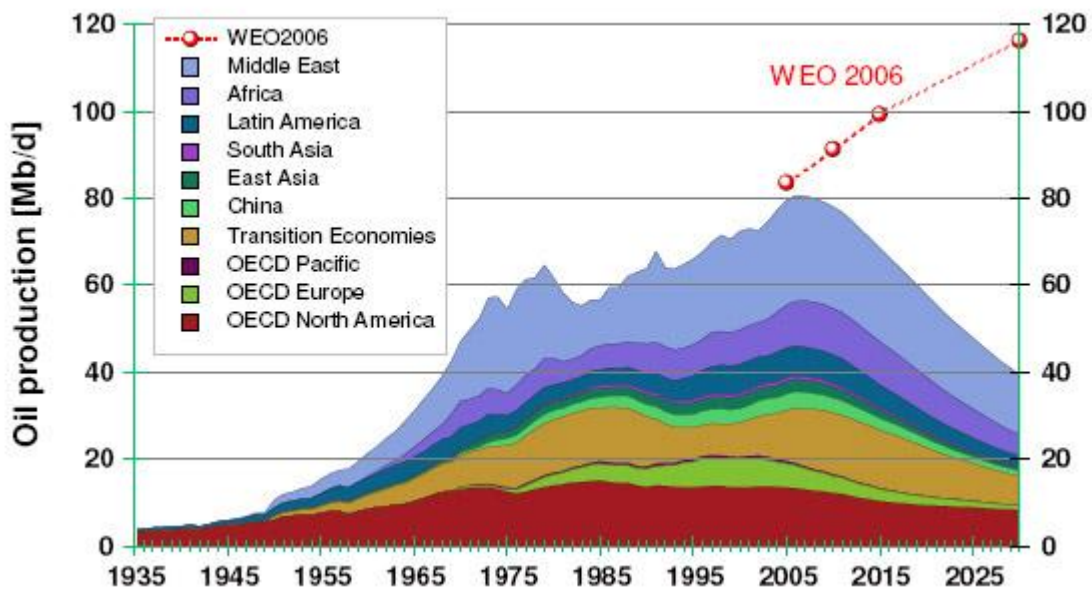
8.1. ENERGY TRENDS

The chart below from the Energy Watch Group shows the heart of the problem.

The red line is the World Energy Outlook (WEO), from the International Energy Agency (IEA), which predicts the demand for oil will rise from the 85 Million Barrels per Day (Mb/d) range to nearly 120 Mb/d around 2030.

This is the fundamental disconnect: a projected demand by consumers of 120 Mb/d and a projected supply by the producers of only 1/3 of that amount.

This means that in year 2030 2/3 of the fossil fuel demand has to be covered by new fuels that we do not have today.





8.2. ENVIRONMENTAL TRENDS

8.2.1. CO₂

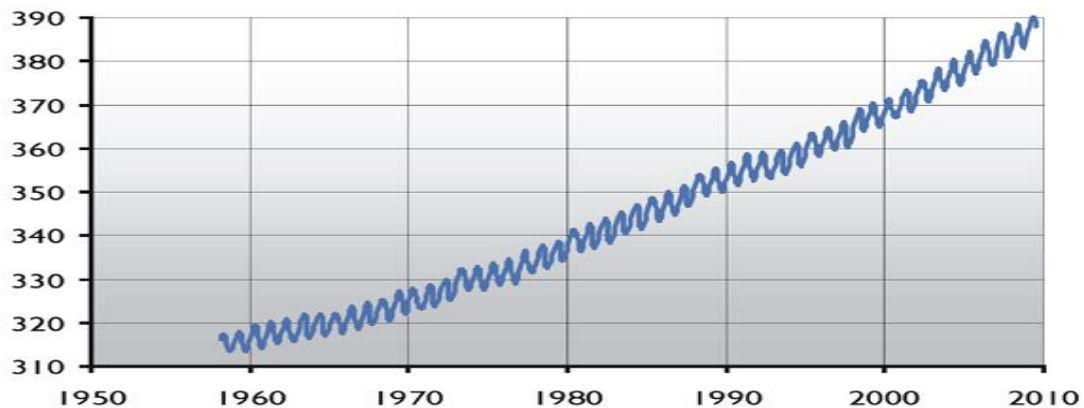
Carbon dioxide (CO₂) is a non-toxic gas which is produced by natural sources and human activity.

Carbon dioxide is a chemical compound of one carbon and two oxygen atoms. It is referred to by its formula CO₂. It is a non-toxic gas which is set to contribute to the greenhouse effect and thus to global warming. Other greenhouse gases are water vapour (H₂O), methane (CH₄), nitrous oxide (N₂O) and Fluorocarbons (PFC, HFC)

8.2.2. CO₂ TREND.

Atmospheric CO₂ is accelerating upward from decade to decade (we can see it in the graph on the right). In the past ten years, the average annual rate of increase was 1.91 parts per million (ppm).

This rate of increase is more than double what it was during the first ten years of CO₂ instrument measurements at the Mauna Loa Observatory.





9.KDV FINANCIAL HIGHLIGHTS

9.1.FINANCIAL ISSUES



9.2.INPUT MATERIALS

One of the key issues is about the price of the input materials as the TWRKDV plant doesn't need to process expensive materials to convert it to Synthetic diesel.

Our process is able to take just all the unwanted residues by the Industry, by the agriculture, by the houses, and this means that we can access to cheap materials or even we can be paid (tipping fee) to take out this residues to get a big value from them.

9.3.BUSINESS MODEL

Another key issue is concerning the business model and the final destination of our product directly as diesel or indirectly as energy (electricity production) and the net selling prices we can get for our energy carrier.

Some countries are just changing their legislations with the clear aim to promote the production of new, clean and renewable energies with excise tax exemptions and proper prices for the production of new energy carriers.



9.4.FEASIBILITY STUDY

Every project is really different even in the same country, that is why it is highly recommended from the beginning to draw up a Feasibility study, in order to develop the right Business model based in the TWRKDV technology.

Beside of the right analysis of the specifics of each project, as a highlights we would say that our projects are expecting to have a production cost per liter around 23 to 25 euro/cents and a global investment payback of 4 to 6 years.

10.FAQ'S

WHAT RAW MATERIALS CAN BE CONVERTED INTO TWRKDV - DIESEL?

All organic matter like:

- Biomass (C-3 and C-4 plants), wood, biogenous residues like leaves, straw, etc.
- Waste oil (also contaminated oil), refinery residues, bitumen. etc.
- All kinds of plastics and synthetic materials (PVC, PP, PET, etc.)
- Municipal Solid Waste (MSW) and Industrial Waste.

WHAT IS THE ADVANTAGE OF THE KDV-TECHNOLOGY VS ETHANOL OR BIODIESEL?

- Maximizes Land Utilization. Produces diesel with 4x Ethanol and 5x Biodiesel net energy yield per acre.
- No Food vs Fuel Trade Off. Can convert into TWRKDV-Diesel a wide variety of feedstocks, including Municipal Solid Waste, agricultural waste (straw, husk, bagasse) and grown energy sources like Jatropha.
- Economical. TWRKDV-Process will enjoy a 42% per BTU cost advantage over Ethanol, and a 51% BTU cost advantage over Biodiesel.
- Immediate Market Acceptance. TWRKDV-Diesel is cost-effective and universally usable, requiring no new infrastructure investment. It is compatible with existing engines, pipelines, and fuel pumps.
- Catalyst not Bugs. Catalysts have been proven to be the most effective way to produce fuels and petrochemicals and have greater success utilizing cellulosic biomass than fermentation methods.
- Carbon Neutral. TWRKDV-Process produces a net gain in energy recaptured.



WHAT IS THE QUALITY OF THE PRODUCED TWRKDV DIESEL?

The produced Diesel (chemical composition) fulfills the European norm DIN E590 for automotive fuels, once the product has been desulphurized (the amount of Sulphur depends of the type of feedstock), and its main properties are detailed as follows:

- Cetane index of around 59
- Density at 15 °C around ,830
- Viscosity at 40 °C around 3.2
- Flash point (°C) around 57
- Sulphur content (it depends of the feedstock)
- Lubricity around of 255

WHAT ARE THE BENEFITS OF A FUEL WITH A HIGH CETANE INDEX?

The TWRKDV Diesel is expected to have a cetane index of around 58 which is quite a high value. High cetane fuels are faster burning fuels. The fuel ignites spontaneously as soon as it is injected into the combustion chamber. Provided the fuel is injected smoothly and forms a well-controlled spray pattern, it will burn smoothly leaving little or no unburned fuel remaining by the time the piston reaches top dead centre. The benefits are a cleaner engine, less engine stress, improved fuel economy and reduced emissions.

WHAT ARE THE BENEFITS OF LOW-SULPHUR DIESEL?

The TWRKDV Low sulphur diesel order to reduce particulate emissions. Fine particulates, often referred to as PM10 or PM2.5 are now known to exacerbate respiratory and cardiovascular conditions. This can lead to hospital admissions and even early deaths in a few cases.

Particulates are reduced by reducing the sulphur content of the fuel but the real benefit of 50 ppm (or less) sulphur diesel is that regenerative particulate filters can be fitted to engines without the risk of a reduction in performance over time. Low sulphur diesel has benefits for engines. Sulphur oxides generated during combustion can react with water vapour to generate sulphurous and sulphuric acids. Modern heavy-duty engine lubricants contain alkalis to neutralise these acid gases but the risk of premature engine wear such as corrosive ring wear is reduced if low sulphur fuel is used.

HOW DOES THE DESULPHURATION PROCESS WORKS?

Sulphur in diesel is mainly in the form of substances called benzo- and dibenzothiophenes. These can be broken down by reacting gas oil refining streams with hydrogen in the presence of a catalyst under high



temperature and pressure conditions. This process is called hydrodesulphurization.

Reducing sulphur in diesel need not affect the bulk composition of the diesel greatly but three important effects can arise. Some less stable components are removed, the aromatic content (especially poly-aromatic hydrocarbons, PAH) of the diesel can be reduced and trace nitrogen and oxygen-containing substances that give diesel good lubricity are also reduced.

The first two of these effects are beneficial. The resulting fuel is more stable to oxidation, and its cetane quality is improved. One downside of lower aromatics is the effect this can have on injector pump seals in direct contact with the fuel. The last of these effects is detrimental to injector pumps that rely on the fuel to lubricate their moving components.

IS THE KDV TECHNOLOGY PROTECTED BY PATENTS?

Dr. Christian Koch is the one and only innovator and owner of the patents. The Technology patents are filed worldwide as follow:

- Patent No. DE10 2005 056 735 from 29.11.2005 (19 patents and patent accretions)
- Patent No. DE10 2006 054 506 from 17.11.2006 (16 patents and patent accretions)
- Patent No. EP1798274A1 (for Europe) and WO2007062811A3 (World Patent)

WHAT ARE THE AIR EMISSIONS PRODUCED BY THE KDV PROCESS?

The TWRKDV-process is performed in a special plant called KDV unit. The plant must ensure a safety operation of the TWRKDV-process. The whole plant is a closed system and is operating with temperatures around 300°C and with a light under pressure. The under pressure in the system is maintained with special vacuum pumps. These vacuum pumps suck the in the TWRKDV-process synthesized gases (burnable gas).

These burnable gases will be directed to the air supply duct of the diesel generator. In the diesel generator these gases are recycled in a thermal post combustion. This way of operation ensures that no harmful emissions can pollute the environment. The only emissions are the emissions of the diesel generator.



11.MATERIAL BALANCE

MATERIAL BALANCE			
DESCRIPTION	INPUT TONS PER YEAR	OUTPUT TONS PER YEAR	REMARKS
Biomass, example forest residues, residues as dry substance	120.000		
Catalyst, additives	2.400		
Diesel fuel		40.800	Density 0,85 kg/l
Process energy (gaseous)		10.800	
Process energy losses		8.400	
Steam/CO2		28.800	
Coal substance		26.400	
Waste, incl. used additives		7.200	
Total balance tons/year	122.400	122.400	

Explanations: CO2 is bound in the diesel fuel. Steam is distilled to water. The carbon paste can be dried and pressed into pellets.

12.CONCLUSIONS

When facing a situation with decreasing liquid fossil fuels, many countries will try to make up for the supply gap with alternative fuels. As the Hirsch report states it is never too early to start and industry and society will need at least 30 years for a change.



KDV 1000 COMPACT





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***TWR IS COMMITTED TO PUT ALL EFFORT TO
MAKE THIS PROJECT HAPPEN, COMMITMENT
FOUNDED BY OUR SLOGAN***

"PEOPLE HELPING PEOPLE"

WE APPRECIATE YOUR VALUABLE TIME

