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Renewable oil crops as a source of bio-based products

Politechnika Wrocławska

Brussels, February 12, 2014

Activity of Wroclaw University of Technology related to implementation and commercialisation of knowledge

Wroclaw University of Technology
is one of the biggest technical universities in Poland at the same time holding a leading position among them.

Wroclaw University of Technology
is the biggest university in Lower Silesia region with about 35 000 students,
1 000 PhD students and more than
2 000 students at postgraduate courses

Wroclaw University of Technology
employs about 4 800 people with
1 900 academic staff
(professors, doctors, assistants)

The activity of Wroclaw University of Technology is compliant with the goals of the **regional innovation strategy**

Wroclaw University of Technology participates in regional clusters and scientific networks on the basis of agreements and as a partner:

- Wroclaw Technology Park
- Lower Silesian Innovation and Science Park
- Walbrzych Technology Park
- and other scientific and research units

Wroclaw University of Technology conducts extensive scientific and research activity in **basic, development and applied research.**

Particular organisational units of the University (**15 Faculties**) conduct scientific and research activities:

under Framework Programmes, using structural funds, funded by the Marshal Office and other regional government units, funded by the National Science Centre (NCN), funded by the National Centre for Research and Development (NCBiR), funded by the Ministry of Science and Higher Education (MNiSW), funded by the Foundation for Polish Science (FNP), funded by economic enterprises (large, medium, small and family businesses), funded by foreign economic entities.

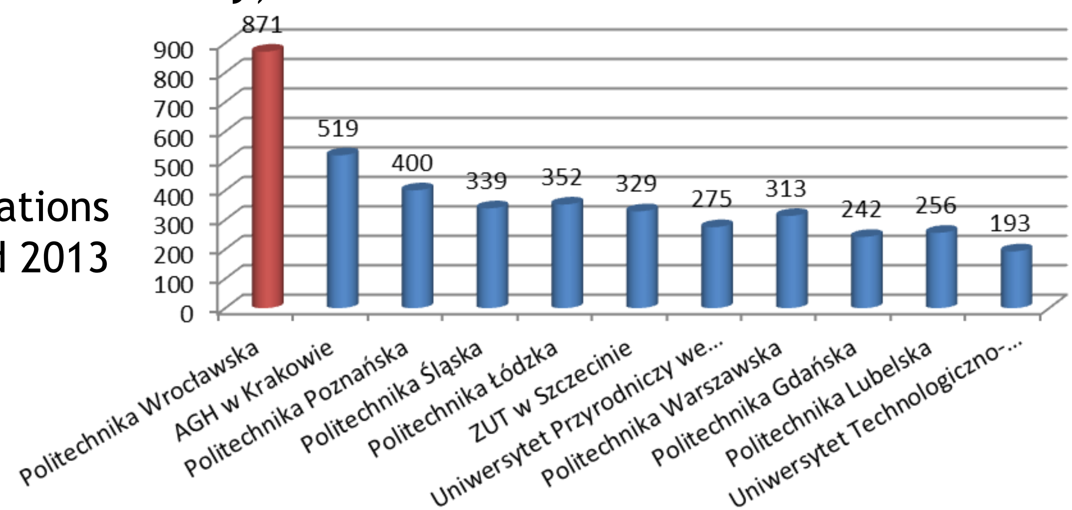
11 Research Centres implementing international research projects
11 Certified Laboratories
Research Laboratories offering over 190 various technologies
Dozens of experts performing specialized reports and reviews about the innovative products developed by the companies
Over 600 University Laboratories

At the turn of 2003-2014 (January)Wroclaw University of Technology has signed more than 1200 contracts with economic entities.

Results of scientific and research activity as well as innovative solutions are transferred to economic entities :

- under bilateral agreements concluded by the Organisational Units of Wroclaw University of Technology,
- through the Wroclaw Centre for Technology Transfer (WCTT) at the Wrocław University of Technology,
- through the Academic Entrepreneurship Incubator in which there are over 50 students' companies,
- through University Office of Protection of Intellectual Property and Patent Information (about 150 patents annually)

number of patent applications published between 2008 and 2013



Krupp AG

ELECTRICITE DE FRANCE - EDF Polska Ltd.

TAKRAF

Thyssen Krupp AG

RAFAKO S.A.

VW

Bosch AG

IBM

WABCO

Steel-works Stalowa Wola

Siemens

PGE

Sitech

Ruukki

Orlen

KGHM

PGNiG

Microsoft Ltd.

Hamilton

PGW

Toyota

Volvo Polska Ltd.

LG Electronics

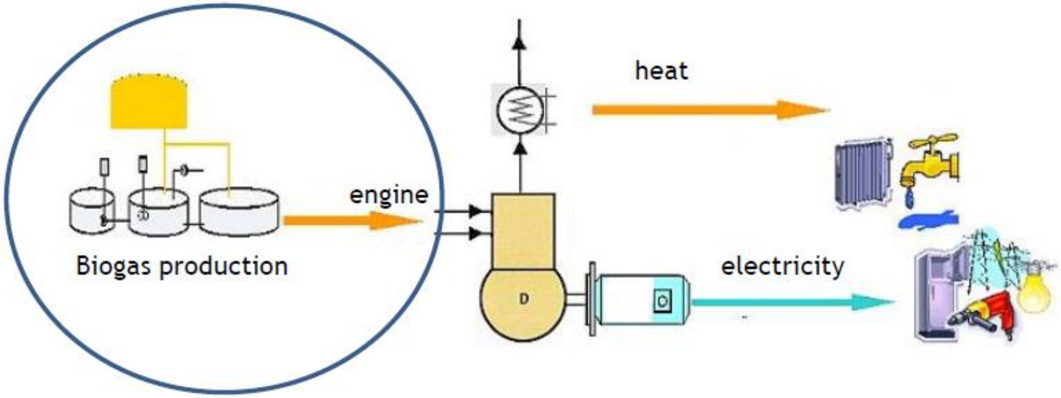
Wrocław University of Technology conducts direct cooperation with foreign economic entities and other foreign scientific entities and companies

National Project POIG.01.01.02-00-016/08 *Model agroenergy complexes as an example of distributed cogeneration based on a local renewable energy sources* in the Innovative Economy Operational Programme 2007-2013 and co-funded by the European Union using financial funds of the European Regional Development Fund

TASKS

- Analysis and preparation of a feed
- Monitoring and process control of biogas plants
- Purification and treatment of biogas
- The quality and application of biogas
- Storage and use of biogas as a fuel for an internal combustion engine
- Treatment, storage and packaging waste digestate

Developing a model of agricultural biogas plant disposing of organic agricultural waste, livestock and industrial and droppings



Installation of biogas purification and enrichment

The method for the treatment and purification of biogas was elaborated.

- **Built and operated installation working according to this method.**
  biogas desulphurisation by selective oxidation with oxygen,
- **CO_2 removal by VPSA on carbon molecular sieves.**

Fig. 1 Installation of biogas purification and enrichment

- **CH_4 yield efficiency exceeds 80%, and increases with increasing the flow rate of biogas.**
- **The presence of oxygen and nitrogen is not affected in a significant manner to yield methane.**
- **CH_4 content in the enriched gas exceeds 90%, and decreases with increasing gas flow rate.**

Preparation of sorbents, carbon and mineral-carbon with high surface development greater than 2000 m^2/g, applicable to storage energetic gases (CH_4 and H_2)

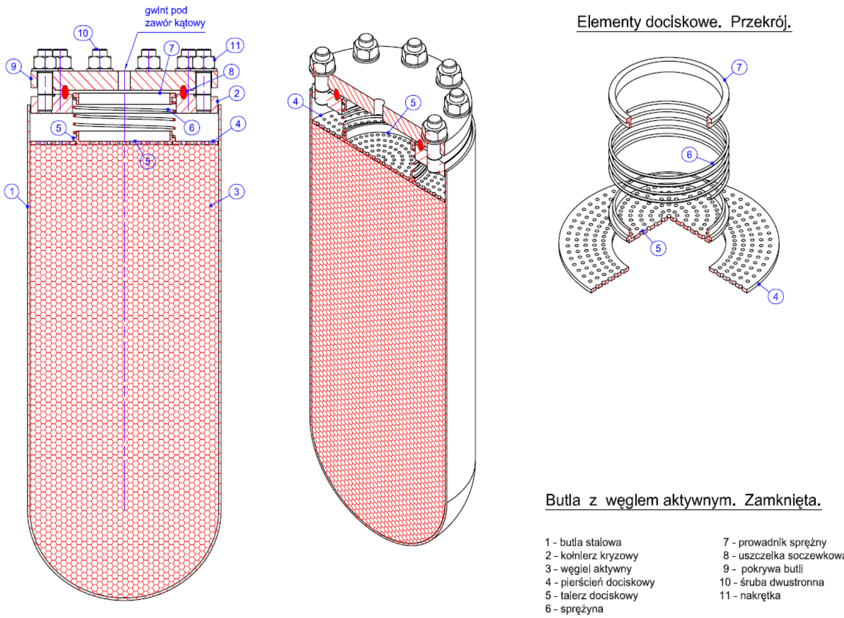
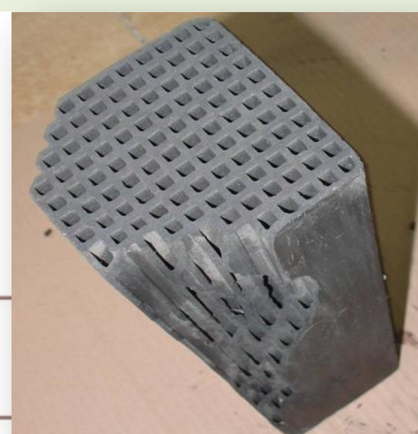
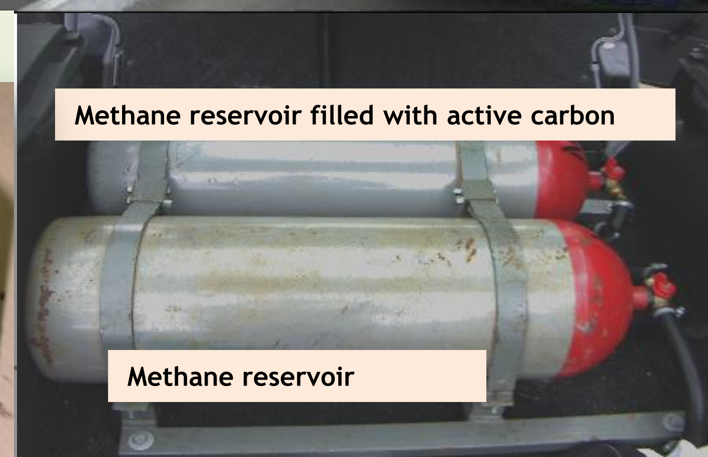


Fig.3. Methane reservoir filled with active carbon





The materials such as corn cob and rapeseed straw can be used as precursors in manufacturing active carbons. Active carbons obtained from corn cob and rapeseed straw are microporous materials with high content of wider micropores, and can be a promising material for gas storage. The distribution of pore sizes largely depends on the initial/starting material and its thermal processing (carbonization and activation). The obtained adsorbents are characterized by their high sorptive volume compared with hydrogen and methane, and can be applied to storage of theses gases.

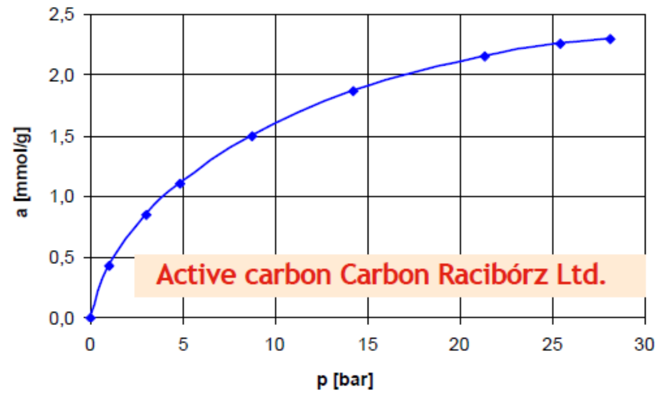


Fig.6. Isotherms of CH_4 adsorption on the industrial active carbon.

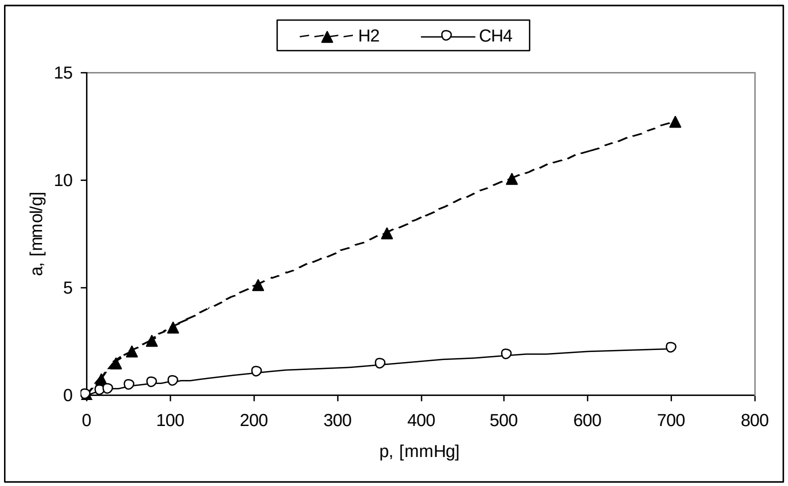


Fig.5. Isotherms of H_2 and CH_4 adsorption on the active carbon obtained from rapeseed straw.

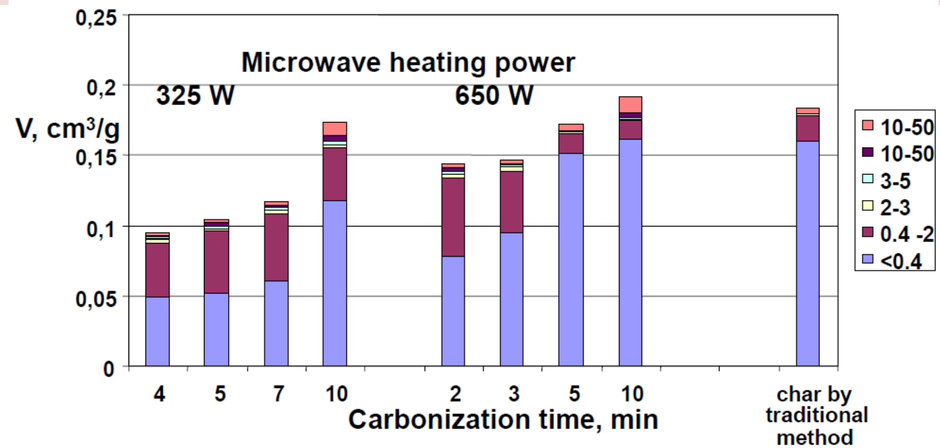


Fig.7. The influence of corn-cobs carbonization time on the chars pore volume distribution (sorption method)

HYDROPROCESSING OF DIESEL OIL- RAPE OIL MIXTURE

The goal of the process is hydrodesulphurization of diesel fuel, hydrogenation of unsaturated fatty acids components and ester bonds. Hydrorefining experiments were carried out using 20 wt % rape oil in light gas oil as a feed, reduced and sulfided commercial NiMo-Al_2O_3 catalyst forms. The hydroprocessing experiments were realized in laboratory continuous flow apparatus presented in Fig. 7.

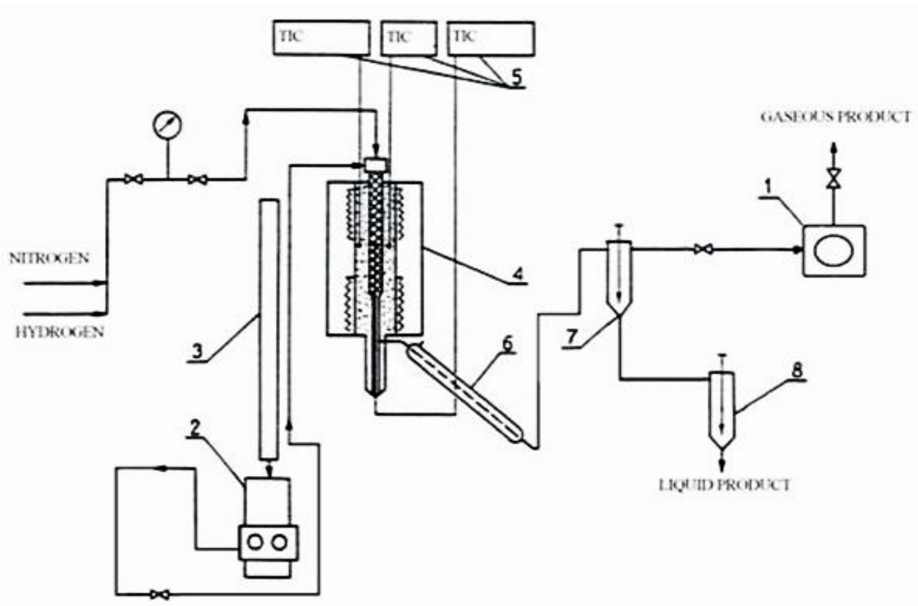


Fig. 7. Schematic view of hydrorefining apparatus

Table 1. Properties of the feed and hydroprocessing products.

Properties	Feed	Sample		
		1R	2R	3R
Initial boiling point [°C]	171	123	80	70
50% [°C]	272	264	255	200
90% [°C]	319	314	312	296
Temp. of 95% distill. [°C]	355	312	298	293
Flash point [°C]	68	39	24	>25
Density 15°C [kg/m^3]	847.7	834.3	828.6	763.9
Viscosity at 40°C [mm^2/s]	4.11	2.91	2.68	1.48
CFPP [°C]	-30	-23	-22	-30
Bromine number, g Br_2/100 g	12.37	4.34	3.98	1.57
Acid number, mg KOH/g	0.49	6.93	7.2	3.84

The prepared oil feed mixture (100 cm^3/h) was dosed by membrane pump (2) from the feed tank (3) to the catalytic reactor (4). Hydrogen, 50 dm^3 per hour i.e. 500 m^3/m^3 was fed to the reactor by the second one inlet port. The gas-liquid reaction mixture from the reactor was cooled in cooler (6) separated in gas-liquid separator (7 and 8).

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Hydroprocessing of rapeseed pyrolysis bio-oil

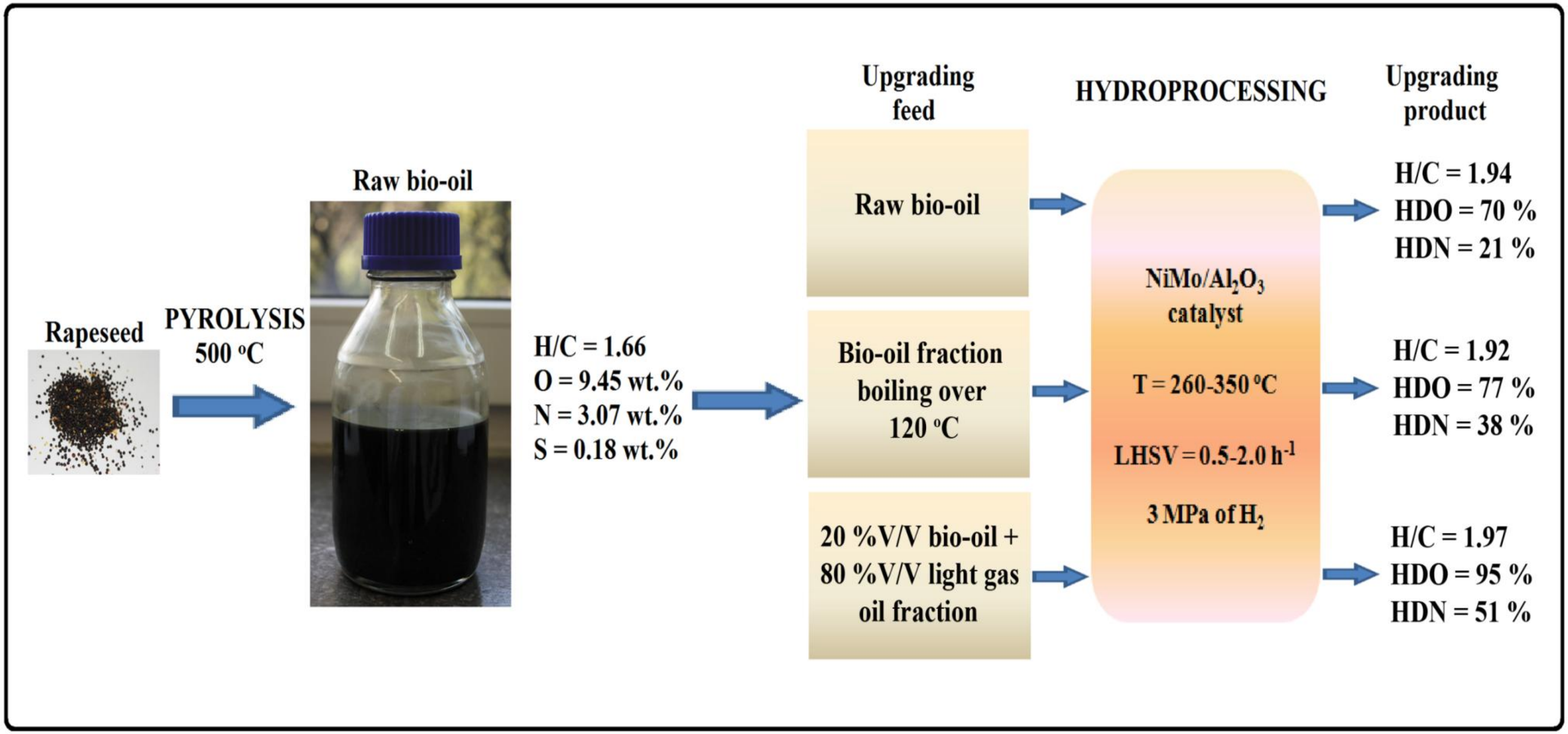


Fig. 8. Hydroprocessing of rapeseed pyrolysis bio-oil over NiMo/Al_2O_3 catalyst

Pstrowska, K., Walendziewski, J., Łużny, R., Stolarski, M., „Hydroprocessing of rapeseed pyrolysis bio-oil over NiMo/Al_2O_3 catalyst." Catalysis Today 2014, 223, 54-65.

Microwaves in the transesterification reaction

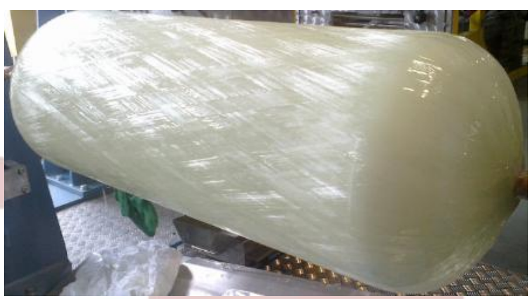
The study aimed at obtaining methyl esters from fatty acids of vegetable oils using microwave heating, and determining the influence of methyl esters addition to engine fuel on its physiochemical and functional properties.

Fig.9. Laboratory microwave unit

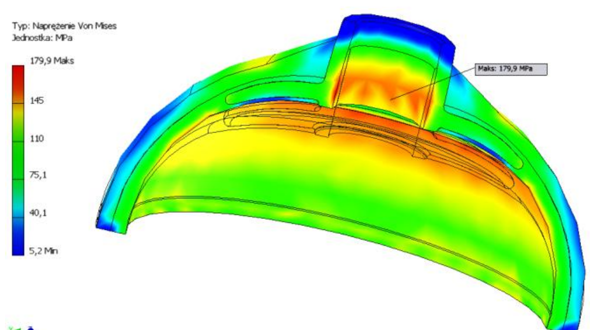
The application of microwaves in the transesterification reaction results in considerable savings of the energy required for the reaction and the duration of the entire process is 30 times shorter compared with transesterification carried out using traditional heating of the reactor.

Composite high pressure vessels for biogas storage

Nominal Working Pressure (NWP): 20-25 MPa
Burst pressure: 2.35xNWP
Operating conditions: temperature -45ºC ÷ +100ºC and humidity 0÷100%
Lifetime: 15000 cycles
Operating range for cars: 600 km per one refuelling
Mass application in automotive and stationary applications due to high safety level and competitive price
Low weight comparing to steel equivalent



Manufacturing by winding technology



FEM modelling

Hydraulic testing (according to ECE R110)

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Oil crops towards obtaining electricity

Biogasification of oil crops (CH_4 + bio-H_2)

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Purification of biogas (desulphurisation)

↓

Upgrading of biogas methane

↓

Steam reforming of biogas (H_2 +CO)

↓

Power fuel cells

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Thank You for your attention