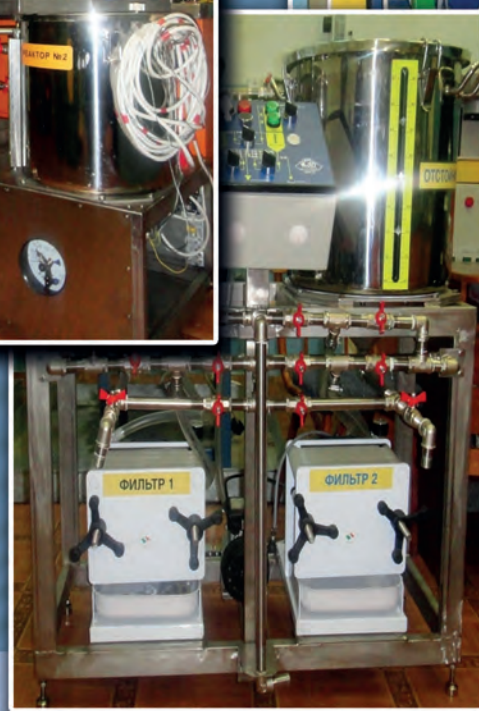


ADVANCED R&D AND TECHNOLOGIES

THE NAS OF UKRAINE



**FUEL,
LUBRICANTS,
AND TECHNOLOGIES**

ADVANCED R&D AND TECHNOLOGIES

THE NAS OF UKRAINE

SPECIAL ISSUES

ENVIRONMENT AND NATURE PROTECTION

FOOD INDUSTRY

FUEL, LUBRICANTS, AND TECHNOLOGIES

INDUSTRIAL AGRICULTURE
AND LANDSCAPE GARDENING

INFORMATION AND SENSOR SYSTEMS
AND DEVICES

INFORMATION TECHNOLOGY

MACHINE-BUILDING
AND INSTRUMENT ENGINEERING

MEDICAL PRODUCTS
AND MEDICAL DEVICE ENGINEERING

POWER ENGINEERING
AND ENERGY EFFICIENCY

TECHNOLOGIES AND EQUIPMENT
FOR EXPLORING, ESTIMATING,
AND EXTRACTING MINERAL RESOURCES

TECHNOLOGIES FOR CONSTRUCTION
AND FUNCTIONAL MATERIALS

ANTIFRICTION LUBRICANT FOR METALLURGICAL EQUIPMENT



Areas of Application

Lubrication of friction units of metallurgical equipment operating within the temperature range from $-30\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$, under high loads and in corrosive environments

Specification

The grease is a dark brown substance, easily soluble in hydrocarbons, with a dropping point $>250\text{ }^{\circ}\text{C}$, a strength limit over 400 Pa at $20\text{ }^{\circ}\text{C}$, and with an increased oxidation stability at a temperature over $150\text{ }^{\circ}\text{C}$; it improves the protection of metal surfaces of friction units from corrosion

IPR Protection

IPR3

Advantages

The grease has a 1.4 times higher stability, a 1.5 times higher anti-wear protection factor, and a 2.9 times higher anti-fretting protection factor as compared with the domestic counterparts. Its properties are 1.8, 1.34, and 1.67 times higher, respectively, as compared with the best foreign counterparts

Stage of Development. Suggestions for Commercialization

IRL5, TRL6

A prototype is manufactured and tested at customer's site; support in the design works and production organization is provided upon request

Contact Information

Grygorii S. Pop, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine; +38 044 559 60 59, e-mail: gpop@bpci.kiev.ua

AUTOMATIC ANALYZER OF LIQUID FUEL COLOR *CU TEP-TMT*



Areas of Application

The device is proposed for using at laboratories of petroleum refineries to control fuel color according to ASTM international scale and international standards D1500, ISO 2049, GOST 20284 and others

Specification

The measurement range, color index number: 0.5 – 8.0
Reproducibility: max 0.5 of color index number ($P = 0.95$)

Stage of Development. Suggestions for Commercialization

IRL7, TRL6
The device is manufactured upon request

Advantages

As compared with the foreign counterparts that have similar characteristics, this device has a relatively low price

IPR Protection

IPR2

Contact Information

Alexander I. Chaika, Institute of Engineering Thermophysics of the NAS of Ukraine;
+38 044 456 93 81, e-mail:chailka@ittf.kiev.ua

BIODIESEL FUEL BASED ON BIORENEWABLE RAW MATERIALS



A pilot plant for producing biodiesel fuel from bio-renewable raw materials

Areas of Application

To be used in compression-ignition engines in its pure form or mixed with petroleum diesel fuel

Specification

The product meets the requirements of EN 14214 (European) and DSTU 7178:2010 (Ukrainian) standards of alternative fuels for diesel engines

Stage of Development.

Suggestions for Commercialization

TRL4, TRL4

Pilot batches of products based on various vegetable oils can be produced upon request

IPR Protection

IPR3

Advantages

As compared with the analogous products based on high-toxic and non-bio-renewable methanol this product is based on environmentally safe, non-toxic, and bio-renewable ethanol. The product ensures high power and ecological characteristics of engine operation.

The bio- and petroleum diesel mixtures (with a bio-component content of 20–100%) have as good power characteristics as the high-quality petroleum diesel fuel and dominate over it in terms of their ecological indicators. In particular, they produce much lesser harmful emissions of CO₂ (by 1–5%), NO_x (by 15–20%), CO (1.2–1.3 times lower), and incomplete combustion products (1.9–3.3 times lower)

Contact Information

Lyubov K. Patrylak, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine; +38 044 559 71 60, e-mail: lkpg@ukr.net

ETEROL-NS MULTIFUNCTIONAL LUBRICANT ADDITIVE



Areas of Application

The product is a multifunctional additive to transmission and industrial oils, greases, and refrigerating lubricants for improvement of tribological and antioxidant properties

Specification

Eterol-nS is a substance with a mass fraction of sulfur $n = 5-38\%$; it is a non-volatile non-hazardous transparent brown color liquid with a kinematic viscosity $3-8 \text{ mm}^2 \cdot \text{s}^{-1}$ at 100°C , an acid index of $2-10 \text{ mg KOH} \cdot \text{g}^{-1}$, a flash point in open crucible of $265-270^\circ\text{C}$ and an ignition temperature of 319°C , soluble in hydrocarbons

Stage of Development. Suggestions for Commercialization

IRL5, TRL6

The additive is manufactured and tested at customer's site; support in the design works and production organization is provided upon request

Advantages

The additive improves viscosity-temperature, protective, anti-wear, and anti-seize characteristics of lubricants under high load and velocity. The product's operational and ecological properties exceed those of counterparts based on fatty acids and their derivatives and are as good as those of highly effective foreign analog

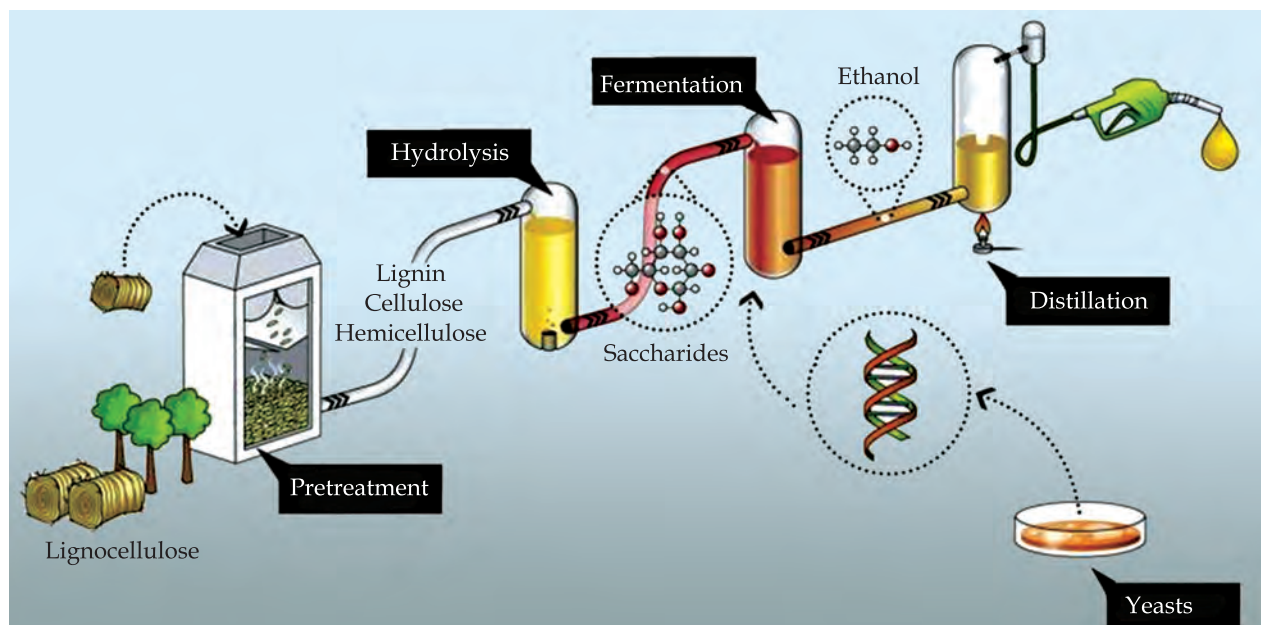
IPR Protection

IPR3

Contact Information

Grygorii S. Pop, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine;
+38 044 559 60 59, e-mail: gpop@bpci.kiev.ua

ETHANOL BIOTECHNOLOGICAL PRODUCTION FROM XYLOSE WITH THE USE OF YEASTS



Scheme for ethanol production from lignocellulose with the use of yeasts

Areas of Application

Ethanol is a promising renewable liquid fuel used as a gasoline additive to reduce the content of toxic substances in exhaust gas and to prevent emission of additional carbon dioxide to atmosphere due to the use of renewable vegetable raw material (lignocellulose)

Specification

Ogataea (Hansenula) polymorpha recombinant strains with a 25 times higher yield of ethanol from xylose, an optimized medium composition, and conditions of their cultivation are a framework for obtaining effective producers of ethanol from lignocellulose hydrolysates with a maximum yield of target product

Advantages

O. polymorpha yeast recombinant strains are more thermotolerant as compared with the known counterparts. Due to a high ethanol yield in the course of high-temperature xylose alcohol fermentation the obtained strains can be used in simultaneous saccharization and fermentation of lignocellulose

Stage of Development. Suggestions for Commercialization

IRL3, TRL3
Recombinant strains with increased yield of ethanol from xylose, which have been tested on real hydrolysates of vegetable raw materials are provided

IPR Protection

IPR3

Contact Information

Oleg V. Stasyk, Institute of Cell Biology of the NAS of Ukraine;
+38 032 261 21 46, e-mail: stasyk@cellbiol.lviv.ua

GREASE FOR FRICTION UNITS OF INDUSTRIAL MACHINERY



Canning of ready-to-use grease lubricant



Final treatment of grease lubricant

Stage of Development. Suggestions for Commercialization

IRL5, TRL6

A prototype is manufactured and tested at customer's site; support in the design works and production organization is provided upon request

Areas of Application

The grease is an effective antifriction agent to be used for lubricating the friction units operating in wet and corrosive environments at a high temperature and pressure at brick, glass, ceramic, and cement factories and plants

Specification

The grease is a dark brown substance, easily soluble in hydrocarbons, with a dropping point $>250\text{ }^{\circ}\text{C}$, a strength limit of $800\text{--}830\text{ Pa}$ at a temperature $20\text{ }^{\circ}\text{C}$, a welding load of 7350 N at a temperature $(20 \pm 5)\text{ }^{\circ}\text{C}$, and a critical load of $1470\text{--}1842\text{ N}$; it improves the protection of metal surfaces of friction units from corrosion

Advantages

The grease is notable for improved tribological and protective properties and an increased thermo-oxidative stability. It leaves behind both domestic and best foreign analogs in terms of operational and environmental properties

IPR Protection

IPR3

Contact Information

Grygorii S. Pop, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine; +38 044 559 60 59, e-mail: gpop@bpci.kiev.ua

HIGH-OLEIC CROP VARIETIES AS SOURCE OF BIODIESEL



Euro 12 variety

Areas of Application

The varieties are to be used in agriculture and energy sector for producing biodiesel, solid biofuels, and well-balanced fodders (as by-products)

Stage of Development. Suggestions for Commercialization

IRL3, TRL3
The commercial use of varieties is governed by license agreements. Seeds and recommendations on plant cultivation and use are provided

IPR Protection

IPR3

Contact Information

Jamal B. Rakhmetov, M.M. Gryshko National Botanical Garden of the NAS of Ukraine;
+38 044 285 01 20, e-mail: jamal_r@bigmir.net



Phytopal variety

Specification

The plants are annual varieties of spring and winter crops (turnip x wild cabbage hybrid, turnip, false flax, fodder radish).

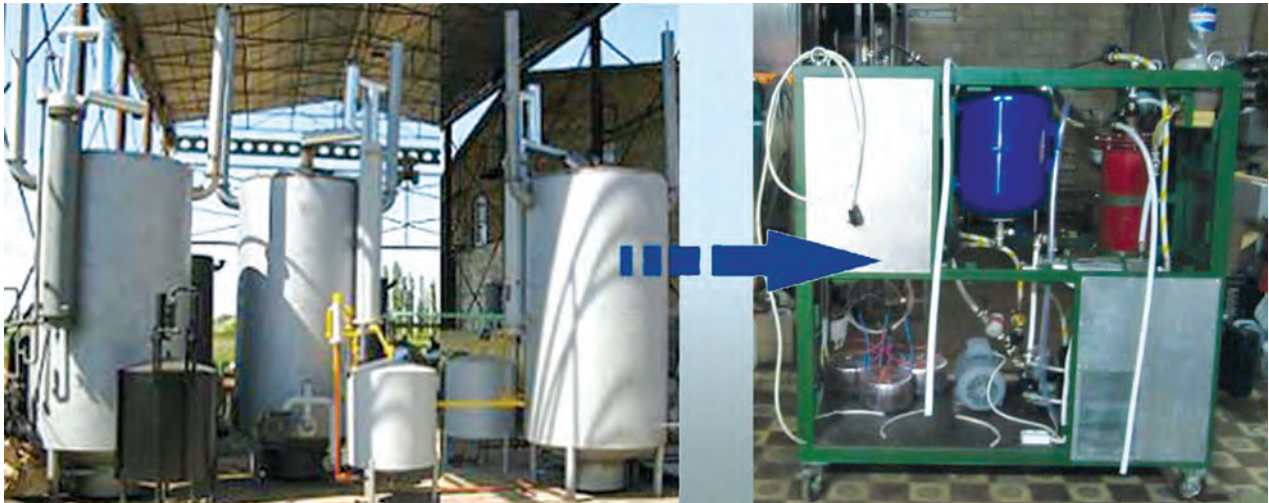
The *Phytopal*, *Ramira*, *Peremoha*, *Euro 12*, and *Raiduha* varieties bred at the NBG have been recorded in the State Register of Plant Varieties of Ukraine.

Yield of seeds, t/ha	2.5–3.0
Oil content, %	35–47
Oil output, kg/ha	800–1400
Oil energy production, Gkal/ha	50–90
Output of biofuel from by-product material, t/ha	5–6
Energy production of by-product material, Gkal/ha	>40
Protein content, t/ha	≤1.0

Advantages

The high-oleic varieties surpass the similar crops in terms of winter hardiness and drought resistance; they have a higher productivity and a better quality of phyto-material; can be used as alternative to the conventional oil crops (rapeseed and sunflower) for rotation

INERTON BIODIESEL PRODUCTION TECHNOLOGICAL SYSTEM



Specification

The technology implements the process of impulse electromagnetic treatment of reaction components (vegetable oil and methanol), which intensifies the transesterification reaction that is the main reaction to obtain biodiesel.

The performance of one module is 3 tons of biodiesel per hour, the annual output of the module operating in two shifts is 15 thousand tons. The reactor occupies an area of 3–5 sq. m, it is easy to transport and to assemble the installation. The biodiesel production in the flow though mode consumes less than 0.005 kWh electricity per 1 liter of biodiesel. The produced biodiesel meets the European standard EN14214. The number staff to maintain the system is 2–3 workers per shift (staff training takes up to 3 hours)

Areas of Application

The system is designed for producing biodiesel from any vegetable oils (including oil waste) or animal fat

Stage of Development.

Suggestions for Commercialization

IRL3, TRL5

Investment project for joint implementation; seeking partners for joint investment project; a prototype is developed and tested at the developer's facilities; search of sales markets in cooperation with investors

Advantages

The equipment is much smaller in comparison with analogs; has a modular structure

IPR Protection

IPR1

Contact Information

Yuri L. Zabulonov, Institute of Environmental Geochemistry of the NAS of Ukraine; +38 044 502 12 26, +38 044 502 12 23, e-mail: 1952zyv@gmail.com

IRENA PORTABLE ANALYZER

Areas of Application

The device is proposed for measuring the research and the motor octane numbers and evaporation temperature of clear gasoline at oil refineries, gas filling stations, and for individual use

Specification

Octane number measurement range, units	66–98
Discreteness of octane number measurement, units	0.1
Error of octane number measurement, units	±0,5
Operating temperature range, °C	-10...+45
Error of gasoline temperature measurement, °C	+0.5
Time for obtaining the octane number measurement result of 50% gasoline evaporation, s	≥150
Measuring block dimensions, mm	165 × 85 × 40

Advantages

There no foreign counterparts. The device performs a rapid analysis of gasoline quality, saves money and time. Due to modern technologies, the analyzer is small, light and easy to use. Before each measurement the device is self-calibrated for reaching maximum accuracy of results

IPR Protection

IPR1, IPR2



Irena portable analyzer: 1 – measuring sensor; 2 – indicator; 3 – control panel

Stage of Development.

Suggestions for Commercialization

IRL7, TRL6

Upon request, the device is manufactured, delivered, and maintained during the warranty period; also, staff training is provided

Contact Information

Yuri F. Lohvinov, O.Ya. Usikov Institute for Radiophysics and Electronics of the NAS of Ukraine; +38 057 315 20 09, e-mail: logvinov@ire.kharkov.ua

NEW ENERGY CROP VARIETIES FOR SOLID BIOFUEL PRODUCTION



Silver grass varieties

Areas of Application

The varieties are to be used in agriculture and energy sector for producing solid biofuels, cellulose, and well-balanced fodders (as by-products)



Phytoenergy variety

Specification

The plants are perennial crops (with a productive longevity of 10–20 years): sida, switch grass, sorghum, as well as silver grass and compass plant varieties. The plants are undemanding to soil, winter-hardy, and resistant to drought. The *Gulliver*, *Snihopad*, *Zoriane*, *Phytoenergy*, *NBS-75*, *Yuvileinyi-90*, *Bohatyr*, and *Columbo* varieties bred at the NBG have been recorded in the State Register of Plant Varieties of Ukraine.

Yield of raw material, t/ha	70–120
Yield of solid biofuel, t/ha	10–20
Energy production, Gcal/ha	70–120
Estimated cellulose production, t/ha	~10

IPR Protection

IPR3

Advantages

The varieties have no counterparts among the perennial crops in terms of productive longevity. As compared with the conventional crops they have a higher yield (by 20–40%) and profitability (by 80–150%); require minimum costs and power consumption

Stage of Development. Suggestions for Commercialization

IRL3, TRL3

The commercial use of varieties is governed by license agreements. Seeds and recommendations on plant cultivation and use are provided

Contact Information

Jamal B. Rakhmetov, M.M. Gryshko National Botanical Garden of the NAS of Ukraine; +38 044 285 01 20, e-mail: jamal_r@bigmir.net

ONE-STAGE PROCESS FOR DIMETHYL ETHER PRODUCTION

Specification

The one-stage process of synthesis gas conversion for the production of dimethyl ether (DME) as an alternative diesel fuel; the conditions are as follows: copper-zinc three-functional catalyst in the form of thin-layer membranes; temperature and pressure of 240–260 °C and 4.0 MPa, respectively; $H_2/CO = (3\div 5)/1$

Stage of Development.
Suggestions for Commercialization

IRL3, TRL4

Terms of reference for the dimethyl ether production process are proposed; ready for the elaboration of business component



Areas of Application

Production of dimethyl ether
as a substitute for conventional diesel fuel

IPR Protection

IPR3

Advantages

The process matches the world counterparts. The parameters of 10 liter reactor pilot plant run are as follows: DME yield reaches 44–52%, DME selectivity is about 50–52%, and total CO conversion makes up 75–88%. The process intensification is a result of ionic activation of catalytic centers

Contact Information

Raisa V. Korzh, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine;
+38 044 559 04 95, e-mail: bort2001@gmail.com

PHOSPHOLIDIN MULTIFUNCTIONAL ADDITIVE FOR PETROLEUM PRODUCTS



Specification

Phospholidin is a greasy dark brown substance with a fluidity temperature of 27–29 °C; soluble in hydrocarbons; its acid index does not exceed 25 mg KOH · g⁻¹

Advantages

The additive enhances anti-wear (by 50%) and anti-seize properties (2.1–2.4 times) of greases and lubricants and improves their toxicological, environmental, and anti-oxidative parameters as well as protection of cast iron, steel, and copper from corrosion. It is 2–6 times cheaper than the domestic DF-1dialkyl dithiophosphate additive

Areas of Application

Active multifunctional additive to anti-friction greases, motor oils, and refrigerating lubricants for rolling or sliding bearings and other friction nodes operating under high temperature and corrosive environment

IPR Protection

IPR3

Stage of Development.

Suggestions for Commercialization

IRL5, TRL6

The additive is manufactured and tested at customer's site; support in the design works and production organization is provided upon request

Contact Information

Grygorii S. Pop, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine; +38 044 559 60 59, e-mail: gpop@bpci.kiev.ua

TECHNOLOGY FOR BIODIESEL PRODUCTION FROM FALSE FLAX (*CAMELINA SATIVA*)



Pilot plant for biodiesel production

Areas of Application

The technology is proposed for reducing the production costs and improving the physical, chemical, and environmental characteristics of fuel products

Specification

A full cycle to obtain biodiesel from oil seeds of spring false flax (*Camelina sativa*) varieties bred at the Institute via esterification of fatty acids by ethanol. The productivity of pilot production line is 1 tone biodiesel daily

Advantages

New high-yield varieties of spring false flax (*Camelina sativa*) with improved resistance to environment effects and agronomic parameters as compared with the existing oil crops have been bred. They can produce 3–4 t/ha seeds with oil content of 45–50%. In addition to biodiesel production, the Camelina oil can be used in food industry and medicine insofar as it almost does not contain erucic acid

Stage of Development. Suggestions for Commercialization

IRL6, TRL6

The equipment (production line) is designed and a process plan for commercial production is provided

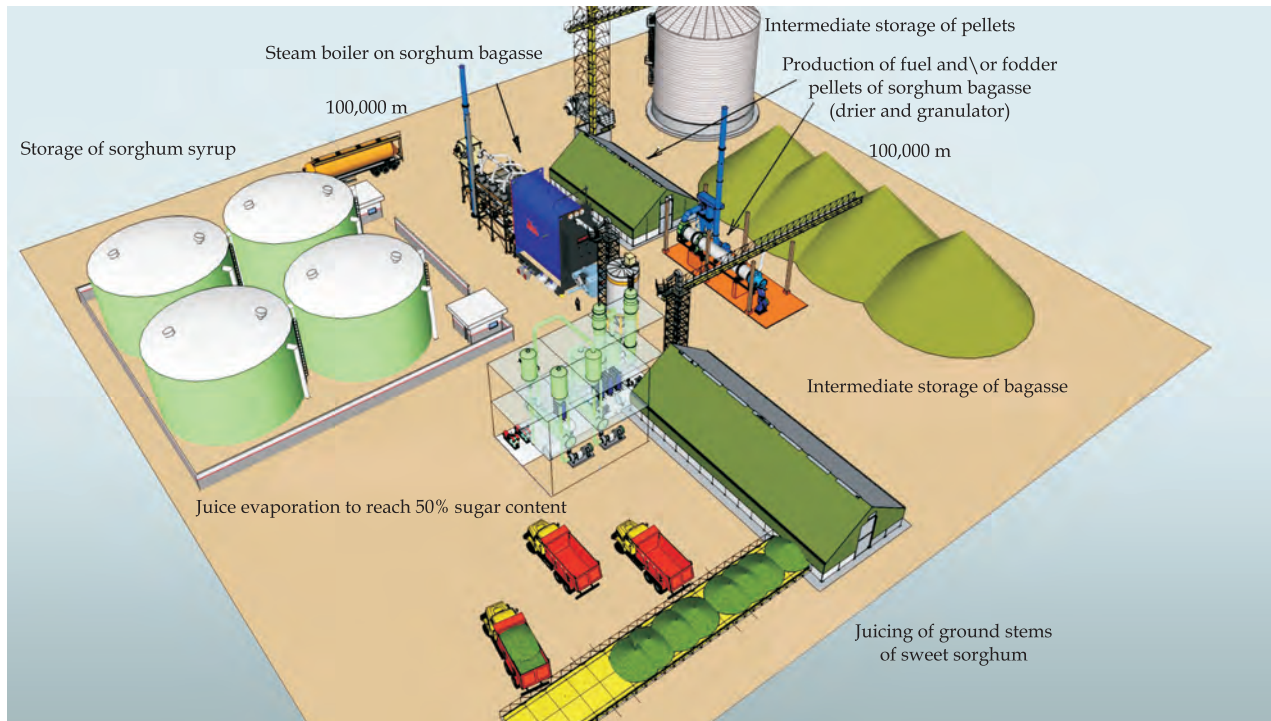
IPR Protection

IPR1, IPR3

Contact Information

Yaroslav B. Blume, Institute of Food Biotechnology and Genomics of the NAS of Ukraine;
+38 044 434 37 77, e-mail: cellbio@cellbio.freenet.viaduk.net

TECHNOLOGY FOR BIOETHANOL PRODUCTION FROM SWEET SORGHUM



A pilot production of bioethanol from sweet sorghum with a capacity of 50 tons daily

Areas of Application

The technology is proposed for introducing a non-waste processing of sweet sorghum into bioethanol

Advantages

This complex processing of sweet sorghum into bioethanol enables reducing energy dependence on fossil fuels due to their replacement by biofuel. This leads to reducing emissions of carbon dioxide into atmosphere

IPR Protection

IPR2

Specification

The technology enables to obtain a high-quality bioethanol with the following physicochemical characteristics.

Density, kg/m ³	787 – 792
Volume fraction of water, %	≤0.2
Volume fraction of oxygen-containing organic compounds	≥98.3
Sulfur concentration, mg/kg	≤10
Phosphorus concentration, mg/dm ³	≤0.5
Inorganic chlorides concentration, mg/dm ³	≤20

Stage of Development. Suggestions for Commercialization

IRL5, TRL5

Pilot production of bioethanol from sweet sorghum with a capacity of 50 tons daily is proposed

Contact Information

Yaroslav B. Blume, Serhii P. Tsygankov, Institute of Food Biotechnology and Genomics of the NAS of Ukraine; +38 044 434 37 77, e-mail: office.ifbg@nas.gov.ua, cellbio@cellbio.freenet.viaduk.net

VARIETIES OF ALTERNATIVE CROPS AS A SOURCE OF BIOETHANOL



Botanichnyi variety



Yevhenia variety

Areas of Application

Alternative crops are to be used in agricultural production, energy and food industry for producing bioethanol and solid biofuels, fertilizers, and well-balanced fodders (as by-products)

Specification

Annual crops with a high content of carbohydrates (sweet sorghum, finger millet); the Botanichnyi, Enerhodar, Yevhenia, and Yaroslav-8 varieties bred at NBG have been recorded in the State Register of Plant Varieties of Ukraine.

Yield of raw material, t/ha	≤100
Bioethanol output, t/ha	3–7
Seeds yield, t/ha	4–8
Sugar content, %	>20
Energy production, Gcal/ha	80–110
Solid biofuel output from by-product material, t/ha	>10

IPR Protection

IPR2, IPR3

Advantages

As compared with conventional crops for bioethanol production, the new varieties require up to 1.5 times less acreage. The new varieties of alternative crops have a higher sugar content as compared with the feed crop varieties (by 12–13%); their seeds can be gathered separately and used as fodder. The production profitability reaches 80–120%

Stage of Development.

Suggestions for Commercialization

IRL3, TRL3

The commercial use of varieties is governed by license agreements. Seeds and recommendations on plant cultivation and use are provided

Contact Information

Jamal B. Rakhmetov, M.M. Gryshko National Botanical Garden of the NAS of Ukraine; +38 044 285 01 20, e-mail: jamal_r@bigmir.net

ZHRO RAILWAY GREASE



Areas of Application

The grease is a special lubricant to be used for the friction units with rolling elements bearings of locomotives, diesel trains, and multiple-unit trains

Specification

The grease is a homogeneous mass having a color ranging from light yellow to brown; a dropping temperature of 190 °C; a penetration of 190–250 m·10⁻⁴ at a temperature of 25 °C; a viscosity of 1650 Pa·s at a temperature of -30 °C and an average gradient of strain rate of 10 s⁻¹; a strength limit of 480 Pa at 50 °C; a welding load of 2600 N at a temperature of (20 ± 5) °C; a flashpoint in closed crucible of 183 °C; and an ignition temperature over 250 °C

IPR Protection

IPR3

Advantages

Due to improved mechanical stability, low-temperature, tribological, protective and environmental properties and operability in the temperature range from -50 °C to +120 °C, the grease leaves behind Both domestic and best foreign counterparts based on petroleum oils thickened with lithium soaps of fat acids of expensive castor oil

Stage of Development.

Suggestions for Commercialization

IRL5, TRL6

A prototype is manufactured and tested at customer's site; support in the design works and production organization is provided upon request

Contact Information

Grygorii S. Pop, Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine; +38 044 559 60 59, e-mail: gpop@bpci.kiev.ua

TECHNOLOGY READINESS LEVEL (TRL) SCALE

Stage	TRL	Interpretation	Definition and Description
Invention	TRL1	Basic principles observed	Basic scholarly research is translated into potential new basic principles that can be used in new technologies
	TRL2	Technology concept formulated	Potential areas of application of basic (technological) principles, including the technological concept are identified. Basic manufacturing principles are elaborated and potential sales markets are identified. A small research team is established to assess the project feasibility
Concept validation	TRL3	First assessment of concept and technology effectiveness	Based on preliminary study, actual research is conducted to assess technical and market feasibility of the concept. This includes active R&D works at the lab and first negotiations with potential customers. The research team expands. Market feasibility is assessed
	TRL4	Prototype validation at lab	Basic technological components are integrated to assess early feasibility by testing in laboratory environment. Manufacture options are studied with basic manufacturing principles identified. Key markets are researched to study demand. The organization is ready to scale up, possible services are analyzed. Comprehensive marketing analysis is made
Prototyping and incubation	TRL5	Prototype testing in user environment	The system is tested in user environment with broader technological infrastructure involved. The actual use is tested and validated. Production-support works and pre-production tests are done in lab environment. Trial batches of prototypes enter the key markets. The organization starts activities to further distribute the prototypes and to enter the sales markets
Pilot production and demonstration	TRL6	Pre-production, including tests in user environment	The product and manufacturing technologies are completely ready for launch of a pilot line/pilot plant (low-scale manufacture). The product and manufacturing technologies are assessed and finalized. This may include additional R&D works. The early products and manufacturing technologies are tested in the key markets with simultaneous organization of manufacture (marketing research, logistics, production facilities, etc.)
	TRL7	Low-scale pilot production demonstrated	The product manufacture is fully operational at low rate. Actual commercial products are manufactured. The final products are verified in the key markets. The organizational component is completed (comprehensive marketing strategy, all components of manufacturing activities). The products are formally launched in test markets
Initial market introduction	TRL8	Manufacture fully tested, validated, and certified	The manufacturing flow charts, product final version, production organization, and marketing tools are completed. The full-scale manufacture has been launched. The final product is sold in majority of domestic and international markets
Market expansion	TRL9	Manufacture and products fully operational and competitive	The full-scale manufacture is sustainable, with the product gaining new markets. Minor modifications and improvements create new versions. The technology and product output are optimized through implementing innovative concepts on manufacturing process. The product is fully customized to the key markets

INNOVATION READINESS LEVEL (IRL) SCALE

IRL	Innovation Readiness Level	Definition
IRL1	Inventor or team with a dream	The lowest level of readiness where the intention transforms into an idea of space system application or the space technology transforms into a business venture
IRL2	Paper studies produced	Once the basic ideas have been formulated, they are put down on paper in studies and analyses of business opportunities
IRL3	Experimental evidence of business opportunity	Active research and development are initiated, including analytical / laboratory studies to validate predictions regarding the market, the competition, and the technology
IRL4	Capability to implement limited-scope programs with project teams	Basic technological and business components have been developed to establish that they will work together; an initial business plan is available
IRL5	Capability to support project engineering development and design (no product, no revenues)	The basic technological and business components have been integrated with reasonably realistic supporting elements. The business plan is credible, but still needs to be validated against the final product characteristics
IRL6	Capability to support development and design with a market-driven business team (product, no revenues)	The representative prototype system has been tested in a relevant environment. The business team is still incomplete and the venture is not yet ready for commercialization. A full business plan including the market, the operational, the technological, and the financial aspects is available
IRL7	Capability to support limited production; full business team in place (product and limited revenues)	The business can run on a limited scale. The full team is in place
IRL8	Capability to advance to full production and distribution (product and revenues)	The technology has been proven to work and the venture structure has proven to be able to support growing market shares
IRL9	Fully articulated business with appropriate infrastructure and staffing (growing market share)	The offering incorporating the new technology has been used in operational conditions and the business is running with a growing market share

Intellectual Property Rights Protection¹ Levels

IPR codes	Protection Level
IPR1	Technical solutions are know-how ²
IPR2	Applications for copyright protection of IPR objects are expected to be or have been submitted
IPR3	The copyright protection of IPR objects as established by the applicable law of Ukraine has been obtained and is kept in force
IPR4	International industrial patent application(s) (according to the PCT system, etc.) has (have) been submitted. Application(s) for industrial patents has (have) been submitted in foreign country(ies) under national procedure
IPR5	The industrial patent(s) in foreign country(ies) has (have) been obtained and is/are kept in force

¹ The IPR protection measures are implemented by R&D institutions in accordance with the applicable legislation of Ukraine and the requirements of paragraphs 5, 8, and 9 of the Regulations for the use of intellectual property objects at the NAS of Ukraine as approved by Resolution of the Presidium of the NAS of Ukraine No.15 of January 16, 2008, on the Structural Units Responsible for Technology Transfer, Innovation Activities, and Intellectual Property (as revised)

² Know-how is technical, organizational, or commercial data obtained with the use of experience and upon trials of technology and its components, which are: closely held (not a part of general knowledge or available for public) on the date of license agreement; essential, i.e. important and useful for manufacture of products, manufacturing process, and/or provision of services; and elaborate i.e. detailed and complicated enough to verify their compliance with the criteria of being never-before-known and essential (Clause 1 of the Law of Ukraine on the State Regulation of Technology Transfer Activities)

Reference book

THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE

R&D AND TECHNOLOGIES

THE NAS OF UKRAINE

IN 11 SPECIAL ISSUES

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FUEL, LUBRICANTS,
AND TECHNOLOGIES

Compiled by
I.A. Malchevskyi and S.A. Bespalov

Translated, edited, and proofread
by O.A. Zagorodnia

Art work by
Ye.O. Ilnytskyi

Technical editor
T.M. Shenderovych

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V.M. Kanishcheva, N.M. Kovalenko,
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