

INFORMATION

DEPARTMENT OF OIL SHALE TECHNOLOGY, TALLINN UNIVERSITY OF TECHNOLOGY

In Estonia, there exist long-time traditions on research of oil shale whose resources have been widely used in industry both as fuel for power generation and as technological raw material for production of oil and gas since the 1920s. In the beginning of the last century Tartu University served as the center of oil shale researches where in 1925 Prof. P. Kogerman founded the specialized Oil Shale Laboratory. As Prof. P. Kogerman was appointed the first rector of the newly established Tallinn Technical University in 1936, the laboratory was transferred to Tallinn. In the post-war years, in addition to universities also research institutes of the Estonian Academy of Sciences, the Institute of Chemistry in the first place, were engaged in the problems of chemistry and technology of oil shale. However, there was no specialized institution for oil shale researches. Continuous extension of mining and processing of oil shale led to the foundation of the Oil Shale Research Institute at Kohtla-Järve, the centre of Estonian oil shale industry. The corresponding resolution was passed in 1958, and on June 1, 1958, the Institute began to work. During the first years scientific-technical problems of both mining and processing were studied. In 1966 its tasks were restricted to the problems of oil shale processing only. The institute has been dealing with these problems up to the present time.

Oil Shale Research Institute founded in 1958 under People's Economy Council of Estonia was transferred to All Union (the USSR) subordination where it stayed from 1965 till 1989. Since 1998 Oil Shale Research Institute was structurally coupled with Tallinn University of Technology.

On January 1, 2005, the Institute of Oil Shale Research at Tallinn University of Technology was reorganized. It became the Department of Oil Shale Technology at the Faculty of Chemical and Materials Technology, carrying on its principal scientific directions. In addition to the existing oil shale research laboratory in Tallinn, and fuel research and testing laboratory at Kohtla-Järve, the department involves the Chair of Fuel Chemistry and Technology. Establishment of the chair restores training for specialists in fuel specialty at diploma level at Virumaa College at Kohtla-Järve and at master level at Tallinn University of Technology on the basis of new syllabi that will be implemented since the academic year 2005/2006. That change in the Institute's history can be viewed as one of the most important steps in ensuring continuity of oil shale science in Estonia. The new establishment creates good conditions for development of oil shale and chemical industry and for implementation of the century-long scientific and industrial

experience worldwide in the circumstances of expanding use of non-conventional oils (shale oil, heavy oil, oil sands).

Department of Oil Shale Technology possesses expertise of 45 years in studying and processing of oil shale and is the only specialised centre of the world in this field.

Structure of the Department

1. Laboratory of Oil Shales in Tallinn



Researcher Michail Bitjukov and PhD student Kristjan Kruusement preparing an experiment



Researcher Laine Tiikma consulting master student Natalja Prjadka

Research Objective

Optimization of conversion processes of organic high-molecular substances: chemical composition of the products, their properties and refining.

The aim of the task is to produce maximum amount of liquid fuels and chemical raw materials from natural and synthetic high-molecular substances. Wood, peat, reed, fire-brush, oil shale, plastics and rubber waste are under investigation. The properties and chemical composition of liquid products produced from these substances and their mixtures with oil shale are being researched. Pyrolysis, hydrogenation and supercritical extraction are used to prepare the liquid products.

2. Laboratory of Fuels at Kohtla-Järve

Accredited by *The Estonian Accreditation Centre (Certificate L 059, October 26, 2001).*

Research Objective

Carrying out research on oil, oil shale and chemical industry products and analysis of solid and liquid fuels by chemical and physical methods.

Modern analytical apparatus is used.

Analyses are carried out in accordance with international standards and their quality is guaranteed.



Senior researcher L. Kekisheva analyzing liquid fuels with gas and liquid chromatographs

Development of oil shale thermal processing technologies and reduction of their hazardous effect on the environment, especially that caused by retorted shale (semicoke). Separation of shale oil and phenols into group constituents, studies on their composition and development of new products.

In three recent years the institute has acquired research and analytical equipment worth about six million kroons and built modern laboratories at the total cost of about ten million kroons financed by PHARE program and state funds.



President of the Republic of Estonia Mr. A. Rüütel and Prof. J. Soone visiting a laboratory at Kohtla-Järve

3. Chair of Fuel Chemistry and Technology

The basic activities of the department include:

- Study of chemical and technological properties of oil shales originating from different deposits of the world.
- Development of new methods and improvement of both existing methods and retorts for thermal processing of oil shale.
- Studies on the composition and properties of oil shale, development of new fuel and chemical products on the basis of oil shale.
- R&D activities in the field of chemistry and technology of liquid and solid fuels, including co-processing of oil shales, heavy petroleum oils and industrial wastes.
- Development and coordination of projects for economic evaluation of oil shale resources.
- Development of resource-saving and environmentally safe production.

Cooperation in scientific and educational activity with Virumaa College and Department of chemical technology of TUT in the field of applied higher education and master studies in the following disciplines: fuel chemistry and technology, oil shale chemistry and technology, motor fuels and lubricants.

The department has studied chemical and technological properties of oil shales originating from the deposits of different countries: Estonia, Bulgaria, Russia, China, Kazakhstan, Belarus, The U.S.A, Uzbekistan, Brazil, Israel, Cuba, Ukraine, Morocco, Australia, Syria, Thailand.

The research associates of the department have in excess of 200 author's certificates for inventions.

Patents on inventions of the department employees were granted in the USA, the UK, Sweden, Greece, Tunis, Canada, Brasilia, the Netherlands, Cuba, Morocco, Yugoslavia and other countries. The first patent was from Greece in 1976.

25 volumes of transactions of the institute have been published.

In 2002 "The International Symposium on Oil Shale" was organised in Tallinn by Tallinn Technical University, Estonian Oil Shale, Estonian Ministry of Economic Affairs, Narva Power Plants, Estonian Academy of Sciences, World Energy Council, and Estonian Energy Council.

Basic developments in cooperation with industrial enterprises of Estonia in introducing oil shale processing technology

Retorts of oil shale thermal processing.

- Processing large-particle oil shale in vertical retorts.
- Processing fine-grained oil shale in retorts with solid heat carrier.

Retort designs for processing oil shale developed by the Institute of Oil Shale Research have been introduced in Estonia, Russia and China. Processing fine grained oil shale by solid heat carried retorting introduced in Estonia.

The former Oil Shale Research Institute has participated in working out the following products

- Shale oil
- Fuel for small boilers and bunkering
- Epoxy resin AREM-2-20
Used in adhesive compositions, mastics and coating compositions.
- Solid epoxy resins ARE-1-8 and ARE-2-8
Used for fixing linoleum covers and as promotor of rubber mixes.
- Epoxy adhesive EPO-1 and EPO-2
Used for bonding metal, glass, porcelain, surfaces of stone, etc.
- Rubber modifiers (promoters) RU-D-1, RU-D-2 and ARU-D, ARU-D-1, ARU-D-2 based on resorcinol and alkyl resorcinols
Used in rubber mixes in the tyre industry.
- Pure 5-methyl resorcinol
Used as chemical reagent in medical and biological research.
- Plugging composition TS-20
Used for repair and insulation of oil and gas wells.
- “Slaks-1” and “Slaks-2” protecting greases
Protects unpainted surfaces of agricultural machinery during storage, etc. from atmospheric and biological corrosion.
- Anticorrosion oil “Slacor-X”
Protects unpainted metal surfaces under tropical conditions.
- Anticorrosion oil K-89
Efficient for prolonged storage of machinery (up to 10 years).
- “Esmol-1” and “Esmol-2” mastics
Used for fixing roofing materials and for hydro insulation of buildings (“Esmol-1”), and for long-time anticorrosion metal protection (“Esmol-2”).
- Film-forming inhibitor composition “Metacor”
Used for anticorrosive protection of metal structures during 3-10 years.
- Corrosion inhibitors “Bemo-1” and “Bemo-2”
Protects ferrous metals from atmospheric and acid corrosion.
- Protective composition “Bena”
Used for protection of metal surfaces from atmospheric and bio corrosion. A film is formed on the metal surface.
- Detergents “Viker” and “Viker-D”
Used for washing of glass, porcelain and wooden surfaces and also for disinfection of dishes, floors, woodware, hospital utensils, etc.
- Pure benzoic acid (oxidation product of toluene)
Used as a reagent and for molecular weight control in polyamide fibre production.
- Preservative “Superben” (oxidation product of toluene)
Efficient silo preservative, particularly for protein rich fodder.
- Soman- additive to boiler fuels

- SO-2E additive to diesel fuel
- Shale oil derived biocide materials
- Biofuel
- Shale gas derived motor fuels

Projects and collaborators

1. New Technology of Shale Oil Production

USA-Estonia joined program on oil shale research and utilization.

The aim of the program: to develop a new oil shale processing technology for production of enhanced value products.

New products: biocides and antioxidants from shale oil.

In the framework of USA-Estonia co-operation programme in shale oil research and utilization efforts are made to derive biocide agents and antioxidants from shale oil. The obtained products possess high functional activity in relation to paint coats and building materials. Several technologies have been developed at the Oil Shale Research Institute that enable to prepare biocide agents with high concentration of the active substance. These agents were tested at specialized scientific organizations and their high functional activity in relation to paint coats and building materials was proved.

2. Environmentally Acceptable and Resource-Saving Oil shale Processing Technologies

Improvement of industrial oil shale thermal processing existing in Estonia (including description and application of technologies to cut back environmental pollution in terms of the Best Available Technique (BAT) criteria) with the aim to increase shale oil yield and calorific value of gas and to reduce organic matter and carbon in solid residue and waste waters during oil shale thermal processing by the way of optimization of technological parameters.

Use of oil shale, renewable fuels and industrial wastes, their combined upgrading. The Department of Oil Shale Technology at TUT is carrying out investigations on combined upgrading of oil shale and wood. Further studies including other Estonian renewable fuels and industrial wastes are being planned.

Co-processing oil shale and heavy oil and other non-conventional oils for upgrading and utilization

3. Collaboration with Estonian Enterprises in the Framework of Oil Shale Technology Development Center Foundation

Strategic Line of Development: Oil Shale Usage

Partners: Narva Power Plants Ltd, Viru Chemistry Group Ltd, Kiviõli Chemical Industry Ltd, Eesti Põlevkivi Ltd, Kunda Nordic Cement Ltd, Department of Thermal Engineering TUT, Department of Chemical Engineering TUT, Department of Chemistry TUT, Department of Mining TUT.



Production manager of Oil Factory A. Kaidalov (left) and Ph.D. J. Zhiryakov visiting the factory

Senior researcher of oil shale laboratory at Kohtla-Järve Ph.D. J. Zhiryakov (left) and director of Oil Factory N. Golubev on the territory of Narva Power Plants



Fruitful cooperation of Estonian oil shale scientists with engineers of Oil Factory of Narva Power Plants Ltd. has brought about an increase in oil output of the factory: from 32.5 thousand tonnes in 1992 to 115 thousand tonnes in 2004. Environmental hazard of solid wastes – oil shale ash – is under control.

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