

**SYMPOSIUM ON OIL SHALE
18–21 NOVEMBER 2002, TALLINN, ESTONIA**

SECTION “OIL SHALE RESOURCES, GEOLOGY AND MINING”

There are no technical and technological problems concerning oil shale mining, therefore the section “Oil Shale Resources, Geology and Mining” concentrated mainly upon resources and mining impact on the environment. The problems were analyzed and discussed basing mainly on the ample experience of Estonia.

At all sections the amounts of oil shale resources of the world and of Estonia were discussed. One must bear in mind that this term has to be interpreted in the context of economy, technology and nature protection. For example, the reserves of the Estonia deposit have been determined proceeding from the technology used in power plants and electricity price. At present an oil shale bed is considered mineable when its energy rating is at least 35 GJ/m^3 (see the report by M. Veiderma). The latest researches of the Department of Mining of Tallinn Technical University completed only after the symposium show that in the case of using run-of-mine shale for oil production the cut-off grade could be lower and the amounts of mineable shale would be considerably larger.

Extensive nature protection areas located just above the Estonia deposit limit mining activities as well, i.e. one can mine much less oil shale than official reserves. Providing power plants with oil shale may be disturbed after some 10-15 years already. Opposition of environment protectors to the new oil plant applying ATP process has retarded the design of the *Ojamaa* mine to be exploited for this purpose. A number of solid and practical reports were made about the impact of mining on the environment and the possibilities of its mitigation (A. Adamson, K. Erg, T. Kattel, J.E. Sørli).

I. Valgma from the TTU Department of Mining presented the mathematical model created for finding optimal solutions for oil shale bed exploitation. As an example of using the model the shale oil cost price (USD/bbl) distribution in the Estonia deposit has been given. The model can be used for composing development plans of the mines, especially for large flat deposits like the Baltic oil shale area, including Estonia and Oudova (Leningrad) deposit.

Enno REINSALU

SECTION "POWER GENERATION FROM OIL SHALE"

The previous international oil shale symposium in Estonia took place in 1968, i.e. two years after the first world biggest oil-shale-based power station – Baltic Power Station – achieved its full capacity. At present the capacity of the station is 1290 MW, and boilers with a productivity of 220 and 320 tonnes steam per hour are in use. Already in 1969 Estonia began to build an even more powerful oil shale power station, and in 1973 it achieved its designed capacity of 1610 MW. The station uses pulverized combustion technology. Steam generators with a steam production of 324 tonnes of steam per hour are specially designed for combustion of oil shale. The temperature of the steam after reheat temperature is 525 °C. The boilers have been designed on the basis of Estonian research; the relevant experience is eighty years old.

Before this conference, Estonian oil-shale-based power generation had reached the implementation stage of new-generation boilers, which rely on fluidized-bed technology. One energy block (215 MW) both in the Baltic Power Station and the Estonian Power Station will be renovated installing specified boilers worked out by *Foster Wheeler OY* in co-operation with Tallinn Technical University and *AS Eesti Energia (Estonian Energy Ltd.)*. The renovation of the rest of the blocks with the purpose of enhancing efficiency and improving compliance with environmental requirements will be decided after achieving the designed capacity of the first renovated blocks.

Against the background of such fast development, discussions in plenary sessions, sections as well as at poster presentations took place on many interesting research, technological, operational and environmental issues concerning the use of oil shale. The total estimated oil shale resources in the world are fairly big – over 10^{13} tonnes, and a lot of countries have oil shale resources, but the experience of using oil shale in power production is still to make its way in the world. Hence the great interest of researchers and specialists from numerous countries in learning about the Estonian experience.

The power generation section offered three plenary presentations on global issues of oil shale energy: by Dr. Klaus Brendow (World Energy Council), Prof. Mihkel Veiderma (Estonian Academy of Sciences) and Prof. Arvo Ots (Tallinn Technical University), twelve section presentations were given and ten poster presentations were analyzed. Speakers represented the USA, Russia, England, Finland, Switzerland and Estonia. As in Estonia the implementation of oil shale energy has continuously been extensive and research into oil shale has been carried out for a long time, no wonder that the majority of the presentations were given by Estonian researchers and specialists.

Estonians analyzed the existing system of oil shale energy and put forward the ways of increasing the efficiency of oil shale energy and mitigating environmental impacts. Foreign specialists were interested in the analysis of the advantages and disadvantages in using oil shale for power production

and the competitiveness of oil shale in comparison with other types of fuel, such as natural gas, nuclear fuel, renewable energy sources, etc. As negative aspects of oil shale, its low calorific value (8–9 WJ/kg), great content of ash (45–48 %) and carbon as well as high concentration of sulphur dioxide in flue gases were pointed out. Those were the aspects that the majority of presentations focused on, being mainly related to the insurance of the quality of oil shale as a fuel for power production, organization of the combustion process, ash removal technology and environmental problems in ash fields as well as the reduction of the concentration of harmful gaseous components and solid particles.

The positive aspects of the use of oil shale pointed out were the advantages of a domestic fuel over imported fuels (low price, employment, existence of technological solutions for raising the efficiency of power production from 26–28 to 34–36 %). That has helped to keep the price of oil shale electricity in Estonia on a fairly low level (in 2002 the total average price was 5.04 € cents per kWh, for households 5.69 € cents per kWh) and to ensure high GDP growth (5–6 % per year). In Estonia over 90 % of the needed electricity is produced from oil shale, and because of its great resources (5 billion tonnes) oil shale will still remain the main primary energy source for many years.

Analyses showed that the negative aspects of oil shale energy could be most significantly reduced by transition from pulverized combustion technology to circulating-fluidized-bed combustion technology. The new-technology boilers with a steam production of 324 tonnes per hour have been worked out and will be installed in Estonian oil shale power stations. Already in the foreseeable future, Estonian energy specialists will gain new and very important experience that can be disseminated to all countries interested in developing oil shale energy. All environmental parameters of all energy blocks with the new circulating-fluidized-bed combustion technology are in accordance with the requirements of EU directives.

As shown by the round-table discussion of the section on the competitiveness of oil shale energy, thanks to the implementation of the new efficient combustion technology, renovated oil shale power stations will become in the future entirely competitive with power stations using other fossil fuels as well as with nuclear power stations. Solutions have also been found to the water problems of ash fields and the reduction of the concentration of harmful gaseous components and solid particles. Therefore, countries with great oil shale resources (the USA, Russia, Brazil, Jordan, China, etc.) are justified in making investments in oil shale research and technology development as well as in the construction of oil shale power stations. In this connection, the need to continue Estonian oil shale research and disseminate the existing experience at international level was underlined.

Ülo RUDI

SECTION "OIL SHALE CHEMISTRY AND TECHNOLOGY"

At this section three principal fields were discussed:

1. Oil shale processing.
2. Structure of Estonian kukersite kerogen and products obtained from oil shale.
3. Environmental risk assessment and decreasing hazards of wastes.

At the section 15 oral papers were presented and 15 additional ones in the poster session by authors from ten countries.

In the field of oil shale processing one of the papers was presented at the plenary session by Prof. J. Soone, Director of the Oil Shale Institute at Tallinn Technical University (co-author S. Doilov). In this presentation a review was given of the processes for oil shale pyrolysis, including the basic criteria of the technology in vertical retorts and of oil shale thermal processing in Estonia.

At the section seven oral presentations concerning this area were discussed. Under discussion were most of the processing technologies currently known in the world practice.

Of interest were the papers discussing the technology using solid heat carrier for thermal processing of fine-grained oil shale (oil shale fines).

Three papers – by W. Taciuk (Canada), S.J. Schmidt (Australia) and J. Purga (Estonia) – dealt with successful commercial introduction of a new *Alberta Taciuk* process (ATP) in Australia for the production of liquid fuels from the local oil shale and of the developments for applying this process for the pyrolysis of Estonian kukersite at *Viru Keemia Grupp AS (Viru Chemistry Group Ltd.)* in Estonia.

A detailed review was given by N. Golubev (Estonia), Manager of the Oil Factory of *Narva Elektriijaamad AS (Narva Power Plants Ltd.)* on the successful introduction and development of a process by the solid heat carrier technology (UTT-3000) developed by industry and science.

An interesting review was also given by J. Wang and J. Qian on the oil shale thermal processing at vertical retorts in China.

In the poster session W.R.O. Pimentel *et al.* (Brazil) described Brazilian expertise in running vertical retorts in a paper "Thermogravimetric Analysis as a Tool to Access Oil Shale Pyrolysis".

A new interesting approach by Estonian science in oil shale thermal processing was presented by H. Luik in his paper on sub- and supercritical extraction of oil shale which could lead to a new possible future technology for processing lean solid fuels.

The Estonian scientists (L. Tiikma *et al.*) also presented the results of research on co-pyrolysis of oil shale and polymeric materials. Co-processing of tyre waste and various heavy petroleum products has been successfully introduced by the Oil Factory of *Narva Elektriijaamad AS*. Very attractive and promising, in my opinion, would be further research and development activities on co-processing oil shale with heavy natural oils, bitumens, heavy

fractions of conventional petroleum and various solid and liquid industrial and residential wastes. The above processes could be introduced in the near future to produce liquid fuels and chemicals on the basis of non-conventional fuels (non-conventional oil and gas) when the resources of conventional petroleum and natural gas will be exhausted.

The value-adding role of oil shale in substantial increase in the yield of light hydrocarbons and in co-processing of oil shale with heavy natural oils or heavy fractions of conventional petroleum, according to the results of research effects so far, can be explained by the effect of the organic matter of oil shale as hydrogen donor and of the mineral portion as a cracking catalyst.

Apparently, it is necessary to conduct further research on the chemical composition and structure of oil shales.

Therefore, the presentation by Member of Academy Ü. Lille (Estonia) summarizing the studies on the structure of the organic matter of kukersite and a new approach in describing the molecular model of kerogen is of special interest.

One of the possible utilization options of the organic and mineral portions of oil shale in a combined process, so far also successfully commercially introduced in Estonia by *Kunda Nordic Tsement AS* (*Kunda Nordic Cement Ltd.*) was demonstrated by J. Hilger (Germany).

At the plenary session new technological methods of shale oil processing were reviewed in a paper by J. Bungler (USA) from a new point of view aimed at increased production of value-added fuels and chemicals.

Five poster presentations out of eight in the section were made by research associates of the Estonian Institute of Oil Shale Research. Besides problems of possible oil products and chemicals those of utilization of shale gas as motor fuel were also discussed.

As earlier, the interest of scientists is focused on products obtained on the basis of dihydric phenols, now especially on compounds with long alkyl side chains, so-called oil-soluble phenols.

At the section a number of papers dealt with the monitoring and improvement of environmental situation. Special papers concerning these problems were four oral presentations as well as three posters. Thus, interesting papers on environmental problems were presented by Estonian scientists, including the paper by A. Kahru "Ecotoxicological Evaluation of the Hazard Caused by Oil Shale Industry-Related Pollution", by R. Munter on modern technology of waste water treatment, by Y. Zhiryakov on the composition of waste products emitted by oil shale processing technologies, by R. Kuusik on combustion of solid residues of oil shale thermal processing, and by A. Heinaru "Enhanced Biodegradation of Oil Shale Chemical Industry Solid Wastes by Phytoremediation and Bioaugmentation".

A poster presentation was given by J. Kann and A. Kogerman (Estonia) on the international scientific and technical journal *OIL SHALE* which over a long period has been an accepted publishing forum for oil shale experts of the world.

This special issue of *OIL SHALE* offers a good opportunity for publishing the proceedings of the Symposium on Oil Shale. Publication of these materials will be continued in the next issues of the journal.

It may be concluded that Section 3 fully succeeded in completing the set objectives:

- In the oil shale processing, upgrading of the obtained products and environmental risk assessment the objectives were reached.
- Future goals for research and development (R&D) areas were identified.

Moderators in Section 3 “Oil Shale Chemistry and Technology” were Member of Academy Ü. Lille and Prof. J. Soone.

Jüri SOONE