

## EDITOR'S PAGE

### THE 3rd INTERNATIONAL OIL SHALE SYMPOSIUM IN TALLINN

#### Introduction

Estonia has been well known as the oil shale country because of its long experience in mining, shale oil production and electricity production from oil shale. Oil shale related research has been carried out for over 80 years in Estonia. More than 1 billion tons of oil shale has been mined, nearly 200 million barrels of shale oil and more than 550 TWh of electricity has been produced from oil shale in Estonia. These facts demonstrate that Estonia's greatest uniqueness is its oil shale industry with almost 100 years of history.

Despite all that, Estonia has been not very good in selling its oil shale experience and know-how to other countries, which possess notable oil shale reserves (like USA, Jordan, Morocco, China, etc.). Even though 80% of oil shale mined around the world is mined in Estonia, very few scientific conferences related to oil shale research have been held in Estonia. The first truly international oil shale conference took place in Tallinn on 1968. One has to note that at that time Estonia was part of the Soviet Union and it was extremely difficult to organize any international conferences. This conference was also held at a time when a next big step towards large-scale power production from oil shale was taken – construction of Eesti Power Plant, which uses pulverized oil shale fired boilers, was started. Almost 34 years passed until the second international oil shale symposium was held in Tallinn in 2002. That year also marks an important milestone in the history of the oil shale industry in Estonia. During that time Eesti Energia (EE), the Estonian state energy company, decided to invest into oil shale fired Circulating Fluidized Bed (CFB) boilers, which allowed achievement of greater efficiency and better environmental performance. It was decided at the second symposium that symposiums on oil shale should become regular and should be held every four years. However, this decision was not followed.



The next and most recent International Oil Shale Symposium was held at Tallinn University of Technology (TUT) on 8–11 June 2009. The Symposium was organized by EE in cooperation with Colorado School of Mines (USA), TUT and Tartu University. Almost 300 participants from all continents and 24 countries attended the conference. Altogether 80 participants used the possibility to go on field trips, which included visits to Estonia underground mine, Narva open pit mine, oil shale fired Eesti Power Plant and Narva Oil Factory. Again, this conference marks the next step in the development of the Estonian oil shale industry, as EE announced its investment into the next generation shale oil production plant in Narva, which will use the newly developed Enefit 280 technology.

### **Opening plenary session**

The opening plenary session was addressed by Peep Sürje, rector of TUT, who recognized that oil shale is and remains an important energy resource in Estonia. TUT has educated thermal, mining and chemical engineers for Estonian oil shale industry for many decades and it will continue to do so. Sandor Liive, CEO of EE, presented highlights of the Estonian oil shale industry. He displayed EE's oil shale activities in both power and oil production. "Almost a century long experience in oil shale processing and clear vision in the development of the oil shale industry give Eesti Energia a unique competitive advantage. Oil shale is a guarantee for Estonia's energy security and this symposium gives us an opportunity to share our know-how with all interested parties around the world," he said. He also introduced EE's new business name, Enefit, which EE is going to use for its international activities. Peter Webber, president of Outotec's Metals Processing, discussed their partnership with Eesti Energia for development of a new retorting technology, which should have higher efficiency and lower environmental impact. He presented the company's impressive resume in development of fluidization technologies.

Juhan Parts, Estonian Minister of Economy and Communications welcomed delegates and in his speech he stressed the importance of oil shale on the Estonian economy and independence. The minister announced a shift in oil shale usage in Estonia from power production towards shale oil production. The plenary session was concluded by Edward Lucas, correspondent for *The Economist* in Central and Eastern Europe, who emphasized the strategic importance of oil shale around the world and highlighted advantages of the Estonian oil shale industry in comparison with energy industries of other countries: transparency, security of supply and long-term strategic vision. In his opinion, oil shale is one of the possibilities to secure supply of energy, which is extremely important in an environment where the energy sector is used by countries to achieve political goals.



Peep Sürje, rector of TUT opening the 3<sup>rd</sup> International Oil Shale Symposium in Tallinn

### **Technical sessions**

The technical program was divided into eight sessions, which covered all important areas of research and development in the oil shale sector. Presentations covered the whole value chain including oil shale mining, power production, shale oil production, oil upgrading and remediation of waste. However, less emphasis was put on *in-situ* processing of oil shale.

### **Remediation and managing by-products**

Uuve Kirso of the National Institute of Chemical Physics and Biophysics discussed the impact of oil shale waste on the terrestrial environment. She advocated towards wider recycling of oil shale wastes (spent shale and ash). Anne Kahru of the National Institute of Chemical Physics and Biophysics discussed eco-toxicological aspects of landfill sites of solid wastes from the Estonian oil shale industry. She pointed out that in spent shale disposal, hazard may arise from sulfides and alkaline oxides and hydroxides. Whereas disposal of ashes is classified in Estonia as hazardous waste due to the high alkalinity of their leachates. Musa Resheidat, professor of Jordan University of Science and Technology, discussed possibilities of utilization of spent shale in production of soda ash, ammonium sulfate, potassium sulfate, sulfuric acid and use in other industries.

Raimo Jaaksoo of Net Systems discussed remediation of mining dumps and ash fields using Estonian examples. Thomas von Schwarzenberg from RWE Power presented environmental aspects in power production from lignite. He discussed the environmental impact in lignite mining, ground water protection, ash backfilling, dust emissions, and reclamation of mining sites. Jyri-Rivaldo Pastarus, associate professor of TUT, discussed the backfilling technology of ash and mining by-products that is proposed to be used in the underground mines of Estonia.

### **Research on oil shale retorting**

Andres Siirde, professor of TUT, presented a new patented oil shale retorting technology, which uses a fluidized bed pyrolysis system together with a CFB furnace for combustion of by-products (spent shale and retort gas). Indrek Aarna of Eesti Energia introduced the new improved solid heat carrier technology, Enefit 280, which was developed together with Outotec and which will be used in the expansion of Narva Oil Plant. Enefit 280 technology still uses a rotary kiln for oil shale pyrolysis, but has incorporate a CFB into the process for combustion of spent shale. The new technology has a higher unit capacity, lower emissions and higher efficiency. Jimmy Jia from PROCOM Consultants discussed the process modeling method used for the Fushun retort. The model was used as a technology development tool and it was reasonably accurately able to predict results from 1 t/h pilot plant tests. Chuichi Watanabe, CEO of Frontier Laboratories Japan, presented a new rapid, reliable and on-line analysis method for characterization of oil shales by thermal desorption/pyrolysis-GC/MS. The new method was applied on characterization of Estonian kukersite and dictyonema oil shales. Kristjan Kruusement of TUT discussed liquefaction and gasification of Estonian oil shales in the medium of hot compressed water as an alternative to conventional semicoking methods.

### **Developments in shale oil production technologies and upgrading**

Michele Thomas of ExxonMobil Upstream Research Co. introduced the Electrofrac™ process for *in situ* oil shale conversion, where oil shale is heated by a hydraulic fracture filled with an electrically conductive material (calcined coke). ExxonMobile is performing field tests, but the process still needs several years of development before reaching the commercial implementation phase. Anton Dammer of Redleaf Resources Inc. presented the EcoShale™ in-capsule process, which combines the advantages of *in-situ* and surface retorting technologies. The company has performed pilot tests in Utah and is declaring that the production cost of shale oil using the EcoShale™ process is \$20–25 per barrel for 30000 bbl/day plant. Hans Luik of TUT discussed thermal dissolution and hydrogenation technologies as a perspective alternative to semicoking methods. He pointed out that alternative methods enable the most effective oil shale liquefaction and

upgrading. Jim Schmidt from PROCOM Consultants shared his experience from operation of a shale oil upgrader in Stuart, Australia. He emphasized possible challenges in upgrading of shale oils, importance of understanding market requirements, and need for extensive pilot testing before choosing an upgrading process. Alan Goelzer of Jacobs Consultancy presented the results of the pilot plant tests of hydrotreatment of shale oil produced in the Enefit 140 process. He reported that preliminary tests showed very high desulfurization, de-oxygenation and de-nitrification levels and a significant uplift in API gravity, which allows to predict that hydrotreated shale oil products can be sold at prices similar to Brent crude prices.

### **Exploration and geology**

Roland Butler of Altius Resources Inc. discussed the history of the Alberta oil shale project located in eastern Canada. The Alberta oil shale resource has been well studied since 1849 and it has a moderate oil yield (80–100 l/t). Several pilot retort tests have been carried out with Alberta oil shale. Vojin Ćokorilo of the University of Belgrade gave an overview of oil shale deposits in Serbia. The most promising oil shale resource is located in the Aleksinac deposit, which is estimated to have 2 billion tons of oil shale with an average oil yield of around 10%. Marwan Madanat of the Natural Resources Authority of Jordan discussed availability of oil shale resource in Jordan and its exploitation opportunities. There are more than 18 known oil shale deposits with total estimated resource of more than 40 billion tons. Jordan is offering rights to study its oil shale resource for investment purposes. Väino Puura from TUT gave a very detailed study about the lithology and geochemistry of the El Lajjun and Attarat oil shale from Jordan. Tsevi Minster from the Geological Survey of Israel discussed occurrences and properties of oil shale resources in Israel. The geological reserves of oil shale are estimated to be 300 billion tons and it has an oil yield around 45–100 l/t. The resource is currently used for power production at Mishor Rotem FBC power plant.

### **Oil shale as a power source**

Arvo Ots of TUT discussed the peculiarities of combustion of Estonian oil shale, which are influenced by the behavior of the oil shale mineral matter. He also gave an overview of the history of oil shale fired power plants in Estonia. Oil shale fired power plants have faced numerous challenges including ash fouling, high-temperature corrosion, NO<sub>x</sub> and SO<sub>2</sub> emissions, and lately CO<sub>2</sub> emissions. Juha Sarkki of Foster Wheeler Energia Oy discussed the operation of the oil shale fired CFB boilers at Narva power plants. He reported the good results that have been achieved with respect to lower environmental emissions, higher efficiency and higher reliability using Foster Wheeler's CFB boilers. Andrei Dedov of TUT presented research results related to high-temperature corrosion of superheater tubes in oil shale boilers. Laboratory and industrial

scale high temperature corrosion test results revealed that the best corrosion resistant steel was X8CrNiMoNb16-16.

Rein Kuusik from TUT discussed prospects for utilization and recycling of spent shale, which contains environmentally harmful compounds. According to him, the utilization of spent shale in cement production seems to be the most attractive alternative. Tõnu Pihu of TUT discussed possibilities to capture carbon dioxide during oil shale ash deposition. He showed that ash produced at CFB boilers has higher CO<sub>2</sub> capture capability compared to ash produced at PF boilers. He estimated that about 5,5% of CO<sub>2</sub> emitted by Estonian oil shale fired power plants is captured by oil shale ash. Tamer Turna from TES Ltd. in Turkey discussed utilization of ash produced at oil shale fired power plants as a clinker substitute in cement industry. He stressed the advantages of lower carbon footprint and lower costs of cement production.

### **Hints for successful oil shale projects**

James Bunger of JWBA gave a perspective on the oil shale industry from the thermodynamic perspective. He stated that the best oil shales are richer than the best oil sands and that CO<sub>2</sub> emissions do not appear to be a significant issue. Demarco Epifanio of Petrobras discussed challenges that oil shale industry is facing. He pointed out the key challenges existing in retorting technologies, oil upgrading, environmental performance and oil shale economics. Michael Ekelund from the Alberta Department of Energy gave an extensive overview of the development of the royalty and regulatory regime for the oil sands industry in Canada. He stated that the commitment of the Government and continued dialog with the industry were crucial in building up a large-scale oil sands industry in Canada. Guy Ranawake of Lexicon Partners focused on how to finance oil shale projects in the current macroeconomic environment. He presented appropriate financing strategies for individual projects and analysis of potential sources of capital. Howard Gooder from Europe Arab Bank Plc gave a bank's view on financing oil shale developments. Nikola Anastasijevic of Outotec discussed R&D as the key in technology providing business. He presented the experience of converting small-scale test results into the design of industrial-size plants.

### **International oil shale developments**

James Killen of the US DOE, who participated via phone, discussed the status, outlook and trends of oil shale research, demonstration and development (RD&D) in the United States, which has 6 trillion barrels of oil shale resources. He presented progress in the RD&D lease program, oil shale commercial leasing regulation and DOE national lab projects. Shuyuan Li of China University of Petroleum presented fast development activities in the oil shale business of China, a country which has an estimated oil shale resource of over 700 billion tons. He discussed that a total of 280 Fushun-

type retorts are operated in China (total shale oil production 375 000 tons per year) and there are many plants under construction and in the development stage.

Yaakov Mimran from Ministry of National Infrastructures discussed oil shale exploitation activities in Israel. He explained that Israel considers oil shales an alternative energy source for supply security. Ammar Al-Taher of MED-EMIP discussed the European-Mediterranean energy market integration project, which also supports environmentally friendly, energy efficient and financially attractive utilization of oil shale in Jordan, Syria, Turkey, Morocco and Egypt. Maher Hijazin from the Natural Resources Authority of Jordan discussed the strategic importance of oil shale in energy policy and opportunities offered for international investments into the oil shale sector in Jordan. He informed that Jordan is currently putting together environmental regulations and a fiscal regime for oil shale projects. Michael Bromley-Challenor of Continental Precious Minerals Inc. gave an update on the development of the Cambrian alum shale project in Sweden, which can be an important resource for extraction of oil and metals (uranium, vanadium, molybdenum, nickel, etc.).

### **Environmental impacts of oil shale industry**

Inge Roos of TUT presented future trends in greenhouse gas emissions based on current policies implemented in Estonia. She forecasted a reduction in greenhouse gas emissions by 2020 for all scenarios studied. Khosrow Biglaribigi of INTEK Inc. discussed the development, costs and benefits of carbon capture and storage (CCS) technologies, whereas enhanced oil recovery is already considered an environmentally and economically proven technology for storage of CO<sub>2</sub>. Alla Shogenova of TUT discussed possible CCS scenarios for an oil shale based energy industry in Estonia. She presented a scenario, where CO<sub>2</sub> produced at oil shale fired power plants is captured, transported via pipeline to Latvia, which has the capacity to store about 400 Mt of CO<sub>2</sub>, and stored in Cambrian aquifers.

Erik Puura of the University of Tartu discussed possibilities offered by the predictive modeling of environmental impacts of the oil shale industry. He presented water pollution during mining and spontaneous combustion of spent shale as examples from Estonia, which could have been avoided using modeling tools. Donatella Pasqualini of Los Alamos National Laboratory presented a dynamic integrated assessment model to assess socio-economics and environmental impacts of unconventional fossil fuel developments. She discussed also the results from application of the model on *in-situ* processing of oil shale in the US. Ghussaina Hilu from the Natural Resources Authority of Jordan presented an environmental framework for oil shale projects that is under preparation in Jordan. She discussed that the main emphasize of the regulation is on air, water and soil emission limit values and minimizing water consumption.

### **Closing plenary session**

Andres Siirde of TUT presented the report “A Study on the EU Oil Shale Industry – Viewed in the Light of the Estonian Experience”, which was ordered by the Industry, Technology, Research and Energy Committee of the European Parliament. The report highlights the need for fuller exploitation of the EU's resources of oil shale as a potentially useful source of energy, oil and chemicals. Jerry Boak from the Colorado School of Mines discussed why enormous oil shale resources are not taken into exploitation yet. According to him there are four issues conditional to the future progress: access to the resource, technology development, environmental impact, economic viability. Progress has to be made in all fronts in order for oil shale to become a significant component of the global energy mix. The presentation by keynote speaker Klaus Brendow of the WEC, “Oil Shale: A Local Asset Under Global Constraint” is published in the current issue of *Oil Shale*.

The summary of presentations given above reflects the author's personal view on the highlights of each presentation. The symposium included a wide range of interesting presentations, which altogether give an overall picture about oil shale developments around the world. The conference, with its challenging technical substance and field trips to the operational oil shale industry, was a great success. Hopefully the 4<sup>th</sup> International Oil Shale Symposium will be held in Estonia before 2015, when the next large step in the Estonian oil shale industry - the construction of a shale oil upgrader is expected.

For more information about the International Oil Shale Symposium please visit the website [www.oilshalesymposium.com](http://www.oilshalesymposium.com)

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