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EDITOR'S PAGE

PRESENT AND FUTURE OF OIL SHALE BASED ENERGY PRODUCTION IN ESTONIA

The major challenge facing the Estonian power generation industry over the coming decades is meeting more stringent environmental targets and increasing the efficiencies of oil shale-fuelled power plants.

Today there are eight energy production units (consisting of two boilers connected with a turbine) in the Eesti Power Plant, and only four units in the Balti Power Plant. Both power plants have one new 215 MW_{el} energy block (see Oil Shale, 2004, Vol. 21, No. 3, pp 181–182) operating on the circulating fluidized-bed technology (CFB) while in other plants conventional pulverized combustion (PF) is applied. The five-year use of circulating fluidized bed technology for burning Estonian oil shale has proved to be the right choice.

Basic environmental problem at oil shale pulverized firing is high emissions of acidic compounds SO_2 (820–1360 mg/MJ) and NO_x (90–110 mg/MJ). In forthcoming years' Narva Power Plant Ltd. is going to invest in semidry DeSOx reactors and fabric filters to reduce the emissions of sulfur dioxide and particulate matter from pulverized oil shale-fired power units. This action is necessary in order to make energy production from oil shale environmentally friendly and to ensure that current production capacity can be maintained under stricter environmental requirements after new regulations in 2012 and 2016.

By 2012 flue gas desulfurization units will be installed on four old PF power units of the Eesti Power Plant. Last year's studies and tests on PF boilers showed that nitrogen oxides (NO_x) emissions can also be cut down to the limits according to EC Large Combustion Plant Directive coming into force at full scale for Estonia in 2016.

This year Eesti Energia will start to build a new oil shale power plant near the Eesti Power Plant. The new plant basing on CFB technology will have one or two energy production units of 300 MW_{el}. The first unit will be completed by 2016, and the decision about building the second unit will be taken next year. The new power plant will help to ensure the current level of

electricity production and decrease the environmental influence of oil shale power plants.

Today approximately 90% of the electricity produced in Estonia comes from oil shale, but wider utilization of biomass, peat, wastes and wind is increasing from year to year.

The combined heat and power CFB unit in the Balti Power Plant uses 10% biomass, which is burned together with oil shale. This energy unit produces in average 130–140 GWh of renewable energy, which is enough to cover 2% of yearly electricity consumption in Estonia. At the end of 2008 the joint-stock company Digismart finished a project of Tallinn CHP plant with capacity of 25 MW_{el}/49 MW_{th}, including 18 MW_{th} scrubber, using peat and wood chips (300 000 m^3 per year). The CHP plant in Tartu owned by Fortum Tartu and Anne Soojus (25 MW_{el}/50 MW_{th}) started producing electricity and heat from wood chips and peat in 2009. The new Fortum Termest CHP plant (24 MW_{el}/48 MW_{th}) in Pärnu started producing heat and electricity from wood chips and peat at the end of 2010.

All these three CHP plants use bubbling fluidized bed technology.

In 2012 Eesti Energia will commission a new waste incineration CHP unit at Iru Power Plant. The new unit will incinerate up to 200 000 tonnes of mixed municipal wastes of calorific value similar to oil shale yearly. Construction of the incineration unit started in 2010. The new CHP plant will be able to produce 50 MW of heat and 17 MW of electricity.

In 2008 Balti Power Plant closed down the second ash field and recultivated the area. Until now the ash field was associated only with the oil shale power plant, but in the near future it will host a wind generation park. By 2012 Eesti Energia plans to build 17 wind generators with a total power output of 39 MW.

Oil shale is considered to be a problematic low-grade fuel whose usage for energy production should be banned. Thanks to continuous research and adaption of modern technologies, such as CFB firing, DeSOx (flue gas desulfurization) and oil shale co-firing with biomass, we have proven the contrary. Oil shale usage for energy production can be harmless to the environment, and oil shale is the future fuel. Still a lot of research has to be done to keep oil shale a competitive fuel.

Department of Thermal Engineering (DTE) of Tallinn University of Technology has long-term investigation and co-operation practice (experience) with Narva Power Plants Ltd., the owner of world's largest oil shale-firing power plants. Together we have solved a number of scientific and technological problems on utilization of Estonian oil shale. The field of studies has been very wide, starting with oil shale preparation and handling, power production economy and air emissions, ending with ash handling and storage problems on ash fields. Some of the last-time projects are listed as follows.

Behavior of oil shale mineral matter in CFB boiler. As a result of investigations on ash composition and balance at a full-scale CFB boiler,

thermal effects of oil shale mineral matter were described and assessed in details. Methodology of considering these effects at CFB power unit operational parameters was worked out.

Effect of oil shale grade and heating value on CFB boiler thermal efficiency. Operational, economical and environmental effects of firing different oil shale fuels of LHV from 8.3 to 11.5 MJ/kg were estimated at full-scale tests at CFB boiler in the Balti PP. Oil shale fuel of higher quality guarantees higher efficiency of boiler and power unit, lower CO_2 emissions and lower costs of fuel/ash transport and handling. On the other hand, oil shale of higher heating value means higher production costs and fuel price. The results of the investigations form the basis of optimization of the quality of oil shale fuel delivered to power plants.

VIR-technology (low-temperature vortex). This technology proposed by Russian scientists was tested in PF boiler TP-67. The test results show an increase in SO_2 emissions and self-consumption and decrease in boiler efficiency. Basing on the test results, VIR-technology was not recommended for firing Estonian oil shale.

DeSOx. The first energy unit is in commissioning stage. At the request of Narva Power Plants Ltd. DTE is participating in performance tests of the unit. The implementation of DeSOx (NID-technology) together with bag filters reduces SO_2 content of flue gas to 400 mg/Nm^3 and particulate matter content below 30 mg/Nm^3 (environmental requirements from 2016).

Co-firing of biomass and oil shale in CFB boilers has been investigated lately. The main concern here was possible fouling of convective heat transfer surfaces because of changed properties of fly ash. Analyzis of the properties of ash and deposits has proved that co-firing of biomass with 40-50% moisture up to 15% by mass is possible without major changes in CFB boiler operation conditions. Tests with biomass ratio up to 30% are planned for the near future.

Co-firing of oil shale and retort gas. Together with increased interest in larger production of shale oil, utilization problems of oil by-product retort gas have become actual. Retort gas is co-fired with oil shale at PF boilers of the Eesti PP. Until recently the effect of retort gas firing on temperatures in the boiler furnace and convective pass, on heating surfaces and air emissions was not clear. Full-scale tests at one PF boiler and respective balance calculations of boiler heat revealed that the increase in the retort gas share higher than 5% (by heating value) tends to increase furnace temperature and slagging risk. Also air emissions increase with firing retort gas.

Emissions of fine particulate matter at oil shale firing. Investigations on PM 2.5 and PM 10 emissions from oil shale-fired boilers showed, that approximately half of emitted particulates are of the grade PM 2.5 and the finest particulate emissions come from CFB boiler.

CO_2 binding in ash fields. To evaluate the quantity of CO_2 bound in the ash fields and sediment bonds, tests and calculations were carried out. Knowing the share of PF and CFB firing technologies used in the Estonian

oil shale power plants and taking into account the total surface of sediment bonds and ash field, the quantity of CO_2 absorbed is about 5-6% of emitted CO_2.

Characteristics of oil shale power units at changing load conditions. Integration of large and unstable capacities of wind power into the energy system and opening of Estonian energy market raises the need to operate oil shale base-load power units in a new situation – under circumstances of varying load. The investigation is carried through as a part of a larger project in the frames of the State Program of Energy Technologies and is in the start-up phase. The project partners are, beside DTE, also other departments of the Faculty of Energy of TUT.

Application of heat transfer enhancement techniques (turbulators) for augmentation of heat transfer in the convective part of oil shale power units. Special construction devices, worked out at the DTE of TUT for intensifying convective heat transfer in hot-water boilers, will be tested to be used in the oil shale boilers. The expected results will be higher thermal efficiency of the boiler and lower environmental emissions due to lower amounts of fuel fired.

This special issue of Oil Shale has been compiled mainly by the researchers of Department of Thermal and Electrical Engineering of Tallinn University of Technology, one article has been presented by Kaunas University of Technology, and one has been prepared in collaboration with Estonian University of Life Sciences.

Several young scientists (doctoral students), R. Kuhi-Thalfeldt, V. Medvedeva-Tšernobrivaja, R. Attikas, K. Plamus, A. Konist, I. Roos, I. Pertmann, A. Shablinsky, E. Latõšov, and A. Padari, are involved in the research work of the department.

I hope that in this issue of Oil Shale the reader can find a lot of useful information about energy supply problems in Estonia, power system optimization, and especially about the practical oil shale research at Narva power plants.

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