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EDITOR'S PAGE

DEVELOPMENT OF OIL SHALE COMBUSTION TECHNOLOGIES FOR POWER PRODUCTION IN ESTONIA

In Estonia oil shale has been used on the industrial level for over 90 years. Originally oil shale was used as a fuel for locomotives and households. At the beginning of the 1920s the targeted development of industrial-scale exploitation of oil shale started. Development took place in several directions. Oil shale was used as a fuel for power and cement production, as well as a raw material for the production of shale oil and chemical products. These applications are in place in Estonia also nowadays, but power production is prevailing.

Use of oil shale for power production has been described in detail by Professor Arvo Ots in his book "Oil Shale Fuel Combustion" reviewed in the journal Oil Shale No. 1, 2005.

The following is a short overview of engineering searches for and solutions to oil shale combustion technologies for power production in Estonia.

Usage of oil shale for power production in Estonia started at the beginning of the 1920s. At first lump oil shale was fired on grates. Soon it became clear that for oil shale burning a special grate had to be worked out. The necessary grate was designed and manufactured in Estonia and successfully put into use. Soon the exploitation of fine oil shale started as well.

In the 1920s–30s several small power plants were built in Estonia, where the above-named grates were employed. Low-pressure boilers were used, except for Tallinn Power Plant where medium-pressure boilers were in operation. At Tallinn Power Plant also boilers with higher steam production (35 t/h) were functioning.

However, along with technological progress it became clear that the unit capacity and efficiency of grate-furnished boilers were limited and to exceed them would have required unreasonable costs.

The end of the 1940s and the 1950s saw an important breakthrough in the utilization of oil shale for power production when the pulverized combustion

technology was applied. One of the reasons for this was the introduction of mining combines, which resulted in the generation of a lot of fine oil shale.

The pulverized combustion technology was first introduced at Kohtla-Järve Power Plant and then at Ahtme Power Plant. These plants employed medium-pressure boilers. The first boilers were intended to be used for firing coal, but they did not work satisfactorily. Soon special boilers for oil shale combustion were designed and installed.

The development of oil shale combustion technologies for power production continued. During the period 1959–65 the first high-pressure boilers for pulverized oil shale combustion were installed at the Baltic Power Plant, first with a steam pressure of 9.8 MPa, then 13.8 MPa, and with a steam production of 190 and 280 t/h, respectively. The last series of high-pressure boilers for pulverized oil shale combustion were installed at the Estonian Power Plant, with a steam pressure of 13.8 MPa and a steam production 320 t/h.

Earlier the operation of high-pressure boilers was laborious. Due to the specific composition of oil shale mineral part a number of problems arose, such as slag formation on combustion chamber walls, heating surfaces contamination, emissions of SO_2 and other pollutants, etc. Often there were leakages of heating surfaces tubes. Thanks to the efforts of Estonian scientists and engineers several problems were overcome. Special equipment for cleaning combustion chamber walls and heating surfaces were designed and introduced successfully. However, concerns with repair and SO_2 emissions remained. Several efforts were made to solve or mitigate problems emerging by retrofitting the existing boilers. Attempts were made to apply also other combustion technologies in the existing boilers, such as classic fluidized-bed and vortex combustion technologies, but no significant success was achieved. It has been asked why not use shale oil for power production that would eliminate several problems. It is neccesary to note that on today's level of combustion technologies the direct combustion of oil shale is the most efficient. The efficiency of power production through shale oil combustion is lower because the cumulative efficiency of sequential oil production and power generation processes is lower.

The solution to the above-mentioned problems was found in the application of oil shale combustion in the fluidized bed. In 1993 the respective targeted research started. Three world renowned boiler companies reached separately the same conclusion: the circulating fluidized-bed combustion of oil shale is most suited. The main difference between the pulverized and fluidized-bed combustion technologies is in combustion temperature. The fluidized-bed combustion process is carried out at a temperature of 750–950 ^{0}C and the pulverized combustion at about 1400 ^{0}C.

Two 200 MW power units were renovated, one at the Estonian Power Plant and the other at the Baltic Power Plant. The boilers on power units were fully replaced by new fluidized-bed ones. Both units were set in operation in 2004.

The first results confirmed expectations. The designed capacity and efficiency were achieved, emissions of SO_2 were close to zero, emissions of NO_x decreased about one third.

Long-term experience in oil shale usage has shown that:

1. For combustion of oil shale, regardless of combustion technology, a special boiler has to be designed and constructed. The use or modification of boilers designed for combustion of other fuels, such as coal, is not feasible.

2. If oil shale is available, as is the case in Estonia, power production by its direct combustion is more reasonable.

3. A preferable technology for oil shale-based power production is low-temperature combustion. Experience shows that this is the circulating fluidized-bed combustion at atmospheric pressure.

But oil shale combustion in the circulating fluidized bed entails further opportunities for development. Requirements to reduce CO_2 emissions are forcing one to look for new solutions. Circulating fluidized-bed combustion allows burning oil shale together with wood chips and peat without a major modification of the boiler. The Baltic Power Plant has achieved success in the co-combustion of oil shale and wood chips. The new 300 MW power unit under construction will enable co-burning oil shale and up to 50% biofuel.

Long-term experience has demonstrated that using oil shale for power production has good perspectives. I wish scientists and engineers success in the search for new opportunities in oil shale power engineering.

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