Oil Shale, Vol. 14, No. 3 Special
pp. 215-217

ISSN 0208-189X

CIRCULATING FLUIDIZED BED TECHNOLOGY – TEST COMBUSTION OF ESTONIAN OIL SHALE

H. ARRO, A. PRIKK

Tallinn Technical University
Thermal Engineering Department

J. KASEMETSA

SE Eesti Energia

Tallinn, Estonia

The test combustion of Estonian oil shale was carried out in approximately 1 MW_{th} circulated fluidized bed (CFB) test facilities of Hans Ahlstrom Laboratory, Karhula, Finland and Lurgi AG, Frankfurt/Main, Germany.

The objective of the tests was to verify whether Estonian oil shale can be burnt in the atmospheric CFB boiler at a sufficient carbon conversion rate and acceptable pollutant emission levels.

In the second step, a proposal for the design of a 100 MW_{th} demonstration plant was prepared.

A. Ahlstrom Corporation. Tests were performed in Pyroflow CFB test facility PF-600 during August-November, 1994, at Hans Ahlstrom Laboratory, Karhula, Finland (Fig. 1). The project was carried out in cooperation with A. Ahlstrom Corporation, SE Eesti Energia and Tallinn Technical University. The project was a part of Finnish government program concerning Eastern Europe environmental protection based on the decision of the Finnish Ministry of the Environment.

LLB Lurgi Lentjes Babcock Energietechnik GmbH. Combustion test-work was carried out in the 700 mm CFB test facility of Lurgi's research and development center in Frankfurt/Main, Germany, in January 1996 (Fig. 2). The project was carried out in cooperation with LLB Lurgi Lentjes Babcock Energietechnik GmbH, Tallinn Technical University, SE Eesti Energia, and CRE Group Limited, Stoke Orchard within the scope of the EC-funded program "Oil Shale Perspectives within Energy Production of Estonia".

The total amount of 160 tons of oil shale was burned in the tests. Fuel sizes 0-15 mm and 0-25 mm were used.

Four different fluidized bed combustion modes were tested: Pyroflow (CFB combustion) with two fuel feeding modes and fast fluidized bed combustion with/without a cyclone. The tests gave new information about:

- combustion characteristics,
- emission performance,
- corrosion on heat transfer surfaces,
- ash properties.

The Pyroflow mode was the best from all modes tested.

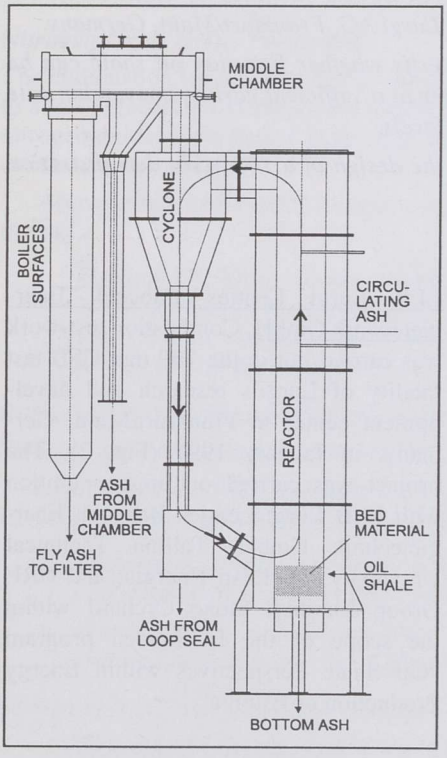

Figure 1. Hans Ahlstrom Laboratory. 1 MW_{th} PF600 pilot plant

The total amount of 160 tons of oil shale was burned in the tests (150 tons of fuel size 0-25 mm and 10 tons – 0-35 mm). Content of coarse particles above 20 mm in the first case was 0-4.2% and in the second case 12.2%.

Eleven different test conditions with a test period of 12 to 27 hours each, were realized to specify the optimum parameters for a long-term test period of about 200 hours. During the program the combustion temperature, the air ratio, the capacity of the plant and the oil shale grain size were varied.

The main incentive for running the long-term test run was to investigate the fouling and deposition effects at different parts of the test facility. During the combustion tests all data needed for designing oil-shale-fired 100 MW_{th} CFB demonstration plant were measured and evaluated.

Different air distribution conditions, primary/secondary air ratio and some low load tests were made in each mode.

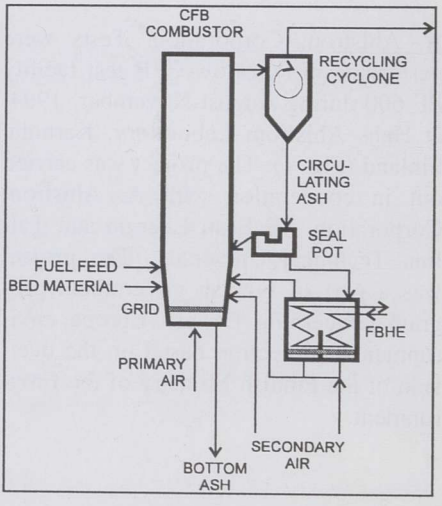

Figure 2. LLB Lurgi. Ø 0.7 m, 1 MW_{th} CFB pilot plant with fluidized bed heat exchanger (FBHE)

The test CFB combustion of Estonian oil shale in both test devices as well as the following laboratory investigations gave quite similar results. Generalization of these results enables to predict the operation conditions of the boiler and to give recommendations for designing a new CFB demo-boiler for Estonian oil shale.

In case of the Estonian oil shale the circulated fluidized bed technology is more effective comparing with the classical fluidized bed. The tests showed that process operated very smoothly and was easy to control. Control of the burning process in the classical fluid bed is quite problematical due to the high content of volatiles in oil shale. The temperature 850°C must be considered as most suitable for burning of Estonian oil shale in respect of fouling and high temperature corrosion of heat transfer surfaces, economical and environmental aspects. The fluidized bed heat exchanger (FBHE) for utilization of heat of ash from recycling cyclone can be recommended as well.

The results of the laboratory investigations enabled to predict the properties of oil shale ash from the CFB boiler as well as the corrosive activity of fly ash and flue gas and fouling of heat transfer surfaces. At the same time the principal recommendations for designing the new CFB boiler burning Estonian oil shale were worked out. More detailed analysis of the questions mentioned above is presented in [1-3].

REFERENCES

1. *Arro H., Prikk A., Kasemetsa J.* Grain composition and corrosive activity of ash from CFB oil shale boiler // Oil shale. 1997. Vol. 14, No. 3 Special. P. 225-235.
2. *Arro H., Prikk A., Kasemetsa J.* On the fouling of heat transfer surfaces of CFB oil shale boiler // Oil shale. 1997. Vol. 14, No. 3 Special. P. 218-224.
3. *Arro H., Prikk A., Kasemetsa J.* Recommendations for design of Estonian oil shale fired CFB boilers // Oil shale. 1997. Vol. 14, No. 3 Special. P. 246-253.

Presented by A. Ots
Received March 17, 1997