27th Oil Shale Symposium

Manufacture Of Synthetic Oil and Gas from Natural Low-Grade Mineral Fuel Fossils

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ATOMENERGOPROEKT

FSUE SPAEP

Processing Technology

The technology is based on the method of high-speed oil shale pyrolysis by solid heat carrier "Galoter" (Russia). The developer of the method is the G. Krzhizhanovskiy Institute of Energy – JSC "ENIN" (Moscow).

The essence of the method is the following: heat, necessary for the thermal decomposition of raw oil shale, is transferred to it from its own ash, mixed during the continuous process with the raw shale and then heated in the process furnace again due to the heat received when burning semi-coke.

The method was studied in 1950-s on the benchscale and pilot plants with the capacity of up to 200 tons of the shale per a day. In 1966 plant UTT[1]-500 (500 tons of the shale per a day was commissioned on oil shale chemical plant "Kiviyli" in Estonia. This plant was exploited till 1981 when it was dismantled. During the exploitation period of UTT-500, it was processed about 2.06 mln tons of shale, received 276 thousand tons of the commercial shale oil and more than 109 mln.m^3 of the semi-coke gas with the combustion value of 10000-11000 kcal/nm^3 (41.9-46.1 MJ/nm^3); the process and equipment analyses and balance tests were performed.

On the basis of the design experience, exploitation and researches of this plant, FSUE "SPAEP" (previous L.O. "Teploproect"), L.F. Orgenergostroy and "Lengiproneftekhim" with taking part of the scientific organizations – ENIN, Institute of Chemistry AN ESSR, Scientific and Research Institute of Shale – developed the project of the head plant of UTT-3000 with capacity 3330 tons of the shale per a day or 1 mln tons per year, and in 1980 the first plant and then in 1984 the second plant UTT-3000 were commissioned on Estonia Electric Power Plant, where they operate successfully till now called Oil Factory in Narva.

So, the scientific method of the low-grade solid fuels processing was modified into the modern technology of the shale processing. This technology was studied and mastered in details on the large

[1] Abbreviation UTT-3000 means in Russian - "*solid heat carrier (SHC) installation with throughput capacity 3000 tons of oil shale a day*". So, both abbreviations English *"SHC"* and Russian *"UTT"* mean the same.

industrial scale that allows when designing and forecasting to determine exactly the need in the initial shale, the production scope and characteristics of the received production, power inputs and influence on the environment and so on.

The plant consists of retorting unit, distillation unit, power plant, control and infrastructure.

Retorting unit includes following systems:

- Raw oil shale feeding system includes stockpiles, belt conveyors, bunkers, crushers, feeders, screw conveyors;
- Raw oil shale drying system consists of air-fountain dryer (AFS), three stages of dry shale cyclone, pneumatic post, connecting dryer with cyclones, feeding and sealing screw conveyer of supplying raw material in semi-coking;
- Semi-coking system including dry shale mixer with heat carrier, heat carrier cyclones, rotary kiln-type reactor, dust chamber, semi-coke screw conveyer, air fountain furnace (AFT), heat carrier bypass;
- Heat recovery system consisting of the following equipment: three stages of ash cyclones, ash heat exchanger, exhaust heat boiler with air heater of feed water;
- Outgoing gases purification system consists of electrofilter and screw conveyers of collected ash from electrofilter;
- Blowing air system is supplying air for semi-coke burning in air fountain furnace and smoke fumes afterburning in exhaust heat boiler from blower
- Auxiliary systems including: Steam pipeline system, Feed water system, Drain and blowdown system, Equipment electrical heating system, Cooling water system, Starting fuel system and fuel for backlighting, Oil-piping system, Ash removal system, Fire Extinguishing system, Water supplying and Sewerage, etc.

Interconnections and features of the essential processing systems are shown on the Fig.1.

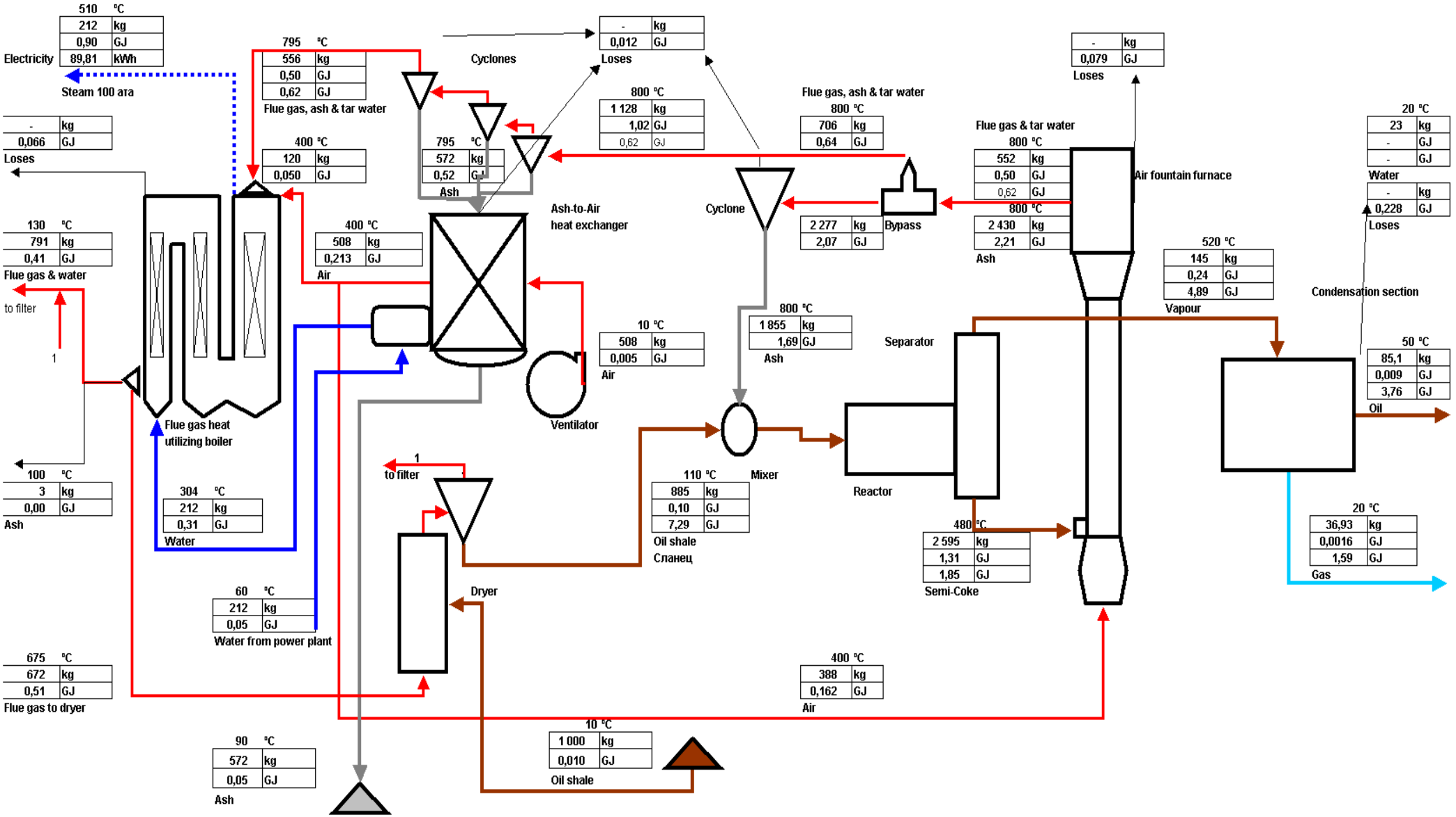

Fig.1. An Example of UTT Heat and Material Balance Scheme

Daily balances of one UTT-3000 installation for oil shales of different origin

Balancing materials, tons	China 1	China 2	Jordan	Brazil
INPUT				
Air	1 693	5 046	4 097	5 006
Raw Oil Shale	3 336	3 336	3 336	3 336
Water	708	3 945	2 139	785
Total input	5 737	12 328	9 572	9 127
OUTPUT				
Flue gas	2 639	6 851	4 699	1 951
Ash	1 907	771	2 392	2 610
Steam	708	3 945	2 139	785
Shale Oil	284	319	342	217
Gas	123	327	-	126
Hot air				3 368
Total output	5 737	12 328	9 572	9 127
SALEABLE PRODUCTS				
- shale oil	284	319	342	217
- gas	123	327	-	126
- electricity, kWh	179 616	1 549 205	905 809	265 523

Materials required for one UTT-3000 installation:

Carbon steel for equipment – 1400 tons

Stainless and alloyed steel – 500 tons

Refractory lining and isolation – 1050 tons

Construction metal rolling – 5000 tons (incl. reinforcement)

Concrete – 9600 ton (depends on climate conditions)

Efficiency of oil shale heat recovery in UTT installation reaches 91% as it is demonstrated on Fig.2.

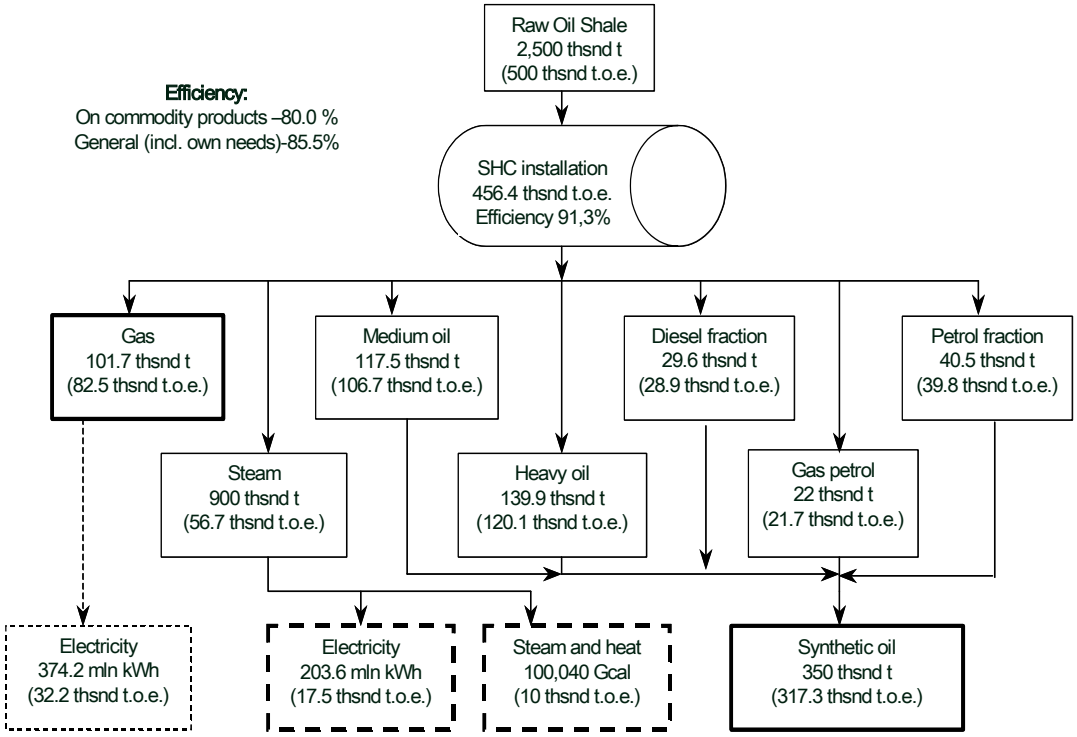

Fig.2. Balance scheme of heat conversion, Leningrad Oil Shale Project, 2006-2007

During 2006-2007 an Association was organized with participation of *FSUE "SPbAEP"*, *Science & Technical Center "ECOSORB", TTU Ltd*, *Advant Technology, Carno International Inc., Shungit Ltd.*

Mission of the Association: Collecting and saving inventions, experience and know-how concerning technologies of processing solid fuels to liquid and gaseous high quality products in installations with solid heat carriers UTT based on Galoter method. Perfection and distribution of UTT technology around the World as based on matured UTT-3000 installations as well as development, perfection and distribution UTT-7000 and UTT-10000 installations.

Goal of Association: To put up UTT installations on all basic oil shale deposits on a turn-key basis.

Base of the Association activity: Main holders of basic patents protecting method, installations and technical decisions on separate essential parts of UTT installations have contributed their rights, experience and know-how to Association.

Science & Technical Center "ECOSORB" headed by Academician, Professor Mr.A.I.Blokhin, has contributed basic patents:

- "Method and installation for thermal processing of high-ash fuels" (RU), priority of 25/04/97;
- "Method of thermal processing of high-sulfur fuels" (RU), priority of 31/12/97;
- "Method of thermal processing of high-sulfur oil shales" (RU), priority of 15/06/99.

Federal State Unitary Enterprise the Saint Petersburg Research & Design Institute "ATOMENERGOPROEKT" has contributed patent "Installation for thermal processing oil shale with solid heat carrier (variants), priority of 05/12/2005 and has reserved exclusive rights for designing works for all agreements concluded by the Association with third parties concerning UTT (SHC) installations. Doing this FSUE "ATOMENERGOPROEKT" has contributed its rich experience in designing oil shale based facilities:

Oil Factory in Narva, Estonia, built under ATOMENERGOPROEKT's design, 1980-84

ATOMENERGOPROEKT's reference list

Plant, Facility	Site & Time of design & Launching	Equipment	Capacity
Ahtme PP	Near to Ahtme, 1951		46,5 MW
Baltic PP	5 km near to Narva, 1959-66	8 x ТП-17 + 8 x ВК-100 4 x ТП-67 + 4 x К-200	1290 MW power, 505 MW heat
Estonia PP	25 km to Narva, 1969-73	8 x ТП-101 + 8 x К-200	1610 MW power,84 MW heat
Kiviyli	Kiviyli, 1950-53	R&D UTT-200 facility	150-200 t/day
Kiviyli	Kiviyli, 1963	R&D UTT-500 facility	500 t/day

Plant, Facility	Site & Time of design & Launching	Equipment	Capacity
Oil Factory	Narva, 1975-1980, 1980-1984	Two commercial UTT-3000 facilities	6000 t/day (in operations now)
Power Technological Plant	Slantsy, 1994-2007	Project 3xUTT-3000	9000 t/day (start in 2007)
Viru Keemia Group Galoter Project	Kohtla Yarve, 2006-2007	Project 1xUTT-3000	3000 t/day (start in 2007)

Foundation of UTT-3000 on Viru Keemia Group Galoter Project Site in Kohtla Yarve, Estonia, made under ATOMENERGOPROEKT's design, 9th Oct, 2007

Achievements: For the time passed since 2006 the Association has concluded LOIs, MOUs, contracts and agreements for involvement in next projects with provision Know-How and technical documentation:

- Project for oil shale development in Brazil, (4xUTT-3000, 6 000 bopd);
- Project for oil shale processing in China;
- R&D for brown coal processing in China;
- Establishment of Joint venture “Advant Technologies” for oil shale development in Pacific islands area;
- Project for Leningrad oil shale deposit development in Russia starting in 2007 (3xUTT-3000 for the first stage 7 000 bopd on Leningradskaya mine field and upto 12xUTT-3000 further, 30 000 bopd on Western and Eastern fields).
- Oil Shale Project in Komi Republic, Russia
- Kashpirskoe Oil Shale Deposit Development Project, Middle Volga, Russia;
- Perelyub-Blagodatskoe Oil Shale Deposit Development Project, Orenburg, Russia;
- Project for solid wastes utilization in Russian Federation (Federal program).
- Oil Shale Development Project in Uzbekistan;
- Establishment of JV for venture financing of R&D program “UTT-10000” (expected to finish in mid of 2009).
- Bankable Feasibility Study for Oil Shale Development in Jordan (18xUTT-3000, 30 000 bopd)
- Initiation of Russian Federal Program on Oil Shale Development

The Association is developing and perfecting methods and installations and has registered number of applications for international patents:

Registered priority	Subject
05/12/2005	Installation for thermal processing oil shale with solid heat carrier
05/12/2006	Method and installation for thermal processing of high-ash low-grade solid fuel
19/06/2007	Method and installation for thermal processing of high-ash solid fuel
03/09/2007	Method of thermal processing oil shale with producing liquid and gaseous fuels, cement clinker, and installation for its realization
02/05/2007	Method and installation for thermal processing of high-ash low-grade solid fuel
29/06/2007	Method and installation for thermal processing of fine-grained fuel
19/06/2007	Method of thermo-chemical processing of tar in mixture with natural activators of cracking
03/07/2007	Bench scale installation for solid fuel semi-coking