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New Developments in Oil Shale Technology

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Denver, USA

Russian technology of pyrolysis — development and maintenance

Technology of oil shale pyrolysis
was successfully mastered
and introduced in industrial scales
at the unit UTT-500
processing 500 t of oil shale per day
and that at the unit
UTT-3000
processing 3000 t per day.

Two units UTT-3000 were put into operation in 1987 at the Power Plant at city Narva, Estonia (in the time of former USSR).

It demonstrate successful experience of thermal processing of Baltic oil shale as well as of waste automobile tires, solid and liquid organic waste in a mixture with oil shale.

The result is <u>the obtaining of high calorific liquid and gaseous fuels as well as the very valuable chemical products.</u>

The production cost of one barrel of shale oil constitutes from 14 to 17 US$ that allows to construct the competitive industrial units practically with unlimited number.

Current cost indicators and prospects

- **The following economic indicators exist on the whole at the Estonian oils factory (September 20, 2006):**
  - **The price of oil shale is 8.6 US$/t;**
  - **The cost of total shale oil is about 100 $/t;**
  - **The sale price of shale oil is 263 $/t;**
  - **The sale price of diesel fraction is 370 $/t.**
- **It is planned to build up in the next 1-1.5 year the two similar units UTT.**

Unit UTT-3000
in city Narva for thermal processing of oil shales

Two units UTT-3000
in Narva take up to now
<u>the leading place in the world</u>
as to the quality
of oils and gas
obtained from oil shale,
ecological indicators and
economic efficiency.

General view

Fig. 1. Nomogram for coefficient Keh as a function of physical and chemical properties: Org - concentration of organic material in dry mass of shale, %; Ck - carbon concentration in kerogen, %.
T – pyrolysis temperature, K, qsk – semicoke output (after pyrolysis) per conventional organic mass.

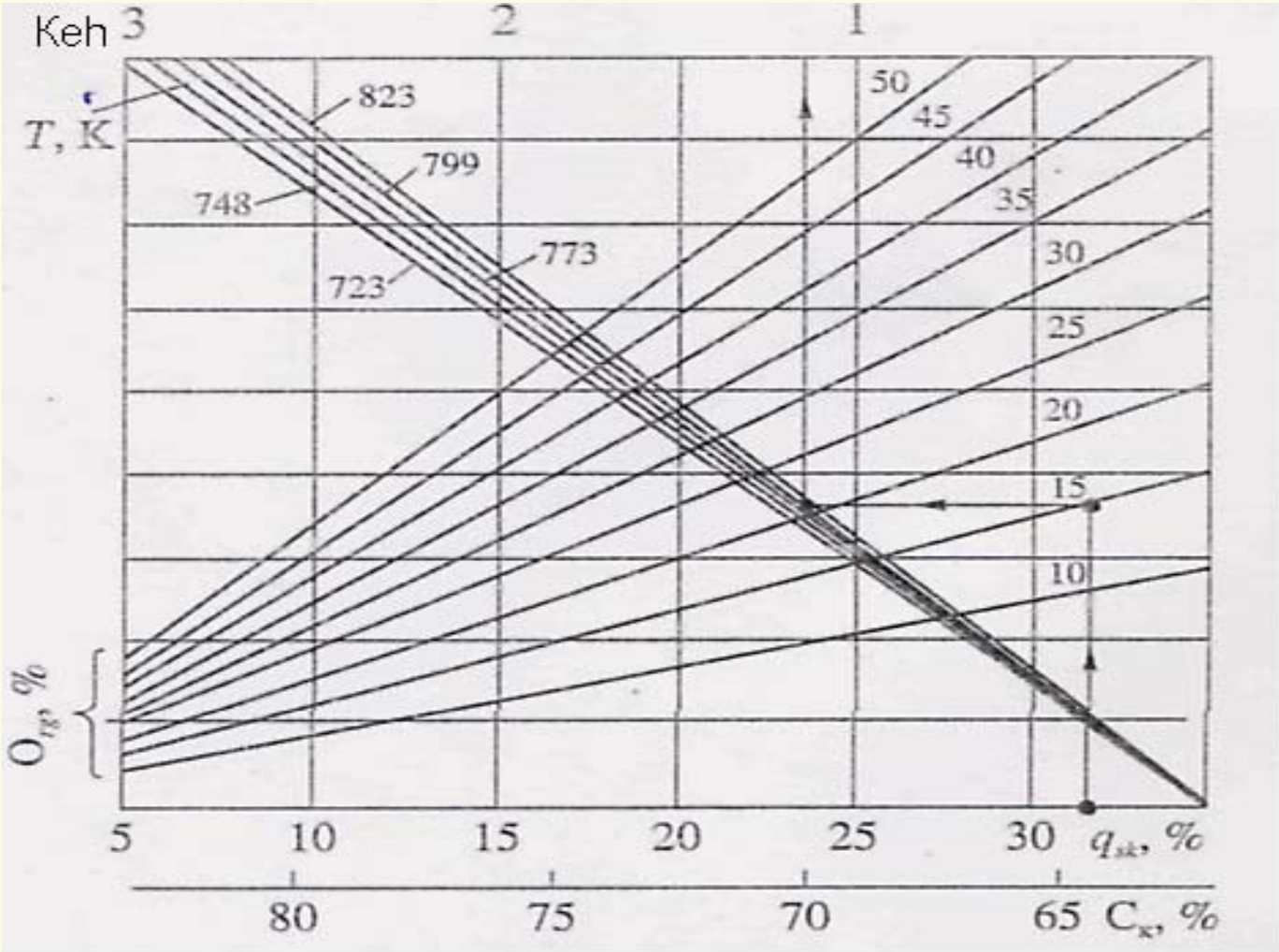


Fig.2 Dependence of semicoke output per conventional organic mass on carbon concentration in kerogen.

Some points in diagram correspond to numbers in table 1.

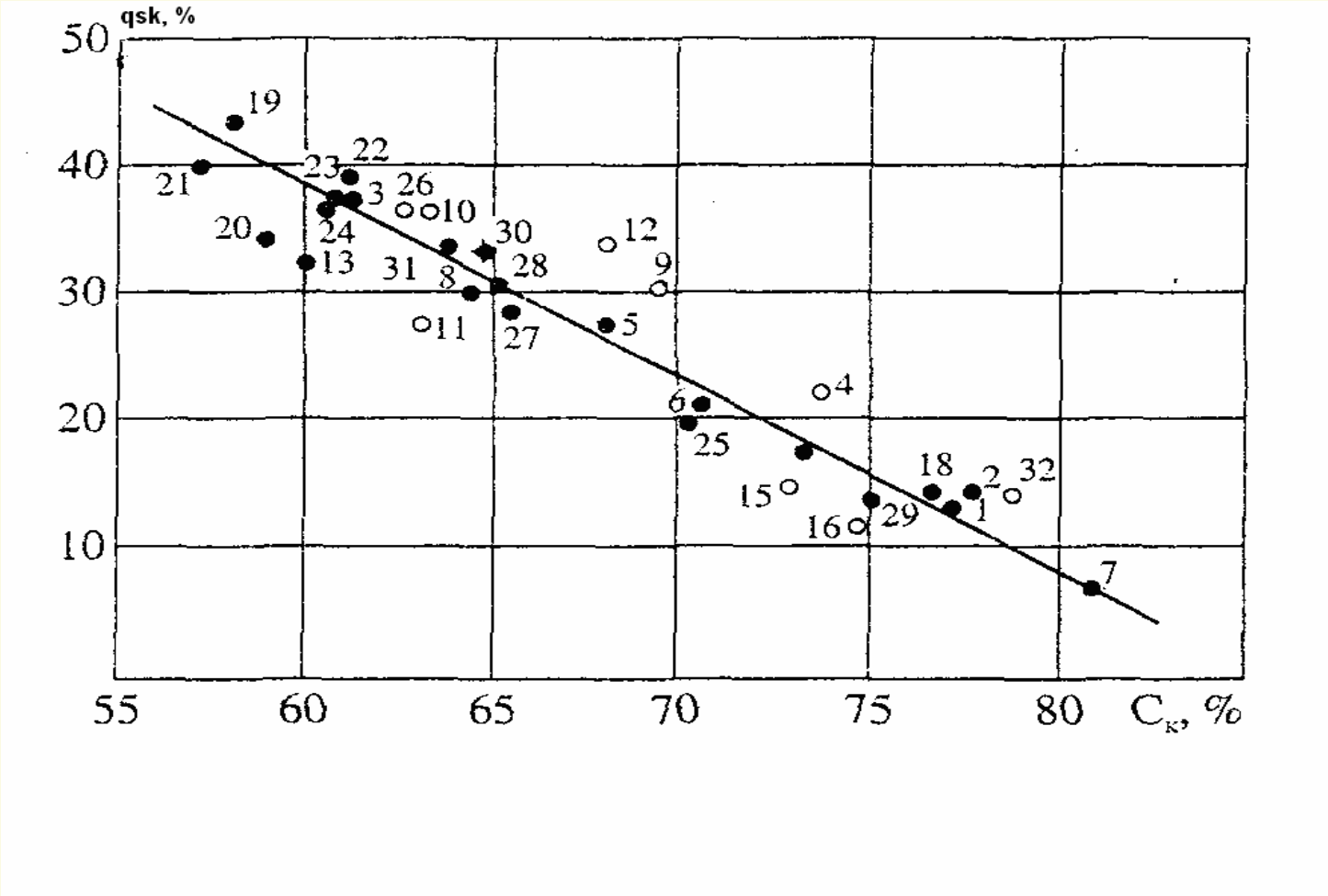


Table 1. Kerogene composition for oil shales of different deposits

Deposit	Composition of kerogene of oil shail			
	C	H	O	S
1. Pribaltyiskoye (Estonia)	77.3	9.8	11.2	1.7
2. Leningradskoye (Russia)	77.7	9.8	11.3	1.2
3. Kashpirskoye (Russia)	61.1	7.3	23.8	7.8
4. Kenderlikskoye (Uzbekistan)	73.8	8.4	17.8	
5. Boltyshskoye (Ukraine)	68.0	9.3	18.3	1.9
6. Timakhdi (Morocco)	70.5	9.3	12.4	7.8
7. Green-River (USA)	80.9	11.4	6.9	0.8
9. Nerke (Sweden)	69.5	7.7	16.8	6.0
10. Lotiani (Scotland)	63.0	10.1	26.2	0.7
11. Render (Australia)	63.1	7.9	28.3	0.7
12. Irati (Brazil)	68.1	10.3	17.9	3.7
30. Rotem (Israel)	65.0	7.0	15.4	10.7

Schematic diagram of thermal processing of Baltic oil shale.
Unit UTT-3000

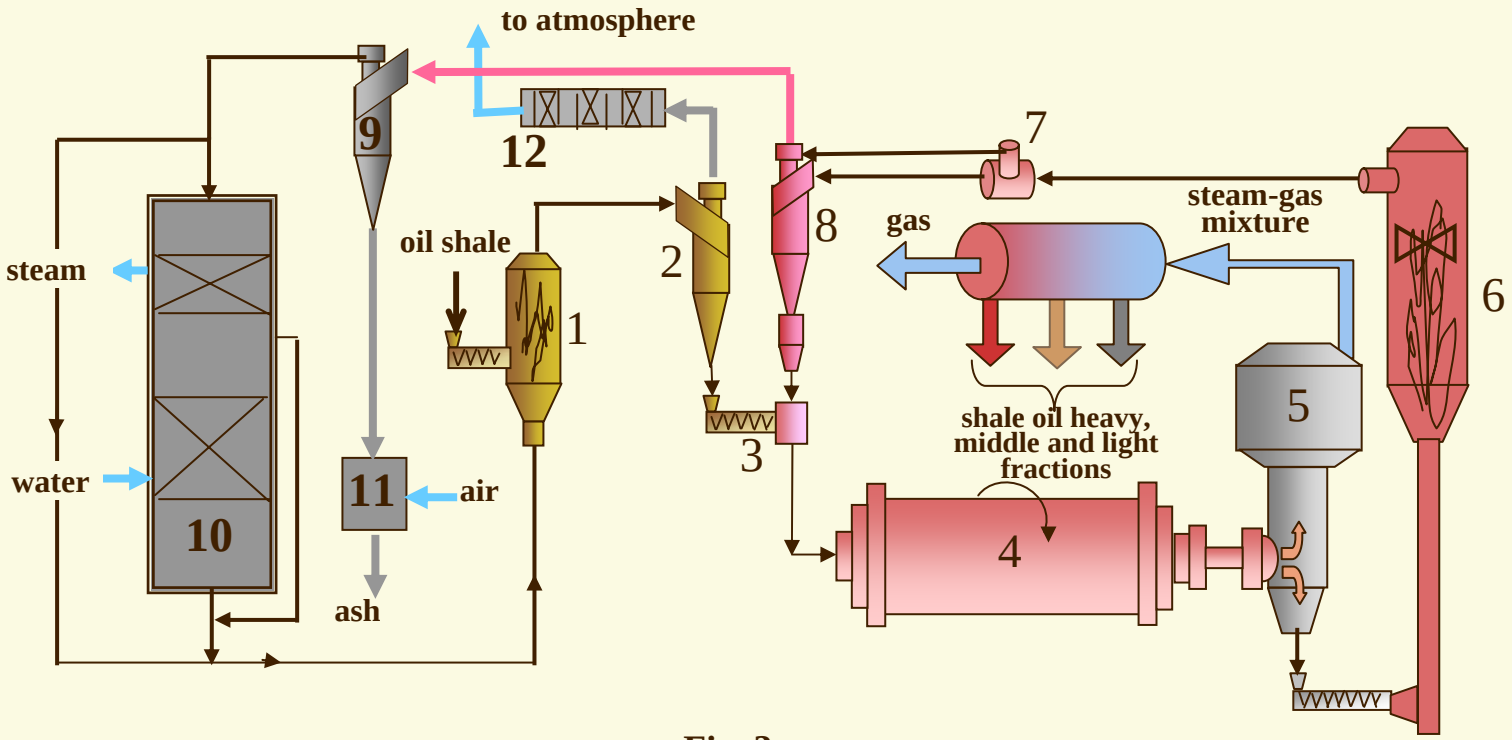


Fig. 3

1 – aero-fountain air spray drier, 2 – dry shale cyclone, 3 – mixer,
4 – drum reactor, 5 – dust separator, 6 – aero-fountain furnace, 7 – flow separator,
8 – heat carrier cyclone, 9 – ash cyclone,
10 – recovery boiler, 11 – ash heat exchanger, 12 - filter

Unit UTT-3000
for thermal processing of oil shales

✓ The main advantage of pyrolysis by means of units UTT is a possibility of oil shale processing **of any fractional composition and quality**

Only the oils shales with calorific value lower than 2.9 MJ/kg require the supply of additional fuel for processing that is necessary for supporting the pyrolysis process.

For reference:

Heat of combustion of Baltic oil shale for Estonia and Leningradskaya region of Russia is ***8,37 MJ/kg***

Unit UTT-3000 in city Narva for thermal processing of oil shales

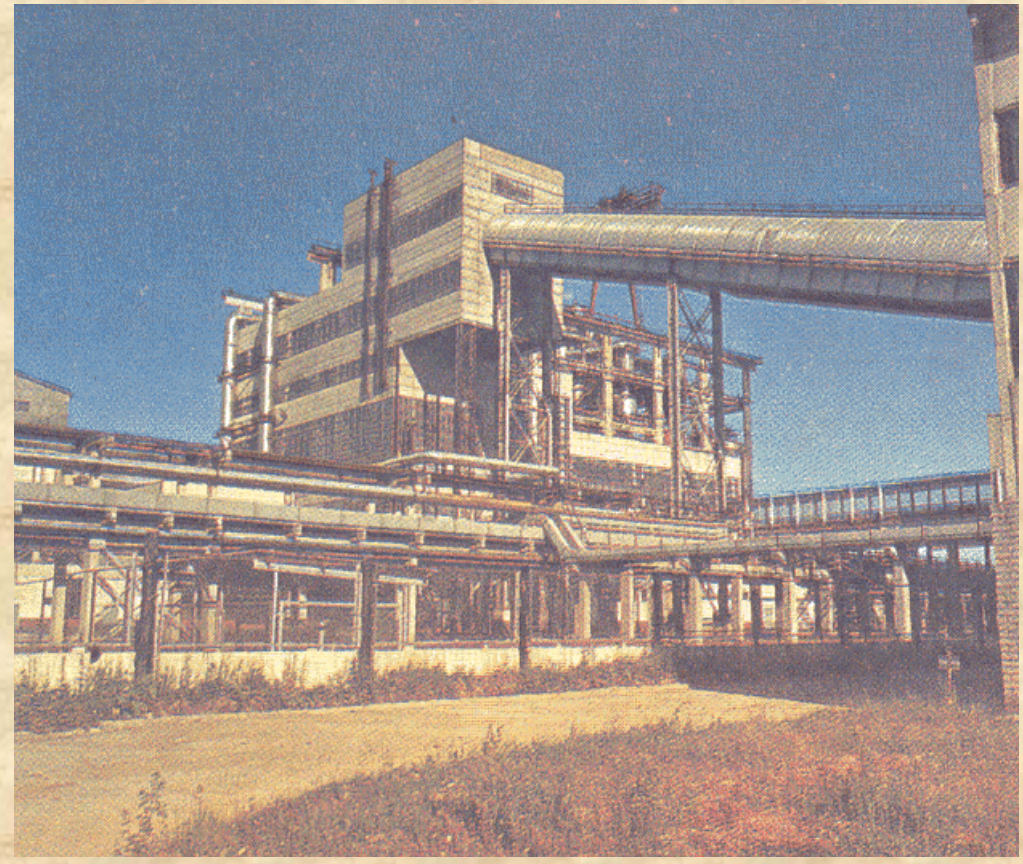
Is in operation since 1989 ➔ more than 17 years

View of

the section

for thermal

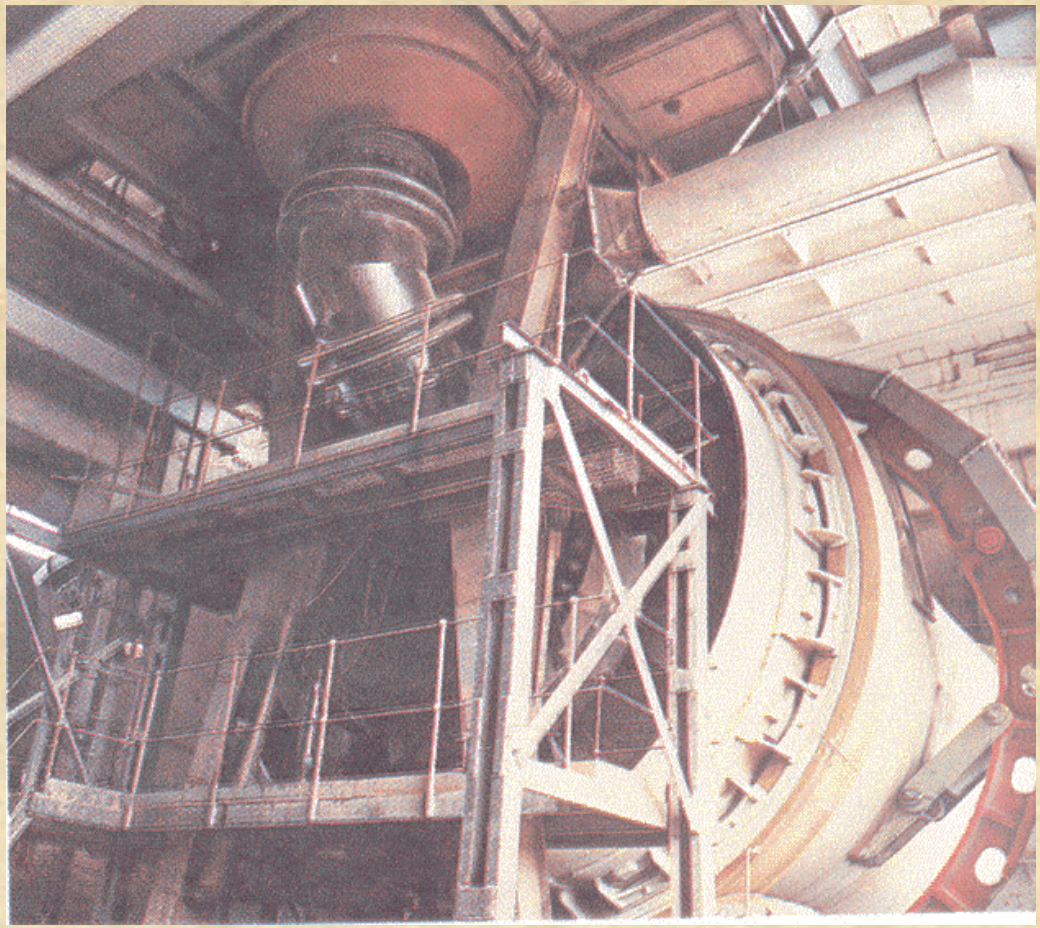
decomposition



Unit UTT-3000 in city Narva for thermal processing of oil shales

Rotating

drum reactor



Unit UTT-3000 has the following advantages:

- The heat of combustion gas obtained after pyrolysis in units UTT is in 2.5-3.0 times more than in the plants of other countries.
  So, the calorific value of pyrolysis gas after the processing of oil shale of Leningradskoye deposits is 42,2 MJ/kg.

- The gas obtained in the units UTTs represents the marketable product - a fuel for gas turbines, while in other technologies the considerable part of gas is used in the cycle itself for combustion in the reactor.

- The utilization of ash instead of gas for pyrolysis increases the efficiency of inits up to 84-89%, while the efficiency doesn't exceed 65% for the majority of plants of other types.

- The total efficiency of cleaning of gas-vapor mixture in cyclones achieves 99.5%. Owing to it, the content of dust doesn't exceed 1.0-1.5% even in the heavy fractions of oil shale.

- The inits UTT-3000 process the waste automobile tires in a mixture with oil shale. The processing of grounds saturated by oil products (for example, because of accidents during transportation) is also technically possible and was confirmed in practice.

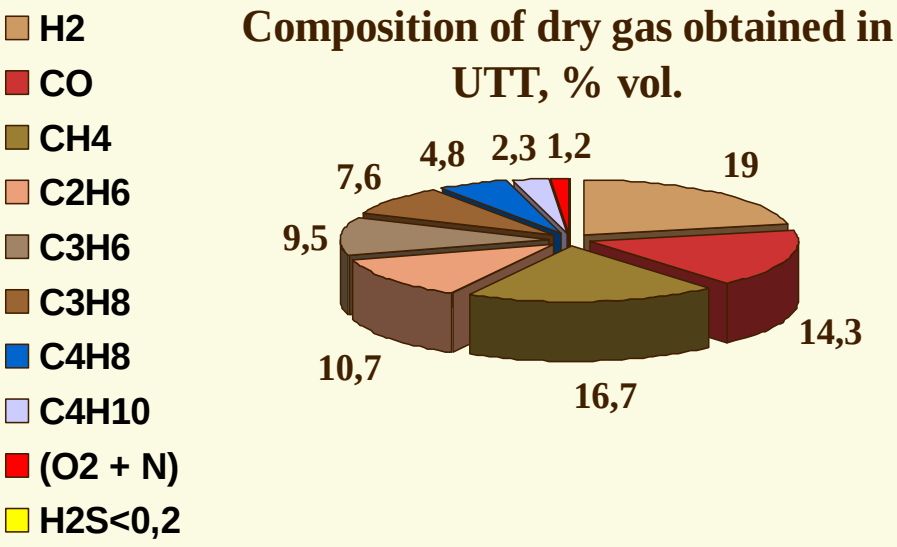
Main characteristics of oil shale fractions obtained in the units UT.

Oil shales of Leningradskoye deposit

Fractions of shale oil	Density, kg/m^3 (for 20°C)	Elementary composition in maximum, %				Heat value, MJ/kg	% evapora-tion in the end of boiling
		sulfur	water	ash	Mechanical admixtures		
Total shale oil	950-1000	0.8	0.3	0.1	0.15	38	64
Heavy oil	1050-1100	0.6	1.0	0.8	1.0	36.5	60
Middle oil	1010	0.8	0.3	0.1	0,15	37.4	70
Diesel oil (fuel for gas turbine)	925	0.8	0.1	0.015	0,02	38.4	85
Petroleum fraction	810-825	1.0	0.1	abs	abs	41.2	90

Characteristics of gas obtained in UTT from the oil shales Leningradskoye deposit

Content of hydrogen sulfide	…..3.2 g/nm^3
Content of sulfur	…..2.86 g/nm^3 ; 0.249% (mass)
Content of hydrocarbon	…..25.0 g/nm^3
Density	…..1.148 kg/m^3
Low calorific value	…..42.2 MJ/kg; 48.44 MJ/m^3
Output of gas per 1 ton of oil shale	…..41.0 kg/t; 35.71 nm^3/t



Main applications of products obtained from shale oil and gas during the pyrolysis of oil shales

- ✓ Thiophene
- ✓ Benzene
- ✓ Toluene
- ✓ Albichtene
- ✓ Ichtyol
- ✓ Plactisizer
- ✓ Souftener
- ✓ Technical sulfur
- ✓ Sodium thiosulfate
- ✓ etc.

◆ chemistry

◆ medicine

◆ agriculture

◆ veterinary medicine

◆ Electric industry et optics

◆ pharmacology

Thank you very much

for your attention

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