REPORT

On Operational Test of Bitumen (Asphalt) Extraction from Bitumen Sands by the mean of BLOWDEC® Process and Simultaneous Conversion of Hydrocarbons into Synthetic Crude Oil

Key Words

Bitumen sands and shale, technology (device and process) for thermo-chemical extraction of bitumen/asphalts, simultaneous conversion of bitumen into light hydrocarbons, synthetic crude oil, high power efficiency, environment-friendly impact, low capital and operational costs

Abstract

Patented device and process (Canadian Patent No. 2,283,138; US Patent No. US 6,165,349; United Kingdom Patent No. GB 233 7265 B; Russian patent RU 218 1126, German Patent No. 19782262) and the BLOWDEC® technology based thereon is an original method verified at the extraction of valuable hydrocarbons from waste materials containing organic fractions.

The performed test has shown the process efficiency also for bitumen (asphalt) extraction from bitumen sands. In an R&D equipment BLOWDEC® 45 kW, was treated at 460°C the artificial homogeneous mixture of asphalt and silica sand containing 13% of bitumen. The sand was separated efficiently from the organic part of the mixture during the process and obtained, as the main product, the synthetic crude oil with the density of 921 kg/m^3, light condensate with the density of 793 kg/m^3 and the hydrocarbon gas composed of C1 to C5.

The production of 1 kg of hydrocarbon product requires 1.6 kW of (electric) power; no other power sources or auxiliary materials (e.g. water, chemicals) are necessary. The process unit consumption rate can be reduced to less than 0,9 kW/kg of hydrocarbon product due to recovery of the energy carried as heat by product streams.

Bitumen sand processing test in the Blowdec 45 kW unit

Test Specification

The goal of the test was to verify whether the BLOWDEC® process is an alternative solution for efficient extraction of bitumen from sands and shale with simultaneous conversion of organic materials into synthetic crude oil. The test was performed in R&D continuously operated BLOWDEC® pilot unit with 45 kW reactor. See Annex for the equipment description.

Insulation asphalt used

No sources of bitumen sands are in Slovakia and therefore artificial raw material has been prepared. Melted bitumen used in civil engineering industry for insulation purposes was mixed thoroughly and gradually with duly heated ordinary river silica sand. A mixture with 13% (mass) of bitumen was made. Bitumen with the density of 1221 kg/m^3 (!) made of crude oil based asphalt (air-blown distillation residue from crude oil vacuum distillation) was used. Total amount of sand and asphalt mixture produced and processed during the test was 45 kg.

Raw material – sand & bitumen mixture

The raw material was processed gradually within the test during 90 minutes approx. in R&D BLOWDEC® equipment at operating temperature of 460^{o}C. During the test, the bitumen sand was feed continuously by screw conveyor into the reactor and, simultaneously, the inorganic phase (the crushed sand without organic particles) was removed. The reaction products taken out from the reactor in form of vapors and gases were quenched in the condensation part of the equipment and, at the same time, the product samples were taken right from the reaction gas stream. The sampling device consists of two degrees – the coolers in series connection, which work at different temperatures, allowing the product samples partial condensation.

The main liquid product, „Synt-crude“, formed ~90% of the total hydrocarbon production; it has dark brown-black color and density of 921 kg/m^3, pour (freezing) point is -24^{o}C (!), interesting viscosity of 10,6 mm^2/s at 20^{o}C and 5.3 mm^2/s at 40^{o}C and noteworthy distillation test within the range from 58^{o}C (162^{o}C - 10% of distillate) to 388^{o}C (90% of distillate). See Summary for other properties.

Process temperature of the bitumen extraction & conversion

The light condensate with density of 796 kg/m^3, formed 6% approx. of the total hydrocarbon production and the HC gases formed 4% approx. thereof. The organic substances were contained in the sand after the extraction at very low level of 450 ppm.

From the properties of the main product (density, distillation test, viscosity) and IR spectral analysis of the light condensate can be concluded that the synthetic crude oil extracted and converted by the mean of the BLOWDEC® process from the bitumen sand is of the paraffinic, naphthenic and aromatic nature.

Blowdec reactor & sampling apparatus

Environmental Impact of BLOWDEC® Bitumen Extraction Process

Byproducts: during the process, very fine crushed sand is generated within the quantity equivalent to the sand content in the raw material. The **hydrocarbon content in the dust** is negligible in comparison with that in the raw material; it was determined by mean of IR method as non-polar extractable substances at the level of **450 mg/kg** (ppm).

Liquid waste: waste water originated from the raw material humidity is the only liquid waste. This water has organic contamination and the treatment by the mean of membrane procedure is required.

Solid waste: no solid process waste, nor coke is generated in process during the equipment operation.

Gas emissions: the process of bitumen extraction and conversion is based on thermal and mechanical interactions on bitumen without presence of air (pyrolysis, cracking). The process is absolutely closed and does not produce any direct gas emissions.
Gas emissions will be produced at the use of hydrocarbon gas in the locality of its utilization - combustion. With regard to the gas composition and absence of contaminants, the use of gas and generation of emissions are identical to those for natural gas or propane-butane combustion. The gas use is expected right in the place of its production.
Power consumption: only the electricity for the reactor electric motor drive (eventually, other source of rotary kinetic energy – diesel engine, turbine etc.) and for the drive of another rotary machines is necessary. The total unit power consumption is equal to 1.6 kW per 1 kg of hydrocarbon products. The process unit consumption rate can be reduced to **less than 0.9 kW/kg of hydrocarbons** due to the exploitation / recovery of the energy carried as heat by product streams.

Summary:

One BLOWDEC® equipment with total installed energy input of 2.2 MW (for example) will be able to process 12 tons of bitumen sands per hour and to produce 1.5 tons of hydrocarbons, i.e. during the operation of 330 days per year; such unit may produce 11,500 tons of synthetic crude oil and lighter hydrocarbons. The power consumption of 1.6 kW per kg of hydrocarbon products is calculated with the minimum use of recovery heat – of the energy contained in the product streams. Using “only“ the heat from crushed sand by it's cooling from 460 to 100 °C, the energy unit consumption can be reduced to 0.9 kW per kg of hydrocarbons products. This favorable power consumption is achieved due to the transformation of kinetic energy to thermal energy right in the point of its use, in BLOWDEC® reactor, while there run, simultaneously, both physical and chemical processes causing the extraction as well as the simultaneous cracking of bitumen. The production and consumption (transformation of the heat as well as the bitumen extraction and cracking are made within single process step, in the BLOWDEC® reactor.
It is expected, that the costs for manufacture of the complete BLOWDEC® equipment (except the building works and storage facilities) with the input of 2.2 MW and the due capacity will not exceed 1.3 – 1.8 million of USD (if made in Slovakia).

December, 2006

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Summary of the products properties

Properties of the raw bitumen and liquid hydrocarbons recovered from bitumen sand in process BLOWDEC®

		Raw Insulation **Bitumen**	**Synt-crude** ~90% yield	Light Condensate ~6% yield
Parameter	**Unit**	**Value**	**Value**	**Value**
Density at 20°C	***kg/m³***	**1.124** /[1]	**921**	**796**
API gravity	**~**	–	**21,6**	–
Viscosity at 20°C	***mm²/s** (cSt)*	solid	**10,61**	–
Viscosity at 40°C	***mm²/s** (cSt)*	solid	**5,31**	–
Viscosity at 100°C	***mm²/s** (cSt)*	plastic	**1,77**	–
Distillation test	**~**	**~**	**~**	**~**
Initial boiling point	***°C***	–	**58**	**45**
10 % vol. recovered	***°C***	–	**162**	**85**
20 % vol. recovered	***°C***	–	**186**	**96**
30 % vol. recovered	***°C***	–	**234**	**105**
40 % vol. recovered	***°C***	–	**284**	**114**
50 % vol. recovered	***°C***	–	**328**	**123**
60 % vol. recovered	***°C***	–	**360**	**133**
70 % vol. recovered	***°C***	–	**372**	**146**
80 % vol. recovered	***°C***	–	**380**	**162**
90 % vol. recovered	***°C***	–	**388**	NA
End of distillation / recovered	***°C / % vol.***	–	**388 / 90**	NA
Sulphur content	***% wt.***	**1,85**	**1,85**	–
Pour point	***°C***	**–**	**–24**	**–**
Colour	**~**	black	black brown	dark yellow
Hydrocarbons distribution (IR method)	**~**	**~**	**~**	**~**
X aromatics	***% wt.***	**–**	34,3	**–**
X naphtenic	***% wt.***	**–**	13,4	**–**
X parafinic	***% wt.***	**–**	52,2	**–**

Notes:
/[1] – certain (less then 25%) of mineral filler were present at raw insulation bitumen

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Reg. No. 031/S-106

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Testing protocol No. 4016

Customer: **ROIL TRADE s.r.o.**
Krížna 12
81107 Bratislava

Quotation number: 06-1120.belnov.
Invoice number: 5671/31

Sampling date:
Accept date: 21.11.2006
Accomplish date: 21.-29.11.2006
Issue date: 29.11.2006

Number of samples: 1

Sample: 1 No. 4016
Sample name: **BS 460-01**

Code		Quality parameter	Norm	Result	Uncertainty of measurement
0002	A	Density by hygrometer at 20° C (kg/m3)	STN EN ISO3675	921,0	1,2 kg/m3
015a	A	Freezing point	STN 65 6072	-24	2 °C
0020	A	Distillation characteristics	STN ISO 3405		
020a	A	beginning of distillation (°C)		58,4	2 °C
20b2	A	10 % vol. distils until (°C)		162,5	2 °C
20b3	A	20 % vol. distils until (°C)		185,6	2 °C
20b4	A	30 % vol. distils until (°C)		234,5	2 °C
20b5	A	40 % vol. distils until (°C)		284,0	2 °C
20b6	A	50 % vol. distils until (°C)		327,9	2 °C
20b7	A	60 % vol. distils until (°C)		360,4	2 °C
020s	A	70 % vol. distils until (°C)		372,2	2 °C
020f	A	80 % vol. distils until (°C)		379,7	2 °C
020d	A	90 % % vol. distils until (°C)		388,1	2 °C
020g	A	end of distillation (°C)		388,8	2 °C
043	A	Kinematic viscosity at 20°C (mm2/s)	STN EN ISO 3104+AC	10,65	0,83 rel. %
043a	A	Kinematic viscosity at 40°C (mm2/s)	STN EN ISO 3104+AC	5,309	0,83 rel. %
043c	A	Kinematic viscosity at 100°C (mm2/s)	STN EN ISO 3104+AC	1,773	0,83 rel. %
121a	SA	Sulphur content (% mass)	STN EN ISO 8754	1,90	3,6%

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All instrument used for testing were calibrated or certified according to actual metrological regulations.
Protocol can be copy only as entity and its parts only with written permission of testing laboratory.

A – accredited testing method
N – non-accredited testing method
SA - accredited subtest
SN – non-accredited subtest

Uncertainty of measurements is enhanced combined with coefficient 2