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A BREAF OVERVIEW OF MOTOR FUELS FROM SHALE OIL OF KUKERSITE

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Non-petroleum fossil fuels and biomass are potential alternative transport fuel sources. Technologies and industrial-scale production of transportation fuels from carbon feedstocks (other than conventional oil) have existed since before World War II. While long-term full-scale applications had in most cases proved to be non-competitive with traditional oil industry due to world economy impacts, research into the development of alternate fuel production technologies has been continuing as depletion of crude oil reserves was expected.

There have been two major technological directions for processing coal and biomass thermo-chemically into high-value oil products including transportation fuels: (1) liquefaction into refineable syncrude followed by upgrading of distillates; (2) converting coal or biomass based purified syngas via Fischer-Tropsch or similar processes to hydrocarbon liquids. Although technological schemes exist, currently only a few conversion processes are applied in large-scale practice on a pilot-plant or commercial level due to economical, technological and environmental factors. Broadly speaking, thermo-chemical conversion technologies to produce alternative transport fuels are at the present time more expensive than conventional oil manufacturing, while biomass to liquid technologies are more costly to implement than are coal to liquid technologies.

Due to large world oil shale reserves, estimated to be equivalent to more than 2.9 trillion barrels of recoverable oil [1], there is a general expectation that oil shale should become a considerably significant source for high-value oil products. However, some experts are more critical than others regarding the widespread use of oil shale resources, emphasizing rather the potentials of other alternative resources such as coal, tar sand, heavy oil or biomass.

Upgrading oil shale into transport fuels requires expenses for adjusting hydrogen carbon ratios by adding hydrogen or removing carbon, and

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removing undesirable contaminants such as N, S, O or various inorganic materials and metals. Our literature review shows that during last eight decades, a number of studies from different countries (USA, Estonia, Russia, Israel, Australia, Japan) have been addressing the issue of converting oil shale to transport fuels or fuel additives. Investigations on processing of shale oil from Julia Creek oil shale [2] and shale oils from Paraho processes [3, 4] are examples of exhaustive studies following the mid-1970s Arab oil embargo. Next are some examples from the last decade: Landau et al. [5, 6, 7] upgraded Israeli shale oil, with high sulfur (6.5%) and nitrogen (0.92%) content, to petrol, jet fuel and diesel fuel with very low sulfur content, 0.011, 0.014 and 0.013 mass%, respectively by hydrogenation-desulfurization process [6, 7]; based on the Stuart Shale Oil Project it is clamed that clean gasoline and jet fuel can be manufactured from Australian oil shale [8]; Krichko presented a principal scheme for converting an enriched Baltic oil shale to gasoline, diesel fuel and jet fuel [9]; Luik et al. showed promising results in hydrogenating Estonian shale oil [10]; Raidma et al. demonstrated possibility of producing additives which improve the storage and combustion properties of liquid fuels from Estonian shale oil [11]; a patent application by Department of Chemical Engineering at Tallinn University of Technology describes the compositions of blended bio-diesel and Estonian shale oil diesel fuel fractions in order to improve the cetane number of the latter.

Historically, Estonian oil shale based motor fuel manufacturing was established before the Second World War and abandoned during the 1950's due to poor economic viability and quality reasons. Prewar Estonian motor fuels were produced in four shale oil industrial enterprises: First Estonian oil Shale Industry at Kohtla-Järve, Eesti-Kiviõli at Kiviõli, Eestimaa Õlikonsortsium (Estonian Oil Consortium) at Sillamäe and New Cosolidated Gold Fields Ltd. at Kohtla. 17.3% from the total manufactured shale oil was processed into motor fuels: 15.3% (more than 20 000 tons per year) was converted into petrol (gasoline) and 2% into diesel fuel. Shale oil motor fuels were refined with alkali solutions and sulfuric acid. Rafination of petrol with sodium plumbite and sodium hypochlorite also was investigated, but unsuccessfully. Good results were obtained by the hydrogenation- desulfurization process; however, this method was not economically feasible. Kohtla-Järve shale oil based petrol had octane number up to 68 and elemental composition of C 84.8-85.6%, H 13.4-13.8%, S 0.5-0.75% and O 0.4-0.9%. It contained roughly 35% alkanes (mainly normal), 56% unsaturated hydrocarbons (mainly 1-alkenes), 4% naftenes and 4% aromatics. Elemental analysis of diesel fuel was about C 84.1%, H 11.3%, O 3.6%, S 1%. Comparison to outer heating retorting methods in tunnel-oven (Kiviõli and Sillamäe) and Davidson retorts (Kohtla), the Kohtla-Järve retorts with inner heating gave shale oil with relatively low yields of the petrol fraction. Therefore, at Kohtla-Järve, a heavy oil cracking process was utilized to

manufacture petrol with octane number up to 68 as opposed to straight-run-petrol with octane numbers between 50 and 55. [12–16]

It is quite likely, that the statement that one can prepare European standard transportation fuels from Estonian oil shale in a laboratory scale, does not cause considerable debate. Rather, the issue lies in developing processes that when scaled-up can form the basis for competitive technology based on technical, economical and environmental factors. Rising prices and exhausting deposits of petroleum, together with advances in technology, can open the door for oil shale based transportation fuel manufacturing in Estonia. To convert presently commercially produced vertical retort or solid heat carrier oils to transportation fuels requires complementary experimental investigations and knowledge of up-to-date worldwide technological advances. In Estonia, the staff at the Department of Oil Shale and at the Department of Chemical Engineering at Tallinn University of Technology can use their experience to contribute to corresponding investigations when interest arises.

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