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Synthetic petroleum from oil shale by using direct liquefaction and secondary upgrading techniques

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Oil shale and other solid fuels can be effectively processed to petroleum-like liquid product by using thermochemical methods of destruction. The organic matter in oil shale called kerogen is known as insoluble in conventional conditions and solvents. Oil shales differ by their kerogen content and its chemical composition. Oil shale kerogen is convertible to liquid, gaseous and solid products in the temperature range 350 - 500^{0}C by using pyrolysis, hydrogenation and thermal dissolution methods. Yield and composition of products formed as a result of thermochemical destruction depend on the composition of source oil shale and conditions of thermochemical destruction. Shale oil generated can be observed as unconventional petroleum. The chemical composition of oil generated from different oil shales is different. Shale oils as syncrude can be distinguished from each other and natural petroleum by oxygen, nitrogen and sulfur contents. In Estonia, for liquefaction of Kukersite oil shale the retorting technology basing on slow pyrolysis principles is used yielding about 1 bbl of shale oil per 1 ton of oil shale. Technological fundamentals to enhance shale oil yield and bring its composition closer to that of natural petroleum are being carried out. This work demonstrated that the yield of syncrude can be substantially increased and that of gaseous and solid by-products decreased by using sub-and supercritical thermal dissolution and hydrogenation methods. Almost complete conversion of kerogen to bituminous oil is practicable. Syncrudes originated from Kukersite thermal dissolutin processes using water, carbon dioxide, low-boiling hydrocarbons, alcohols and other solvents are characterised by high oxygen content. Aliphatic, mono- and polycyclic aromatic hydrocarbons, neutral and acidic oxygen compounds, high-polar oxygen compounds, and asphalthenes in the group composition of bituminous oil were detected.As syncrude obtained on thermochemical processing of oil shale differs from natural petroleum by qualities and chemical composition, containing lots of phenols, other oxygen compounds and alkenes, that needs submitting to the further upgrading. Most valuable products as the phenols can be priorly separated by extraction. To bring syncrude and its fractions properties closer to those of crude oil hydrocracking methods were used.It was demonstrated that up to 75% of the primary oil shale wide-boiling liquid can be easily transformed to diesel fraction characterised by boiling-range 180- 350^{0}C. Challenges to the maximum upgrading of the huge oil shale resource with obtaining synthetic petroleum and chemical specialty products includes both modification of the primary thermochemical destruction process and taking into use the processes for syncrude upgrading.

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