Shale oil production and composition – short introduction


Shale oil (so called synthetic crude oil) is produced from oil shale (an organic-rich sedimentary rock). Energetic value of oil shale comes from the kerogen (high molecular polyfunctional organic matter). Shale rich in kerogens that have not been heated to a warmer temperature in the ground to release their hydrocarbons may form oil shale deposits. Estonian has oil shale deposits.

For shale oil production, the shale undergoes thermochemical decomposition process. In retorting (cracking) process the kerogen is decomposed to release hydrocarbons and then hydrocarbons are cracked into lower weight products and separated. The process is alike with traditional crude oil refining. Example scheme of shale oil production¹ is sent together with this document.

Part of oil shale processing (heat, gas) is for electricity production. Shale oils fractions separated in the process are mixed for fuel oil blends (for example blends like VKG C, VKG extra light, VKG sweet, VKG D, VKG light, more information about these blends: [http://www.vkg.ee/eng/products-and-services/vkg-oil-as/shale-fuel-oils](http://www.vkg.ee/eng/products-and-services/vkg-oil-as/shale-fuel-oils)). These blends are then sold, for example for boiler houses or industrial furnace heating. The sold blends have one purpose (heating fuel), the hazards vary mostly in flammability (some blends are less flammable as petroleum products), they all have classified as environmentally hazardous (R51/53).

Shale oils have complex combination of hydrocarbons. Shale oil consists of hydrocarbons and heterocyclic compounds containing nitrogen, sulfur or oxygen. Shale oils have different composition depending of the oil shale types and oil fractions and shale oil blends. In Estonia, there is kukersite type oil shale. Elemental composition² of crude shale oil is for example:

<table>
<thead>
<tr>
<th>Element</th>
<th>Crude shale oil from kukersite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (C)</td>
<td>83,0</td>
</tr>
<tr>
<td>Hydrogen (H)</td>
<td>9,9</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>1,1</td>
</tr>
<tr>
<td>Nitrogen (N)</td>
<td>0,1</td>
</tr>
<tr>
<td>Oxygen (O)</td>
<td>5,9</td>
</tr>
<tr>
<td>Atomic ratio H/C</td>
<td>1,43</td>
</tr>
</tbody>
</table>

¹ Eesti Energia AS (Estonian electricity company)
² Vahur Oja, Alfred Elenurm, Tallinn University of Technology, April 2011.
Substance composition of distillates (shale oil), middle fraction is:

- a group of partially characterized substances consisting of alkanes and alkenes;
- a group of partially characterized substances consisting of oxygen-containing hydrocarbons;
- a group of partially characterized substances consisting of aromatic hydrocarbons;
- a group of partially characterized substances consisting of polycyclic aromatic hydrocarbons.

More detailed information about composition can also be found from ECHA webpage http://echa.europa.eu/ under REACH registered substances (Shale oils CAS Number: 68308-34-9).

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