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EDITOR'S PAGE

What shall we do with oil shale processing solid waste?

Solid fossil fuels account for about one-quarter of the world's total primary energy supply and even if the prices for gas and oil have dropped drastically over the last years, the overall solid fuel consumption is estimated to increase in the coming decades due to the rising energy demand mainly in fast-growing economies. Usage of solid fuels, however, leaves, compared to natural gas or oil, a large amount of solid waste that poses an increasing threat to air, soil and water quality.

Of solid fuels oil shale is probably the worst case. Total world resources of oil shale expressed as extractable shale oil are at least 500 billion tonnes, but the mineral matter content in commercial-grade oil shales is typically higher than 50%. This is several times higher than in typical coal. Therefore, the large-scale use of oil shale fuels will create, in addition to emission of greenhouse gases, also technological and environmental problems in handling vast amounts of combustion waste.

The problem with oil shale waste is especially of concern in Estonia where kukersite oil shale is utilized in thermal power plants for electricity and heat production, and for retorting shale oil and shale gas. The amount of ash that remains after processing of kukersite is ca 45–48% of oil shale dry mass. At present mining and processing rates ca 8 million tonnes of ash is yearly deposited of on ash sediment plateaus with its total amount accumulated over decades exceeding 300 million tonnes. With respect to Estonia's population more than 5 tonnes of solid waste is produced per capita annually that makes Estonia the world's "leader" in this category.

The large amount of solid waste remaining after oil shale processing is only part of the problem. Oil shale deposits are typically associated with carbonate facies rocks. Therefore, the ash remaining after combustion and/or thermal processing for oil recovery is rich in free lime (CaO) due to partial-to-complete thermal decomposition of carbonate minerals. As a result of hydration reactions of free lime and other unstable mineral phases in ash the recycled ash transportation water and meteoric precipitation waters draining off the waste deposits become highly alkaline (pH 12–13). In addition, the residue of shale oil extraction using vertical gas generator technology, so-called semi-coke, is rich in organic residues (oil, phenols, etc.) and poses an additional environmental threat.

Over the past decades a lot of research has been conducted to find suitable ways for utilizing oil shale ash in Estonia, but, nevertheless, more than 95% of the ash produced is transported to waste deposits. Major applications of ash have been and still include stabilisation of road beds in road construction, production of construction materials (e.g. gas concrete) and as an additive in Portland cement, as a soil liming agent in agriculture and a filter material for waste-water treatment.

It is quite evident there is no good and universal solution to the secondary use of oil shale waste. The wider usage of ash, e.g. for mass production of construction materials, is significantly hampered by its properties, as far as not all ash types/fractions are suitable for cement, gas concrete, or road construction. Moreover, evidently there is no market for millions of tonnes of so low added-value products within a radius of reasonable transportation costs. Though the secondary use of ash in construction and development of new products as zeolites, geopolymers or so-called "green" cements is an important field today and in future, then, still, unused and growing amounts of ash leave the backfilling of open quarries and underground mines from where shale was extracted the only large-scale and possibly economically feasible way for ash usage. This would be especially beneficiary in underground mining as would allow minimising the proportion of shale bearing beds otherwise left in supporting pillars. However, doing so, we must delimit and find solutions not only to technological complications but also to environmental problems emerging with backfilling.

Metastable oil shale ash concrete left in water saturated conditions underground is a potential threat to groundwater quality which is largely unknown at present. Alkalinity increase and input of elevated sulfate and potassium are foreseen in case of Estonian oil shale ash, but how this will spread in groundwater and what is the real impact on groundwater composition on a large scale is yet to be studied. Apart from high alkalinity potential Estonian oil shale is of relatively low concentration of potentially toxic trace metals and does not present serious heavy metal contamination problems, but this is not the case with other oil shales worldwide and great caution must be taken to prevent pollution of groundwater reserves by backfilling the mines with reactive ash residues. On the other hand, elevated concentrations of trace metals in some oil shale deposits open another possibility for use of ash residue as a potential raw material for metal extraction employing conventional processing or (bio-)leaching methods.

There is a frequently expressed opinion that oil shale development is unsupportable because it will create far more problems than it will solve. Reactive and potentially hazardous oil shale solid waste is definitely one of such problems. Generation of large amounts of waste during oil shale processing cannot be avoided, but the sustainable and environmentally least harmful use of this natural resource should mean that the waste is put to good use in the way that no additional harm is made to nature.

Kalle KIRSIMÄE
Professor of Geology and Mineralogy
Department of Geology
Institute of Ecology and Earth Sciences
University of Tartu