Management of Petroleum Development Oman's Tank Bottom Sludge

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Abstract

leakages. Each year Petroleum Development Oman (PDO) generates approximately 18,000 tons of sludge, 53,000 tons of petroleum-contaminated soil, and 1,000 tons of mud cuttings. In addition, there are more than 20,000 tons of sludge accumulated at Mina Al-Fal:1 Terminal alone. Disposal of tank sludge is a significant item of tank maintenance for producers, refiners and transporters of petroleum materials. Environmental testing included determination of: heavy metals concentrations in raw sludge samples; rheological properties; flash and fire points; and radiological properties. Tarik bottom sludge was characterized as having higher concentrations of lead and zinc but lower concentrations of nickel, copper and chromium in comparison with values reported in the literature. Also, mercury concentration appears to be high. Apparent viscosities of sludge samples were extremely high and would probably cause handling and pumping problems. To assess the use of tank bottom sludge as a fuel supplement, various properties such as proximate analysis, ultimate analysis and energy content were determined. The results indicate that the heating values, the carbon content and the ash content of the sludge samples are comparable with bituminous coal, sewage sludge, meat and bone meal and petroleum coke/coal mixture, but lower than those in car tyres and petroleum coke. The nitrogen content is lower than those fuels mentioned above, while the sulfur content seems comparable with bituminous coal, petroleum coke and a petroleum coke/coal mixture. Based on the chemical analysis and rheological properties of the sludge samples investigated, it is feasible to use the sludge as an alternative fuel in the cement industry given that the sludge is diluted to a level where it is easily pumped and the emissions of sulfur, heavy metals and particulate matter are monitored to ensure compliance with regulatory standards. Tank bottom sludge mixtures were solidified using various combinations of selected additives such ordinary Portland cement (OPC), cement by-pass dust (CBPD) and quarry fines (QF). Mixtures were subjected to unconfined compressive strength and leachability-based tests. The use of ordinary Portland cement as a solidifying agent yielded the best unconfined compressive strength and unit weight results. This was followed by such blends as S:OPC:QF of 1:0.5:1.5 and S:CBPD of 1:2. Economically, the latter two mixtures would be considered more cost-effective in solidifying tank bottom sludge. The results of the TCLP analyses reveal that no extracts exceeded the established TCLP maximum limits set by U.S. EP A. To assess the potential of tank bottom sludge as a road material, three various mixtures were prepared: hot sludge and hot aggregate mix; hot sludge and cold aggregate mix; and cold sludge and cold aggregate mix. Results were compared with Oman's specifications for roads and the Asphalt Institute criteria. In summary,
the sludge acts as a binder to the aggregate and provides a significant strength. The effect of heating both sludge and aggregate resulted in a significantly higher strength. An optimum sludge content of 6.5%, by total weight of the mixture satisfies the requirements for low traffic surfaces or base layers according to the Asphalt Institute criteria. The results of the laboratory assessment indicate a potential use of the sludge in such application.