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Treatment of Onshore Petroleum Drill Cuttings via Soil Washing Process: Characterization and Optimal Conditions

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Abstract : Drilling is a key activity in oil and gas exploration and production. Drilling always requires the use of drilling mud for lubricating the drill bit and controlling the subsurface pressure. As drilling proceeds, a considerable amount of cuttings or rock fragments is generated. In general, water or Water Based Mud (WBM) serves as drilling fluid for the top hole section. The cuttings generated from this section is non-hazardous and normally applied as fill materials. On the other hand, drilling the bottom hole to reservoir section uses Synthetic Based Mud (SBM) of which synthetic oils are composed. The bottom-hole cuttings, SBM cuttings, is regarded as a hazardous waste, in accordance with the government regulations, due to the presence of hydrocarbons. Currently, the SBM cuttings are disposed of as an alternative fuel and raw material in cement kiln. Instead of burning, this work aims to propose an alternative for drill cuttings management under two ultimate goals: (1) reduction of hazardous waste volume; and (2) making use of the cleaned cuttings. Soil washing was selected as the major treatment process. The physiochemical properties of drill cuttings were analyzed, such as size fraction, pH, moisture content, and hydrocarbons. The particle size of cuttings was analyzed via light scattering method. Oil present in cuttings was quantified in terms of total petroleum hydrocarbon (TPH) through gas chromatography equipped with flame ionization detector (GC-FID). Other components were measured by the standard methods for soil analysis. Effects of different washing agents, liquid-to-solid (L/S) ratio, washing time, mixing speed, rinse-to-solid (R/S) ratio, and rinsing time were also evaluated. It was found that drill cuttings held the electrical conductivity of 3.84 dS/m, pH of 9.1, and moisture content of 7.5%. The TPH in cuttings existed in the diesel range with the concentration ranging from 20,000 to 30,000 mg/kg dry cuttings. A majority of cuttings particles held a mean diameter of 50 µm, which represented silt fraction. The results also suggested that a green solvent was considered most promising for cuttings treatment regarding occupational health, safety, and environmental benefits. The optimal washing conditions were obtained at L/S of 5, washing time of 15 min, mixing speed of 60 rpm, R/S of 10, and rinsing time of 1 min. After washing process, three fractions including clean cuttings, spent solvent, and wastewater were considered and provided with recommendations. The residual TPH less than 5,000 mg/kg was detected in clean cuttings. The treated cuttings can be then used for various purposes. The spent solvent held the calorific value of higher than 3,000 cal/g, which can be used as an alternative fuel. Otherwise, the recovery of the used solvent can be conducted using distillation or chromatography techniques. Finally, the generated wastewater can be combined with the produced water and simultaneously managed by re-injection into the reservoir.

Keywords : drill cuttings, green solvent, soil washing, total petroleum hydrocarbon (TPH)
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