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Evaluation of Water Repellency in Petroleum Drilling Cuttings Treated by Thermal Desorption: Implications for Use in Construction and Agriculture

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Thermal desorption is one of many methods used for the remediation of hydrocarbon contaminated soils and similar materials. It has several advantages over competing technologies, especially with respect to treatment times. While the biological treatment of contaminated soils may take several months depending principally on the type of hydrocarbons and starting concentration, thermal desorption typically takes less than one month, depending on the treatment capacities of the equipment involved, and the volume of material requiring treatment. In the petroleum producing region of southeastern Mexico, this has been one of the principal methods used for the treatment of drilling cuttings, due mostly to the short time required. As with most remediation projects, as well as in the treatment of exploration and production (E&P) wastes, the criteria used to consider the remediation finalized is the concentration of hydrocarbons in the treated material. This is based on the supposition that at some (relatively low) hydrocarbon concentration, the toxicological affects are reduced to acceptable levels. However, little attention has been paid to the physical-chemical properties of supposedly treated material, which may suffer from water repellency, especially in thermal treatment methods. This could greatly reduce the options for final use of treated materials, especially to support plant growth. Conversely, there may be some construction uses of treated material in which some water repellence could be beneficial (caps for land fills, for example). Considering the relevance of the physical-chemical impacts of petroleum on soil and similar materials, we felt it was important to evaluate the efficiency of the principal method used to treat E&P wastes in Mexico (thermal desporption) based on these factors. In this study different operating conditions (temperature and residence time) of a sub-pilot scale thermal desorption unit were evaluated with respect not only to reduction in hydrocarbon concentration, but also based on water repellency. To our knowledge this is the first study of this type. Water repellency severity was measured in petroleum drilling cuttings which had been treated by thermal desorption to reduce the concentration of total petroleum hydrocarbons (TPHs). The initial TPH concentration in the untreated material was 16850mg/Kg (dry). The prototype batch rotary oven used in this study was operated at 25 rpm, at three temperatures and three treatment times: at 150, 200, and 300°C, for 10, 15, and 20 minutes. Four of the nine treatments complied with the Mexican environmental norm (TPH less than 3000 mg/Kg), these being: at 200°C for 20 minutes and at 300°C for 10, 15 and 20 minutes. The treatments at 150°C resulted in a TPH reduction insufficient to comply with Mexican norm, and also resulted in high MED values (3,46 – 3,67). At 200°C, the decrease in repellency was directly proportional to the treatment time (r=-0,950), with a final value of MED=2,61 after 20 minutes. At 300°C, an increase in water repellency was observed to be directly proportional to the treatment time (r=0,9997), with a final value of MED=3,73 (severe repellence) after 20 minutes. This may be due to the partial combustion (rather than only desorption) of hydrocarbons at this temperature, and their deposition on soil surfaces. Based on these observations, operating conditions of 200ºC for 20 minutes are recommended to achieve effective thermal desorption while reducing water repellency in the treated material. If a final material with more severe water repellency is desired for use in construction, a higher operation temperature is required (300ºC) for at least 15-20 minutes.