Calcium Chloride Supported on Purified Spent Bleaching Earth as Potential Adsorptive Material for Air Dehumidification Application

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Abstract

Thecosmic limitation of high humid environment in tropic regions spurs a lot of interest to the developmentof low cost desiccants. Calcium chloride has been indicated as the oldest adsorbentdesiccant among chemicals and gas dehydration industries. However, calcium chloridedissolution behaviour makes it difficult to be utilized well as desiccant. The first attempt to suppressdeliquescence behavior for dehumidification purpose was in 1976 where silt loam wasusedas the host material. Further work has been presented to achieve the same goal using pureclay.The pollution effect of the spent bleaching earth (SBE) necessitated an investigation to determinewhether SHE could be used to eradicate the deliquescence behaviour of calcium chloride.The spent bleaching earth was purified to remove the entrained hydrocarbons through three steps; solvent extraction using hexane, oxidation of the hexane residues using 30% hydrogenperoxide and thermal oxidation. The ratio of 1 gram spent bleaching earth to 5 ml hexane and reactivation temperature of 550 DC in thermal oxidation were established as the optimalconditions for reactivation of spent bleaching earth. Hexane was found to remove about 25% of the entrained hydrocarbons mainly oil which was characterized. The results for the characterization indicated that the oil recovered could be utilized in non-food applications such as bio-lubricant, detergents, soap and other oleochemicals. Hydrogen peroxide removed about 10%of the remaining hydrocarbons after hexane extraction and thermal treatment about 5% after the two preceding steps. Laboratory studies were conducted to assess the mixing ratio of the inorganic salt, auxiliary binder and purified spent bleaching earth in the development of the composite adsorbent. Samples with different ratios were subjected to a humid environment of 88%relative humidity, by preparing a saturated solution of potassium chromate in a sealed beaker.The samples which recorded.minirnum surface wetting, spalling and cracking as well as high water uptake were further subjected to multiple sorption cycle tests. For all the tests performed, sample ratio of 3 :1 :0.25 of PSBE :CaCb :starch recorded the best results and was furthertested for its sorption properties at different relative humidity's. Sorption properties were carried out in a humidity chamber at 11.3, 32.78, 43.16, 52.89, 75.5 and 93.58% relative humidity where the sorption capacity recorded 14.88, 17.60, 20.95, 24.40, 33.40 and 45.55% water uptake respectively. The desiccant developed was found to be effective in high moisture content and thus viable in tropic regions where such environs are common.

The sorption data obtained were subjected to the Langmuir, Freundlich and Brunaeur-Emmett- Teller (BET) adsorption models in order to determine the type of adsorption isotherm that best interpreted . water sorption by the material. Results indicated that, water adsorption onto adsorbent developed followed BET and Langmuir type III isotherm which indicated the formation of multilayer. The sorption capacity of the adsorbent matrix developed recorded 40 to 45% water uptake which cohered with commercially available desiccant such as silica gel. Since the SBE is normally disposed on potential land and limitations for this method of disposal is enormous, it is recommended that, oil manufacturing industries should emphasis on regenerating and re-using this waste in making products such as desiccants which they can use to preserve their products as well as sell to other consumers.