THERMAL REACTIVATION OF A SPENT BLEACHING CLAY: KINETIC AND THERMODYNAMIC

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***Abstract* – Spent bleaching clay from the oil refining industry was subjected to heat regeneration in a box furnace with air. The heat reactivation was conducted without previous extraction of residual oil and with previous extraction of oil using organic solvent. The experimental temperature ranged from 723 at 873 K. A model for the kinetic of thermal reactivation of spent adsorbent has been proposed. The activation energy involved on the desorption phenomenon was determined.**

***Keywords* – Spent bleaching clay, thermal reactivation, kinetic.**

I. INTRODUCTION

The removal of pigments and several other traces of constituents by adsorption is one of the most important stages in the oil refining process. Activated clays with strong inorganic acids have been used as adsorbents. However, the used clays, impregnated with oil, correspond to about 20-30 % of the total weight and are discarded in landing, causing problems of environmental pollution. The restrained unsaturated oils in the discarded clay oxidize quickly when in contact with air. This process causes strong odor and the material spontaneous combustion becomes possible (O'Brien, 1998). Thus, its disposal on the ground is a problem to be solved.

Methods to reactivate used bleaching clays using extraction with solvents have been suggested (Andersen, 1962; Foletto *et al.*, 2002; Nursulihatimarsyila *et al.*, 2010). Nag *et al.* (1997) have studied the effects of the reactivation of used clays on its structural properties. The removal of the residual oil was carried out by the use of organic solvents. Later, the samples have been submitted to acid and thermal treatment. Oil extraction of maize oil refinery using clay was studied by Al-Zahrani and Alhamed (1995) using different organic solvents. Excellent extraction conditions have been reported for each solvent. Other studies have evaluated the recycling of used clays by thermal treatment at high temperatures. The heating of the clay promotes complete removal of the residual oil and other present organic components adhered to clay particles. Solvent extraction followed by calcination at 500 °C is reported to be a method that produces more active clay than the original one (US Patent, 1999). Al-Zahrani and Daous (2000) have tested different organic solvents for removal of the residual oil, followed by calcination at different temperatures. They have found the optimal conditions of regeneration for commercial clay. A study involving thermochemical regeneration with $ZnCl_2$ and heating under a rate of 10 °C.min^{-1} until 570°C, under nitrogen atmosphere for 1 h, showed that the regenerated clay presents good adsorbent properties (Tsai *et al.*, 2003). Ma and Lin (2004) reported an efficiency of 94%, during the spent clay regeneration that is slightly lower than that was found by other researchers, Hou *et al.* (1999), that was 98%. As described previously, some methods for spent clay reactivation have received considerable attention. However, information about kinetic studies of thermal reactivation of used clays is scarce in literature.

In this context, the main objective of this work was to evaluate the reactivation kinetic of a spent bleaching clay. The activation energy involved on the desorption phenomenon was determined.

II. METHODS

Two samples of clays were provided by the Bunge Industry (Santa Catarina State, Brazil): a commercial virgin clay (bentonite) (Engelhard,U.S.A) and a spent clay, containing impregnated soybean oil. The chemical composition of the virgin clay (% by weight) is, determined by X-ray fluorescence (Philips PW 2400 Spectrophotometer): SiO_2 (70.60); Al_2O_3 (9.44); Fe_2O_3 (2.89); CaO (3.14); Na_2O (0.44); K_2O (0.69); MnO (0.02); TiO_2 (0.79); MgO (1.30); P_2O_5 (0.16); Fire Loss = 10.54%. Neutral soybean oil from the same industry was used to determine the efficiency of reactivation in this work.

The procedure of spent clay reactivation was done in two ways: a) the thermal reactivation was carried out without previous extraction of the residual oil; b) the thermal reactivation was carried out after the previous extraction of the oil using organic solvent. For a) approximately 3.0 g of spent clay sample was placed in an alumina crucible. After the temperature stabilization of the oven (Lavoisier, model 400D) (approximately 30 min, under air flow of 10^{-3} m^3.s^{-1}), some crucibles were placed in its interior and the reactivation time was measured. The crucibles have been withdraw in predetermined times for determination of the reactivation kinetic. The reactivation temperature ranged between 723 and 873 K. For b) a system of Soxhlet extraction was used to remove the oil impregnated in the adsorbent.