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Methodology To Produce Hard Coherent Water Adsorbent Using Modified Fusion Method

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ABSTRACT

Efforts were given to find suitable method to produce hard and coherent water adsorbent for ethanol water mixture. Three methods were studied. In the first method, calcined clay was mixed with alumina and KOH or NaOH. Water was added to get 40 - 50% solution and thoroughly mixed. The mixture was aged for 48 hours in closed container at 38ºC followed by crystallization. In the second method, calcined clay or pure silica and alumina sources were mixed with NaOH or KOH and fused in furnace at 550ºC for 12 hours. The fused mixture was mixed with water to get 40-55% solution of KOH or NaOH. Aging was carried out at 38ºC for 48 hours before crystallization took place. In the third method, fused mixture from method 2 was mixed with NaOH or KOH and 5 part of water. The mixture was vigorously stirred for 3 hours and left for aging/crystallization at 60ºC for 24 hours in oven. All the products from the three methodologies were washed and dried before being tested for water adsorbance. Results showed that method 2 was able to produce water adsorbent. The experimental results also revealed that the repetition of reflux may improve the water adsorbance performance of the adsorbent. However XRD analysis showed that the product was not the type of zeolite A.

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INTRODUCTION

Ethanol or bioethanol is recognized as alternatives to fossil fuel. This biofuel offer potential environmental benefits such as reduced toxic gas and lower greenhouse emissions (Walls *et al*., 2011). It can be produced from renewable sources and can be used without engine modification when blended with gasoline (Padala *et al*., 2012). In order to be blended with gasoline to produce gasohol, the ethanol must be anhydrous (Pereira *et al*., 2012). Conventional distillation process is able to purify ethanol-water mixture up to 89.4 % mol ethanol due to the formation of minimum boiling point azeotrope composition of 89.4 % mol ethanol and 10.6 % mol water at 78.2 ^{o}C and atmospheric pressure. Various ways have been used to produce anhydrous ethanol such as azeotropic distillation, extractive distillation, vaccum distillation, adsorption processes, membrane processes etc (Kumar *et al*., 2010).

One of the attractive methods was adsorption using water adsorbent. It was claimed that adsorption was one of the technique that used less energy (Simo *et al*., 2007; Huang and Chang, 2009). There were varieties of methodology to produce water adsorbent especially zeolite A from various silica and alumina sources.

Haden *et al*. (1961), described the method for making hard and coherent zeolite A from from kaolin, $Al_2O_3.2SiO_2.(2\text{-}4)H_2O$. To produce zeolite A, the ratio of silica to alumina should be 1.177 (±0.030) by weight. This ratio can be adjusted by additional source of alumina or silica in clay-alkali mixture. The clay must be dehydrated by calcination at a temperature of about 427 -871^{o}C, preferably at 649 – 816^{o}C. Calcination below 427^{o}C is not sufficient and mullite is formed when the temperature exceeding 871^{o}C. According to this patent, the amount of alkali to be used is in stoichiometry:

$2NaOH + Al_2O_3.2SiO_2 \rightarrow Na_2O.Al_2O_3.2SiO_2.H_2O$

Sodium hydroxide or potassium hydroxide or mixture of both can be used as the alkali source. The range of alkali aqueous concentration should be around 30 – 50%, preferably at 40 – 50%. Low concentration yield fine powder or soft aggregate. Excess of alkali should be washed before crystallization takes place. It was reported that no zeolite A is formed when 50% weigh excess of NaOH was used. The alkali-clay mixture can be mechanically shaped by extrusion, milling, molding etc. Later, the reaction between clay and alkali is carried out at low temperature, 21^{o}C – 46^{o}C, preferably at 38^{o}C to avoid the formation of sodalite at 52^{o}C.

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