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DETERMINATION OF EFFICIENCIES OF REGENERATED BEIGE SEPIOLITES FOR ADSORPTION OF GASEOUS NO_2 IN PACKED COLUMNS

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ABSTRACT: *Adsorption of NO_2 in packed columns was investigated by using beige sepiolite and regenerated beige sepiolite as adsorbents. For this purpose, NO_2 was produced by reacting copper with nitric acid. The produced gas was mixed with air and the mixture was sent to a packed column.. Remaining NO_2 within the gas mixture leaving the column unadsorbed on packing, was further absorbed by passing it through a series of gas washing bottles filled with the solution of NaOH. The amount of NO_2 in the absorption solution was determined by photometric method. The results were plotted.*

KEY WORDS: *Sepiolite, Adsorption, Packed Columns,*

DOLGULU KOLONLARDA NO_2 GAZININ ADSORPSİYONU İÇİN REJENERE EDİLMİŞ BEJ SEPİYOLİTİN ETKİNLİĞİNİN TAYİNİ

ÖZET: *Dolgulu kolonlarda NO_2 gazının adsorpsiyonunu araştırmak amacıyla bakır ve nitrik asit tepkimeye sokularak NO_2 gazı üretildi. Bu gaz, hava ile karıştırılarak dolgulu kolona gönderildi. Bej sepiyolit ve rejenere edilen bej sepiyolit ayrı ayrı adsorban olarak kullanıldı. Adsorplanmadan kolonu terkeden NO_2, NaOH çözeltisi ile doldurulmuş olan seri bağlı gaz yıkama şişelerinden geçirilerek absorplandı. Absorplanan NO_2 gazının miktarı, fotometrik metotla tayin edildi. Sonuçlar grafiğe geçirildi.*

ANAHTAR KELİMELER: *Sepiyolit, Adsorpsiyon, Dolgulu kolonlar*

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I. INTRODUCTION

Nitrogen oxides are among the most prevalent air pollutants. They not only have adverse effects on human health and plant life, but also are corrosive compounds [1].

These oxides can be produced in varying proportions from many sources. Oxidation of organic matter with nitric acid. combustion or explosion of organic nitrocompounds, electrical generation by means of coal and natural gas are some of these sources. Automobile exhausts can be given as example to mobile sources which are the largest sources of nitrogen oxides [2 - 4].

Many of nitrogen oxides are stable. Two of them are nitricoxide and nitrogen dioxide (NO and NO_2). These two oxides are known as pollutant nitrogen oxides and their mixture is represented by NO_x. Nitricoxide, at high concentrations, is rapidly oxidized to nitrogendioxide by atmospheric oxygen. At low concentrations, however, the reaction is much slower and an appreciable amount of nitric oxide may be present in air. In addition, convertion to NO_2 increases with decreasing temperature [5 - 6].

There is some doubt concerning the toxic actions of nitric oxide. However it is certain that nitrogen dioxide has corrosive effect and is a strong lung irritant. Exposure to high concentrations, in the region of 100-500 ppm may lead to sudden death [7] .

Various methods for controlling of NO_x emissions have been investigated. Fuel combustion modifications do not reduce NO_x emissions to desirable levels. There is thus a need for alternative methods of NO_x control, such as removing NO_x from flue gases [8 - 9].

Methods of removing the nitrogen oxides from flue gases may be grouped into four categories: adsorption, absorption, catalytic combustion and vapour phase reactions. Other methods, except adsorption, have some disadvantages as explained by many workers [10 - 12].

Although studies on adsorption have begun many years ago, many of these works are concerned with reaction mechanisms. Adsorption researchers like Almquist [13], Foster [14], Niiyama (15), and Arastoopour [4] used many different compounds as adsorbents. such as silica gel, zeolites, resins, metal oxides and sulfides, activated carbon and perlite. Döğeroğlu [16] had recently tested many adsorbents and argued that perlite had the highest adsorption capacity.

In this paper, adsorption of NO_2 was investigated in a fixed-bed column. Beige sepiolite and regenerated beige sepiolite were separately used as column packing. The results obtained from these two packings were graphically compared.

II. EXPERIMENTAL

NO_2 was produced according to the following reaction:

$$Cu + 4\ HNO_3 \longrightarrow Cu(NO_3)_2 + H_2O + 2\ NO_2 \qquad (1)$$

For this purpose, copper and nitric acid were reacted. The gas produced was mixed with air fed by a compressor. Various concentrations of NO_2 were prepared by controlling the air flow rate and the amounts of copper and nitric acid. The obtained gas mixture was fed to the bottom of the packed column after it was passed through a regulator and a rotameter. Beige sepiolite and regenerated beige sepiolite were used as packing materials, under the same operating conditions. For this purpose, two sets of experiments were performed. All the experiments were conducted under the same conditions, except the packings. The apparatus used for the experiments is schematically shown in Figure 1. The operating conditions are summarized in Table 1.

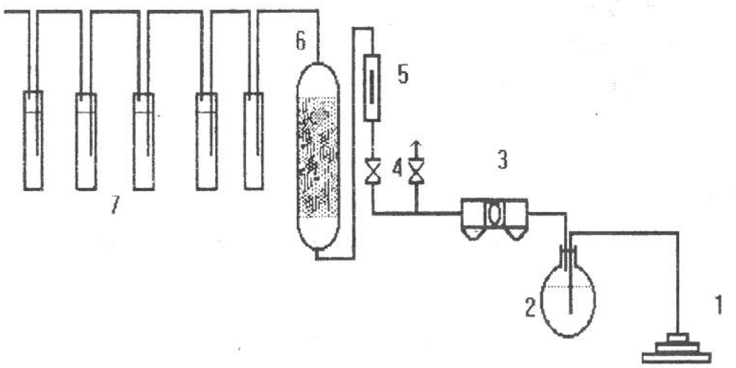

Figure 1. Experimental setup: 1. Compressor, 2. NO_2 reactor vessel, 3. Regulator, 4. Valve, 5. Rotameter, 6. Packed column, 7. Absorption bottles

Regeneration of beige sepiolite was carried out in a glass beaker and 1000 ml of distilled water at 20 °C was added to the beaker. Then it was left for 2 hours for regeneration. After this period, beige sepiolite was filtered and the filtrate was washed with distilled water to remove all the nitric acid that may remain on beige sepiolite particles. Then the regenerated beige sepiolite was dried in the air. Gaseous NO_2 unadsorbed on packing, within the gas mixture leaving the column, was absorbed by passing the gas mixture through a series of five washing bottles filled with a solution of

Table 1. Operating Conditions

Column Diameter, cm	5.5
Column Cross Section, cm^2	23.76
Packing Size, mm	2.250
Bed Height, cm	15.0
Gas Flow Rate, kg/m^2s	0.0366
Concentration, l NO_2/l Air	0.1347
Pressure, atm	1.0
Temperature, °C	25.0

0.1 N NaOH. The amount of $NaNO_2$ produced in the bottles was determined by photometric method which was also used by Wark [5] and Houser [17]. For this purpose, the NO_2^- anion in the solution was reacted with sulphanilic acid to produce diazonium salts. The concentration of the dye produced was determined by using Mp-Photometer Al-25 .

III. DISCUSSION OF RESULTS AND CONCLUSION

The amounts of NO_2 adsorbed per kg adsorbent were plotted in Figure 2, for both the beige sepiolite and the regenerated beige sepiolite. The negligibly small difference between efficiencies of

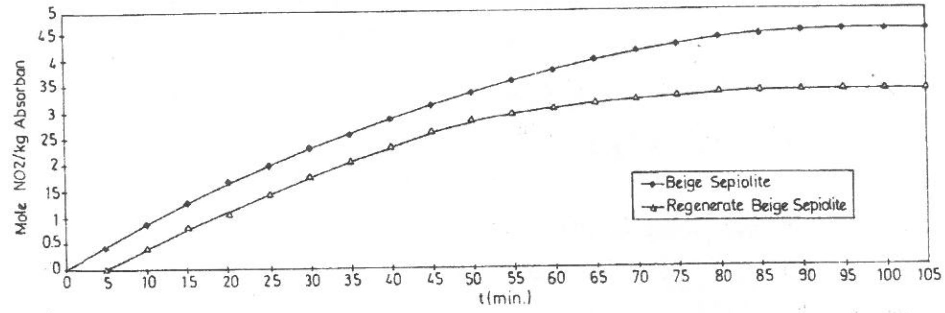

Figure 2. The amounts of NO_2 adsorbed on two different packing materials

the sepiolites may be attributable to experimental errors. Therefore it can be said that their efficiencies are not different. Based on these observations, the subject can be summarized as follows NO_x emission is an important problem in many industrial plants. Although the emission can be controlled by varying the system conditions, process efficiency may decrease due to this variation. Therefore the methods of NO_x elimination from flue gases have to be improved. Many studies on this subject are usually based on absorption. By taking into account the simplicity of use, it can be said that adsorption columns are more suitable than absorption types. Altough recent studies on adsorption showed that perlite is more effective adsorbent compared to many other packings, it was observed in this study that adsorption capacity of sepiolite is much higher than that of perlite and grey sepiolite and can be easily used in many systems [18]. Many parameters such as gas flow rate, packing size, bed height etc. affect the adsorption efficiency. Hence the conditions have to be optimized. The details on this subject were given by Biçer et al. [19].

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