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The Strategy of Adsorption of Carbon Monoxide (Co) on ZSM-5 Membrane In Smoking Area

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Abstract

This research aimed to investigate the ability of ZSM-5 in absorbing cigarette smoke to reduce CO level in smoking area. The research method are according to Gao, 2011 and Mukaromah 2014.The results were characterized using x-ray diffraction (XRD), FTR and SEM.The absorbance test was conducted by placing the gauze absorbed into the enclosed space with volume 18.000 cm3containing CO from cigarette smoke. The research was reached the stage of inorganic and organic substances leaching and oxidized in electrochemistry in H_2SO_4 to 20%. Zeolite zsm-5 membrane has the ability to absorb CO with the decline in CO on the highest levels the surface area of 25 cm2 to the time contact 30 minutes is 0.50 %..

1. INTRODUCTION

Based on the latest data from The Tobacco Atlas (2015), Indonesia ranked first by number of male smokers in the world. The data showed that 66 percent of men smoked in Indonesia (Kompas, 2013). Global data Adults Tobacco's Survey (GATS) 2011 showed the prevalence of smokers in Indonesia of 34.8%, and 67% of men in Indonesia are smokers (Health, 2016). Increasing number of smokers in Indonesia should get serious attention.

Cigar smoke contains around 400 ppm of carbon monoxide (CO) making it a source of CO pollution for both active and passive smokers. CO gas brings bad impact on health because CO gas can shift the oxygen bound to the hemoglobin and bind the Hb to Hb-CO. According to Ganong (2008), CO gas is a colorless and odorless, which is produced by the imperfect combustion process from materials containing carbon or combustion under high pressure and temperature as they

are happening inside the engine (Ganong, 2008).

The characteristics of CO for body include affinity is 250 to 300 times stronger than the O2. CO will form the carboxy bond of hemoglobin, thus inhibiting the distribution of O2 to the tissues. The most sensitive organ to CO poisoning is an organ with the most O2 needs of the heart (Anggraeni, 2009). Therefore, it is necessary to decrease CO gas content originating from cigarette smoke in the smoking room (smoking area).

The reduction of CO gas could be done by activated charcoal, natural zeolite or synthetic zeolite such as ZSM-5 zeolite membrane. ZSM-5 membrane is consist of a buffer in the form of stainless steel gauze coated by ZSM-5 zeolite. Zeolite ZSM-5 is a hydrogenated aluminosilicate compound having a three-dimensional structure constructed by a tetrahedral arrangement of TO4 (T = Si / Al), microporous, and crystalline solids with the principal content of silica, and Na AlO2 and binding a certain amount of water molecules in its core. The crystal compound with this three-dimensional structure has regular interconnected cavities, forming channels in all directions, so as to absorb CO gas better (Adriany, 2011).

2. MATERIALS AND METHODS

They are: glass beaker, stirrer, volume pipette, measuring cup, 50 ml Polypropylene container, Voltmeter, Waterbath, thermometer, pH meters, Analytical balance, buechner funnel, oven, Shaken/Stirer, ovens, CO. FTIR, Scanning Electron Microscopy (SEM) – EDS, JEOL x-ray Difractometer (XRD) Philips PW 1710.

The materials used were cigarette, AlSi 316 stainless steel gauze size 180 mesh, Platinum gauze, HCl, H2SO4, Tetrapropilamonium Bromide (TPA-Br) artificial (Merck), H2O non mineral, artificial NaAlO2 (Sigma Aldrich), NaOH (Merck), and Ludox HS -40 (Aldrich-Chemistry).

Procedures

a. Steel Gauze Treatment

As many as 15 pieces of 1 cm2 steel gauze were soaked in 15% NaOH for 20 min (to remove oil/ organic substance), and then in 15% HCl solution for 20 min (for removal of inorganic substances). The gauze was washed with distilled water in ultrasonic for 20 minute electrochemically oxidized in 20% H2SO4 with a constant voltage of 3-5V and a current of 1.0 A, then dried at 110°C, for 1 hour (Gao, 2011). The procedure was repeated for steel gauze with surface area 4 cm2, 9 cm2, 16 cm2, and 25 cm^2

b. Synthesis of ZSM-5 zeolite precursor solution

In Container no.1, as much as 0.1315 g NaAlO2 and 1.3302 g NaOH 50% w/v were mixed. Meanwhile in container no.2 1.4705 g TPA-Br was dissolved in water 22.0910 g by stirring for 5 min. This solution then added into container no.1 along with 24.9575 g Ludox HS 40%. As soon as semi gel was formed, container 1 was shaken to obtain homogenous gel. Stirring was conducted at 900 rpm for 6 h (Mukaromah, 2014).

c. Coating of ZSM-5 zeolite precursor solution on AlSi 316 steel gauze

Sterilized Stainless steel gauze was coated with ZSM-5 zeolite precursor. Furthermore, the steel gauze was inserted in a polypropylene plastic container and heated at 90° C in the oven for 4 days, thus forming a zeolite ZSM-5membrane. The ZSM-5 membrane was later washed with distilled water and heated at 60° C for 3 hours, then fed into a furnace with a temperature of 550° C for 6 hours (Mukaromah, 2014).

3. RESULTS

Sample testing had been done on zeolite ZSM-5 membrane which had been given early treatment with variations of the surface area of 1 cm2,4cm2, 9 cm2,16 cm2, and 25 cm2. Developed data against CO gas will be absorbed on the respective size of the surface area of the zeolite ZSM-5 membrane. So that it

will obtained influence size broad the membrane surfaces a zeolite ZSM-5 to the process absorption CO gas absorb in 5 min, 10 min, 20 min and 30 min. The test is performed three times with the repetition of different membranes.

The average percentage of CO gas levels were decrease by using Zeolite ZSM-5 membranes of with the variation of surface area and the contact time is served in Figure 1 and Tabel 1

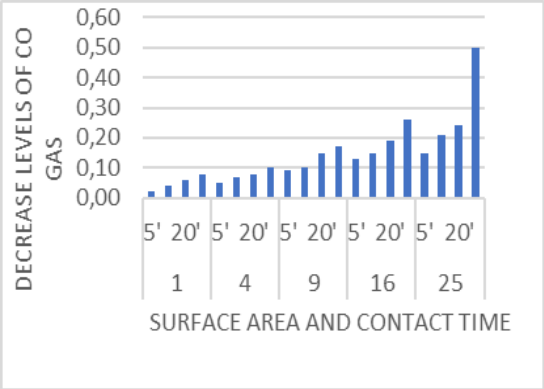

Figure 1. Histogram of decreased levels of CO gas used variation of surface area of zeolite ZSM-5

Tabel 1. The average percentage of the carbon monoxide gas levels (CO) due to variations of membrane surface area of zeolite ZSM-5 and contact time

Surface area (cm^2)	Time Contact (Minutes)	Average of the percentage decline CO gas (%)
1	5'	0.02
	10'	0.04
	20'	0.06
	30'	0.08
4	5'	0.05
	10'	0.07
	20'	0.08
	30'	0.10
9	5'	0.09
	10'	0.10
	20'	0.15
	30'	0.17
16	5'	0.13
	10'	0.15
	20'	0.19
	30'	0.26
25	5'	0.15
	10'	0.21
	20'	0.24
	30'	0.50

The table 1 and figure 1 show that the longer zeolit ZSM-5 membrane contact with CO gas, the higher percentage of dropped levels of CO gas. As seen in the data, surface area of Zeolite ZSM-5 membrane with time contact 30 min could reduce CO gas by 0,5 %. While the decreasing the surface area and time of zeolite ZSM-5 with gas CO shows decrease of CO levels. As indicated in the surface area of a Zeolite ZSM-5 membrane with surface area 1 cm2, the 5 min contact can decrease the CO gas level by 0.02 %

4. DISCUSSION

Zeolite ZSM-5 membrane is a membrane made of AlSi steel gauze and coated with a solution of precursor Zeolite. Zeolite ZSM-5 membrane is consist of silica (SiO_4) and alumina (AlO_4) with cavities which contains alkali metallic ion, alkaline soil and water molecules (Harsodo, 1990).

The existence of a cavity on ZSM-5 zeolite membrane, makes CO gas able to be captured. With greater surface area and longer contact time of zeolite ZSM-5 membrane mean more cavites, resulting in capturing the gas CO better. This is in accordance with finding the theory of Reynold (1982) saying that absorb is very dependent on the surface area of the absorbent. The larger surface area, the greater the absorbent power, and resulting greater levels of efficiency adsorbstion.

5. CONCLUSION

A zeolite ZSM-5 membrane have the ability to absorb CO .CO level can be decreased by 25 cm2 surface area for a 30 minutes of ZSM-5 contact.

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