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ANALYSIS OF OXYGEN CONCENTRATION VALUES IN PORTABLE OXYGEN CONCENTRATOR DEVICES BY USING SILICA GEL AS FILTRATION MATERIAL

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***Abstract*— Oxygen concentrators as a means of separating pure oxygen from free air became an item that was quite sought after when the pandemic case hit in the past 2020 to 2021. This device works by taking free air around us and then processing it by passing the air through a filter so that oxygen is separated from other gases, most of which are nitrogen. However, not all oxygen generator devices are able to filter oxygen to the maximum, this depends on the filtration material used. Most portable oxygen generator devices use synthetic zeolite as a filtration material, but have not maximally filtered oxygen, therefore in this study researchers examined the effect of using silica gel when used as an oxygen filtration medium in the same oxygen concentrator device. In the results of this study, it was found that there was an increase in the oxygen concentration from the standard media device using synthetic zeolite compared to using silica gel material, the increase in oxygen concentration that occurred increased by around 3.3%.**

Keywords—concentrator, oxygen, silica, filter

I. INTRODUCTION

Along with the development of the Covid-19 pandemic, the need for oxygen has also increased rapidly. More and more people need oxygen cylinders, but the amount available is not enough to meet the needs of the wider community. Due to its scarcity, prices have soared so that it is difficult for people to buy oxygen, especially for sufferers of Covid-19, therefore a solution is needed to overcome this problem. Using an oxygen concentrator can be an alternative for people who need pure oxygen in sufficient quantities without worrying about the need for oxygen [1],[2],[3].

Several researchers have conducted research on oxygen concentrators where most of these researchers use large components that require a lot of storage space and electric current. The way this tool works is to filter air somewhere which consists of 78% nitrogen and 21% oxygen and the rest is in the form of other gases. Then the oxygen concentrator filters the air and separates the nitrogen and oxygen through a filter, then the oxygen concentrator throws the nitrogen back into the air and ensures that the user breathes air containing pure oxygen [4],[5],[6].

One of the researchers has made a portable oxygen concentrator, but the system still cannot be integrated with the Android system. Therefore, here the researchers designed a device in the form of a portable oxygen concentrator without using large components so it does not require a large space [7],[8].

II. METHOD

This study aims to analyze how much the increase in the use of silica gel material in portable oxygen concentrator devices, this device has the dimensions of a Pressure Swing Adsorption (PSA) tube with a height of 15 cm and a diameter of about 5 cm. In its specifications, this device is capable of converting oxygen from free air around 20-30%.

Because the value of oxygen filtration is quite small, researchers are conducting research to increase the oxygen content of the device by replacing the filtration material which originally used synthetic zeolite with silica gel. So, it is expected to be able to increase the oxygen levels produced by the device.

The device used uses a portable type oxygen generator with a capacity of 1L / min. Where in this study this device will be disassembled and modified so that the filtration material can be changed.

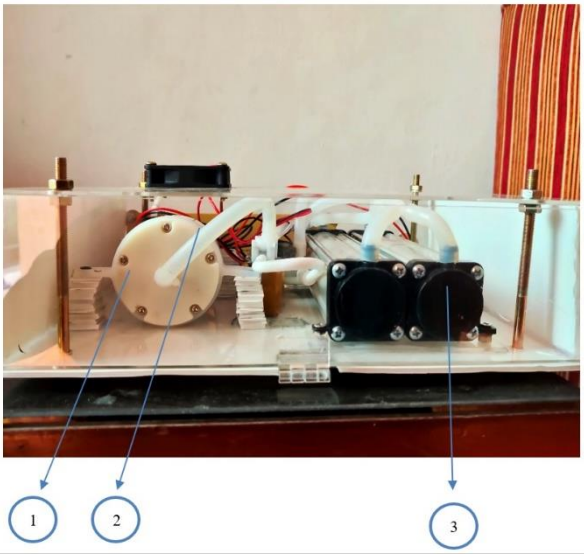

Figure 1. Devices used in the experiment; (1) compressor, (2) air hose, (3) filtration tube

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A. Oxygen Level Measurement Techniques

To determine oxygen levels from filtration results, researchers used chemical measuring cups and beakers. This method utilizes metal corrosion reactions or oxygen oxidation that reacts with oxygen, so that a height difference will be obtained.

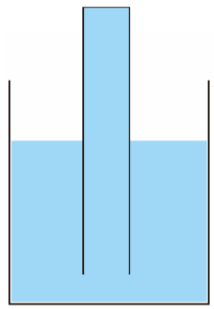

Figure 2. Initial Setting of Oxygen Measurement Method

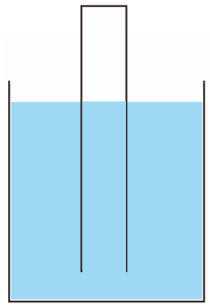

Figure 3. Measuring tube when filled with air from oxygen generator

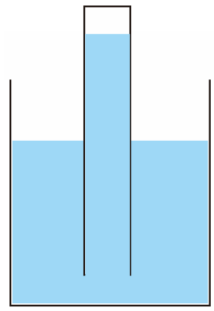

Figure 4. After oxidation occurs

To determine the concentration of oxygen present in the measuring cup, it is calculated by measuring the difference in height before and after oxidation occurs. The step of measuring oxygen concentration with this method fills the tube fully according to Figure 2, then the tube is filled with air from the oxygen filtration generator according to Figure 3. Next, in the oxidation process the tube is inserted iron fibers that have been dipped in vinegar water to accelerate oxidation. The oxygen percentage of this experiment can be calculated from the difference in height before and after oxidation.

B. Synthetic Zeolite

Zeolite is a mineral consisting of hydrated alumina silicate crystals containing alkaline cations or alkaline earth in a three-dimensional framework. These alkaline ions can be replaced by other cations without damaging the structure of the zeolite. The use of zeolite is generally based on high porosity, charge on the surface, the presence of exchange cations, and its abundant amount in nature. Zeolite is divided into two types based on its origin, namely natural zeolite and synthetic zeolite. Synthetic zeolite is more often used for commercial purposes than natural zeolite, this is due to the uniformity of particle size and high purity level in synthetic zeolite. Another advantage is that synthetic zeolite structures can be made as desired. The problem that occurs in research on synthetic zeolite today lies in the availability of silica and alumina sources, as well as the costs needed to find basic materials that are economically valuable and easily available [9]. Because of its advantages in terms of adjustable size, the use of synthetic zeolite is suitable as an oxygen filter material in oxygen generators [10].

C. Silica Gel

Silica gel is one type of adsorbent that is widely used for various purposes, the main content of silica gel is silica. The main component of rice husk ash is silica so that rice husk ash can be used as a basic material for making silica gel. Chemical composition, husk contains some important chemical elements such as moisture content 9.02%, crude protein 3.03%, fat 1.18%, crude fiber 35.68%, ash 17.17%; and basic carbohydrates 33.71. The chemical composition of rice husks according to DTC – IPB carbon (charcoal substance) 1.33%, hydrogen 1.54%, oxygen 33.64%; and silica 16.98%. With this chemical composition, husks can be used for various purposes including: As a raw material in the building material industry, especially silica (SiO2) content that can be used. In addition, because its porosity is small enough that it can be used to reduce oxidation or oxygen filtration materials [11].

III. Results and Discussion

Based on the results of the trials that have been carried out, two pieces of data were obtained from the results of testing oxygen concentrators from the use of synthetic zeolite and silica gel. The test result data can be observed as follows.

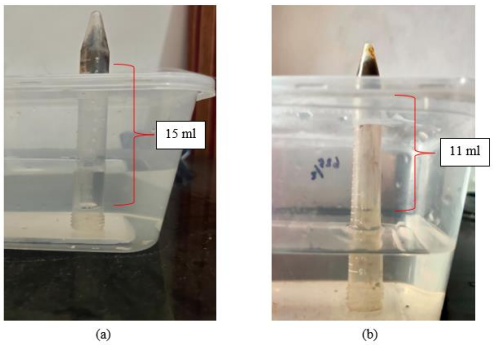

Figure 5. Examples of oxidation experiments

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A. Synthetic Zeolite Filter Testing

Oxygen percentage measurement using a synthetic zeolite filter is shown in Figure 6. In this data, it can be seen that the oxidation process runs long enough, taking about 18 hours to obtain maximum oxidation results. The longer the oxygen concentration level increases until 18 hours of oxidation process obtained a concentration of 23.4%.

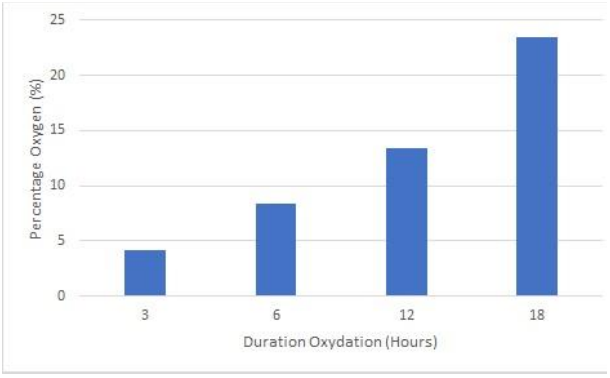

Figure 6. Oxygen percentage using Synthetic Zeolite filter

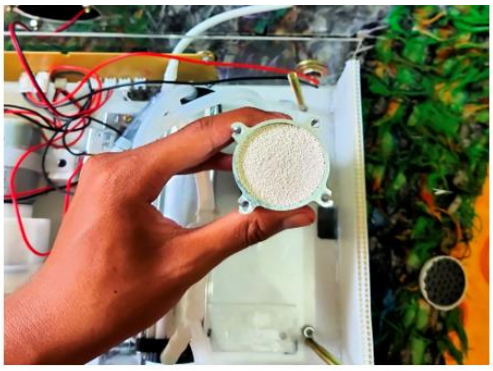

Figure 7. The filtration tube is filled with synthetic zeolite material

B. Silica Gel Filter Testing

The measurement of oxygen percentage using a Silica Gel filter is shown in Figure 8. In this data the hourly increase pattern is almost the same as that of zeolite materials and measurements are limited to 18 hours of oxidation. In the use of silica gel at 18 hours of oxidation process, it can be seen that silica gel is able to produce oxygen up to 26.7% pure oxygen gas.

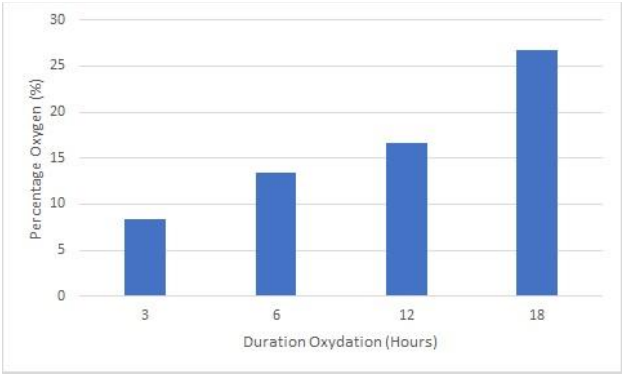

Figure 8. Oxygen percentage using Silica Gel filter

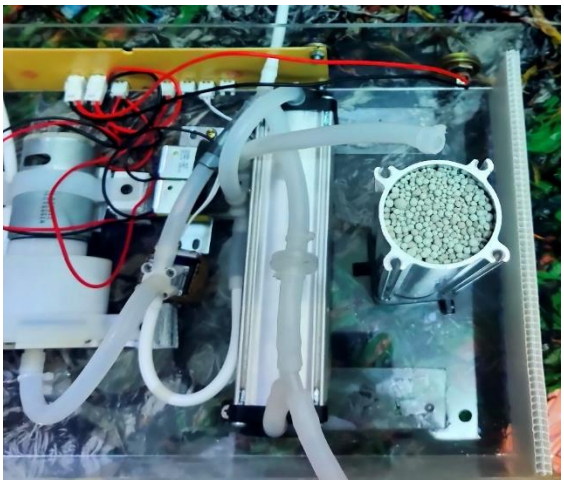

Figure 9. The filtration tube is filled with silica gel material

If we observe the two data on one graph (figure 10), we can see the difference in filtration results using silica gel and synthetic zeolite. On silica gel at the beginning of 3 hours, oxygen concentration measurements were seen almost 2 times more than zeolite. Until measurements within 18 hours this difference was narrowed, with a difference of 3.3% silica gel capable of producing more oxygen than synthetic zeolite.

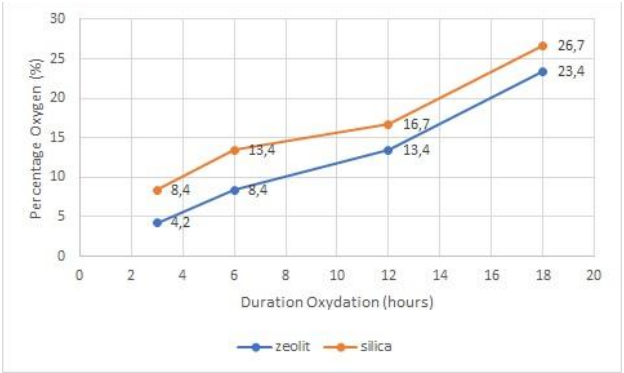

Figure 10. Comparison of data from each filtration material

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IV. CONCLUSION

From the results of the experiment and discussion above, it can be concluded that oxygen concentrators with synthetic zeolite-based filtration materials can be increased in concentration using a substitute filter material in the form of silica gel with an increase in oxygen concentration by 3.3%. However, with test notes using the oxidation tube measurement method with an oxidation duration of 18 hours. In subsequent studies, it is recommended to test with a longer time limit or use special oxygen measuring instrument materials that are more accurate in measuring generator oxygen filtration results.

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