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Modified Zeolites in the making of liquid absorbent Covid-19 masks

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ABSTRACT

Due to covid-19, masks have been embedded in our lives for the past two years and given that we are obligated to wear them in most spaces, they need to be as comfortable for the user as possible. Additionally, in these difficult times of the coronavirus, mask-caused pollution rates have risen to non-manageable levels and are increasing constantly. This paper aims to propound an improved mask, developed with the experimental use of modified zeolites. The main aim of this research is to study modified and natural zeolites and engage those zeolites with polymers in an experiment performed at a factory lab in order to convert the inner layers of a covid-19 mask into a single one. This will help absorb body liquids and provide a better experience for the user. The improved masks will also be reusable because upon sneezing inside the mask, the properties of the zeolites which are integrated on the inside layer of said mask will absorb the mucus. The improved mask will also help reduce the overall environmental impact of mask production. Factors like the materials' compatibility, their ability to preserve the zeolites' hydrophilic properties and also the final product's affinity to human skin will be vital.

Keywords: zeolites synthesis, adsorption

WHAT ARE ZEOLITES AND MODIFIED ZEOLITES?

Natural zeolites have been recognized as useful adsorbents for wastewater treatment as they are useful for removing cations. Natural zeolite is a porous material with large specific surface area but limited adsorption capacity. In recent years, emphasis has been given to prepare the surface of modified zeolite using various procedures to enhance the potential of zeolite absorption for a plethora of applications. Modification treatment for zeolite can greatly change surface chemistry and pore structure depending on the method of modification and the materials used to enhance the zeolite. Natural zeolites are porous hydrated minerals with anionic framework; the crystalline structure comprises of silicon (aluminum) and oxygen tetrahedron, and the pore is formed by a combination of different tetrahedra. Zeolites have the ability to exchange cations in structures, losing or accepting water molecules (Shi et al., 2018).

ZEOLITE COMPOSITION

Zeolite synthesis is an active field of research because zeolites with uniform micropores are important in many industrial processes. For example, in catalysis, adsorption and separation. Zeolite synthesis is finding new applications in electronics, magnetism, chemical sensors, medicine etc. There has been much progress during the last 60 years in the synthesis of zeolites; a large number of profound zeolites with new framework topologies, compositions, and properties have been successfully prepared through continued synthetic efforts. Till date, thousands of zeolite materials have been prepared, which correspond to 174 structure types of zeolites (Yu, 2007).

Zeolites synthesis requires the addition of a strong base or HF as mineralizing agents to dissolve the reactants used as source of silicon and other T atoms (Al, Ge, Ga, etc.) depending on the chemical composition. However, when HF is used in the synthesis, fluoride anions are incorporated into the smallest cages of the zeolite structure compensating the positive charge introduced by the occluded organic cations (Luís Mafra, 2012).

THE EXPERIMENT

In order to view the properties of the zeolite and to examine its reaction to combining it with Polypropylene, an experiment was conducted in the lab of Plastika Kritis. As the author of this study, It is worth noting that Plastika Kritis is my family's company. The specific type of modified zeolite used in the test has a 3 angstrom width (corresponds to the radius of the pore) and is an ultra high-quality form of zeolite molecular sieve that's used for the removal of water from polyurethane adhesives, coatings and sealants as it absorbs 23% of its weight (Baltimore Innovations, n.d.). It is also used for moisture scavenging in polyurea systems and zinc-rich paints. By removing water, it prevents the formation of CO_2 gas bubbles – this improves surface finish and structural strengthof the final product (Baltimore Innovations, n.d.).

Firstly, we decided to make a concentration (masterbatch) by mixing 60% of Polypropylene and 40% of the zeolite for a 2 kg sample (1200gr of PP and 800gr of modified zeolite). The mixture (which was in powder form) was transported to an extruder which is used for heating and fusing the materials together and moulding them into small grain-like shapes.

We then conducted humidity and dispersion tests, in addition to a test for inorganic materials in our mixture. All these tests helped us determine the credibility of our product. For instance, when conducting the inorganic test, a small part of the product was heated to 700 °C, Expectedly, the inorganic materials could not be burned. Indeed, we had 39% of inorganic materials, which is an ideal percentage considering that zeolites are basically a type of rock which are themselves inorganic and nonburnable. For humidity, we also had an outstanding result of 0% which indicates that the process of fusing the modified zeolite and the polypropylene was a success as the final product was dry. In the test of dispersion, we examined our products' homogeneity and sourced it through a 200 mesh (measuring unit which corresponds to 200 holes per inch) filter to observe the level of deposits of inorganic particles accumulated on the filter.

Finally, we sent our product to Turkey at Gaziantep in another branch of our factory chain for a type of testing called *spun-bonding* which combines our product that has a high density with polypropylene to better distribute the density of our product and in order to produce a spun-bonding cloth similar to the one that is used in the internal layer of a covid-19 mask. The end result comes out as a cloth which consists of polypropylene fused with 3% and 5% of the active ingredient (zeolite) that was incorporated into the cloth with the addition of masterbatch. For the final part of our experiment, we had to test if our product actually preserved its hydrophilic properties. Thus, we conducted a water absorption test where we dripped 1-2 water droplets onto the final product. Fortunately, the material absorbed the droplets, providing us with initiative to continue our research on this application.

EXPLANATION OF SPUN-BONDING

It was observed from the experiment that the engineer supplies the material and funnels it through a hopper. It then goes inside the extruder, which heats up the material. The outcome of this process is called a *fibers' web* because of the thinness of the material when it exits the extruder. The product is then passed through a pressuring system which forms it into the pore-like layer resembling the one inside the masks. The cloth is finally collected on a winder.

CONCLUSION

Fortunately, the newly made product absorbed these particles of water and proved that this type of zeolite was capable of preserving its hydrophilic properties after fusion with polypropylene. The results of this experiment have the potential to be groundbreaking on many different levels. Our product has the potential of becoming a dual problem-solver for both the global environmental issue of mask-caused pollution and the comfort of having an absorbent mask for the user.

FUTURE ACTION

Even though the experiment proved successful - as was evident via the successful development of a product that is functional - it still needed improvement changes to it so as to generate an even more efficient material and enhance its absorbing properties. For example, experimenting with higher masterbatch addition rates and examining if the hydrophilic properties were improved with higher density doses of the masterbatch. Another method would be using alternative types of zeolites or organic substances which absorb even more than 23% of their weight in water (which was the percentage of the current zeolite used) and observe if they have an improved performance. Moreover, a critical factor of success in making a beneficial product is optimization of the cost aspect of this project as zeolites can be expensive, meaning that we would have to select a solution that combines the highest efficiency at the lowest cost.

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