

ABSTRACT

Multiple environmental problems (acid rain, eutrophication, human health risk, etc.) can be handled by controlling the emissions of acidic gasses from point sources. The goal of this study is to examine the adsorption capacity of chemically-impregnated carbon adsorbents by developing a dry scrubbing system that uses a controlled source of gas flow. The capacity of adsorption can be defined as the mass of acidic gasses adsorbed by a specific mass of activated carbon.

Chemical impregnation of three types of activated carbon fiber cloth (ACFC) was done with a solution of potassium hydroxide (KOH, 1N). Chemical impregnation of ACFC was done for 3, 6, and 16 hours. The three types of ACFC included knitted, double waved, and single waved fibers. The adsorption capacity of KOH-impregnated ACFC over NO, as an example of an acidic gas can be measured with the inlet and the outlet NO concentrations of the dry scrubbing system. The chemically-impregnated ACFC can remove nitrogen oxides and other acidic gasses from industrial emissions.

It is expected that ACFC impregnated with KOH will have a high capacity to capture acidic gasses. The amount of adsorbed gas can be determined quantitatively by measuring the concentration of NO upstream and downstream of the dry scrubbing system.

INTRODUCTION

London fog of December 4, 1952, a combination of industrial pollution and high-pressure weather conditions that persisted for five days made lethal smog begins to hover over London city, leading to the death of at least 4,000 people. This disaster led to the first detailed analysis that correlate air pollutants with morbidity and mortality (Texas A&M University, 2016).

In the United States of America all stationary and mobile sources have been regulated since 1970 by a comprehensive federal law called the "Clean Air Act" (U.S. Congressional Research Service, 2022). The Clean Air Act protects public health, welfare, and regulates hazardous air pollutant emissions for which the Environmental Protection Agency (EPA) established a national ambient air quality standard (NAAQS) (USEPA, Summary of the Clean Air Act, 2021). The overall function of the NAAQS is to regulate the six criteria air pollutants: ground-level ozone, particulate matter (PM), carbon monoxide, lead, sulfur dioxide (SO₂), and nitrogen dioxide (NO_x).

In spite of the constant development of new technologies and needs of the population; air pollution emission control has been increased ever since the promulgation of the Clean Air Act in 1975. This work is structured to have a simultaneous dry chemical reaction that takes place within the pores of the chemically Activated Carbon fiber cloth (ACFC) for benzene gas (C₆H₆). The ACFC system is modified by impregnation with potassium hydroxide (KOH) to activate the micropores. As a result, the chemically-ACFC will increase in both surface area and adsorption capacity. The now impregnated KOH will undergo a simultaneous acid-base reaction with NO_x gases at a relatively low temperature, from a simulated engine gas flow at a controlled temperature.

MATERIALS & METHODS

Figure 1. Flow chart of the chemical impregnation process of the activated carbon fiber cloth

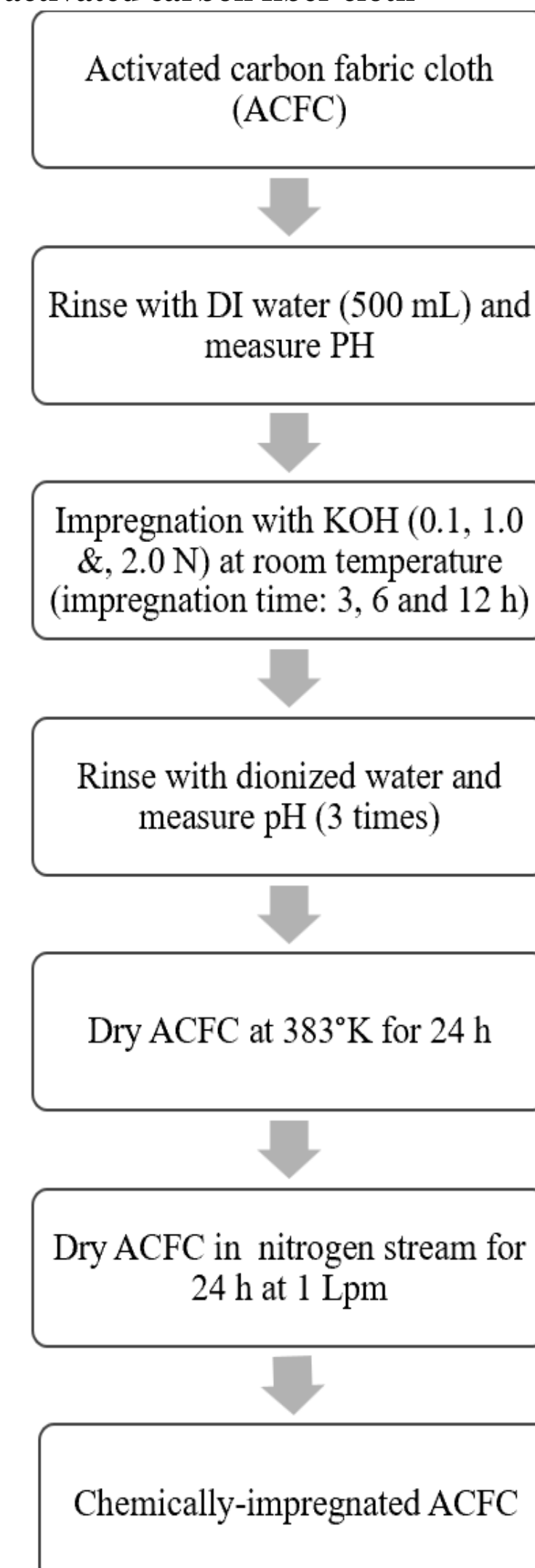


Figure 2 Diagram of the dry scrubbing system

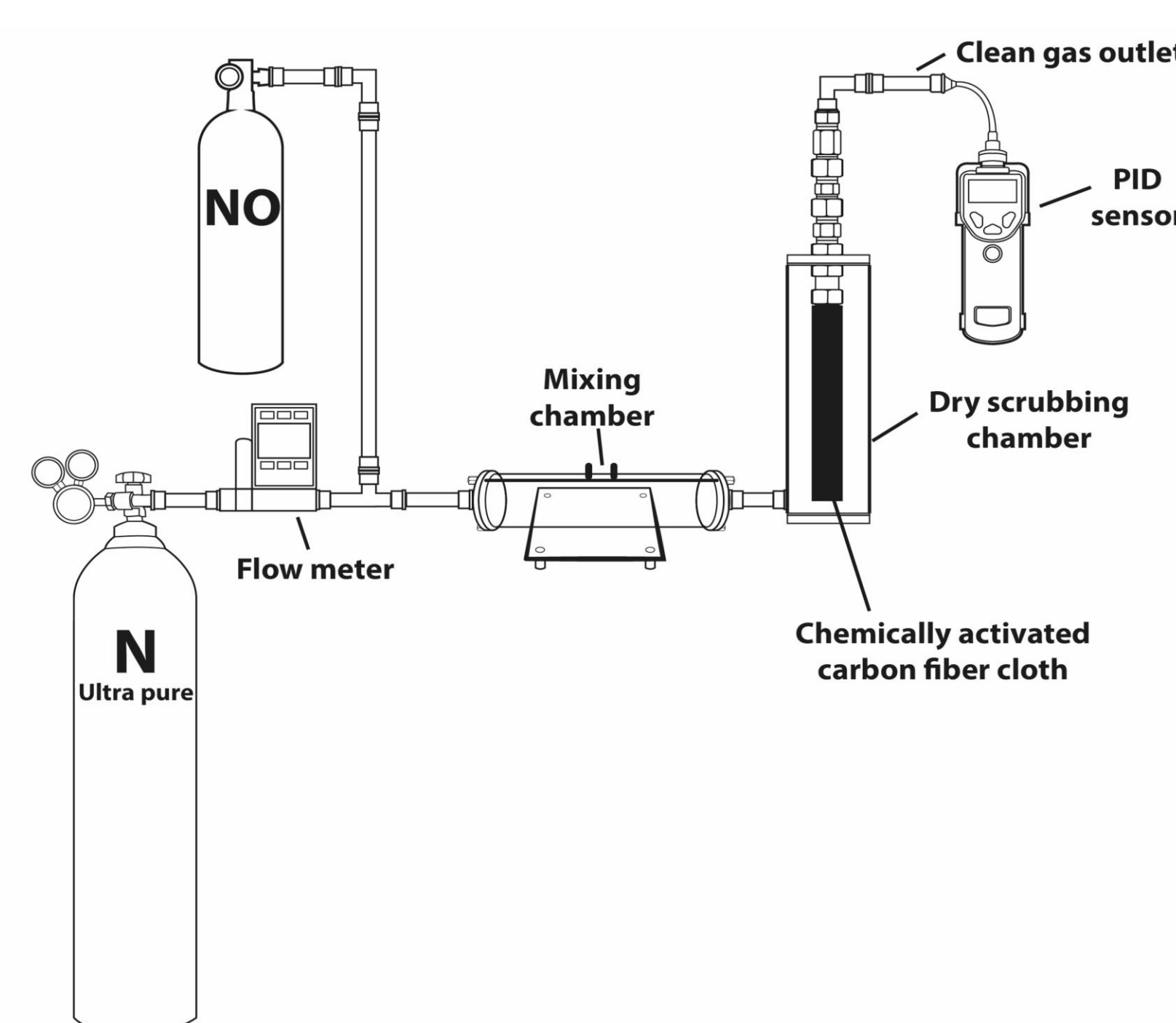
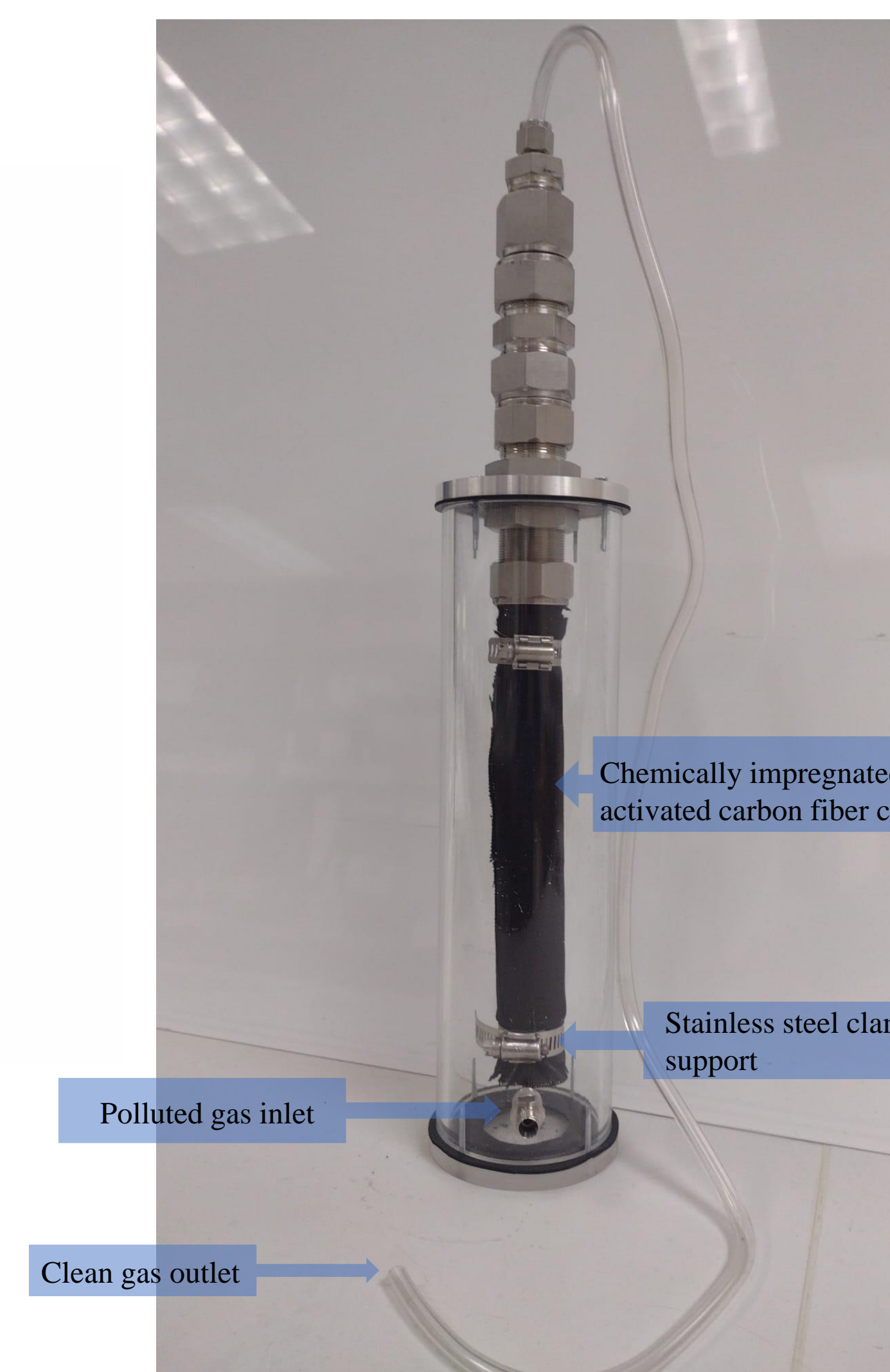


Figure 3 Dry scrubbing chamber



OBJECTIVES

- To chemically impregnate an activated carbon fiber cloth adsorbent, to improve the removal of acidic gasses from an an out stream.
- To design and set up at bench scale dry scrubbing system to capture air pollutants.
- To test the removal of NO with the dry scrubbing system using the chemically impregnated ACFC.

DISCUSSION

Chemical impregnation done in the three different activated carbon fiber cloth consisting in a single waved, a double waved, and knit samples was accomplished.

The impregnation process (Figure 1) performed was the same for the three different samples. A dissimilarity was noticeable that at the end of the of the third step, shown on Figure 1. The difference resides in the most likely absorption the double waved and knit fiber cloths undergo, as contrary to the single waved. The double waved and knit has little to none KOH solution left contrary to the single waved that had almost the same amount of solution as in the beginning.

This project is actively being worked on. The next step is to test the system.

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RESULTS

Acidic gas adsorption in a humid stream at low temperature conditions will be evaluated by generating concentrations tables and experimental breakthrough curves. The overall removal efficiency will be calculated by comparison of the inlet and outlet concentrations. It is expected that the chemically impregnated – ACFC will effectively remove acidic gasses.

Note: this research project is still under work.



Figure 4. Examples of single waved activated carbon fiber cloth chemically impregnated with KOH at 3, 6, and 16h respectively

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