SYNTHESIS AND ANALYSIS OF WEIGHT LOSS OF CMC CARBON AEROGEL

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***Keywords**: Carboxymethyl cellulose, CMC carbon aerogel, mass loss, concentration, temperature.*

ABSTRACT

Carboxymethyl cellulose (CMC) is a derivative of cellulose that shares most of its chemical and physical properties while also Possessing solubility in water and most organic solvents, because of these unique properties CMC was used in this research to produce CMC aerogel at different concentrations of CMC (1%, 2%, 3%, 4%), the prepared CMC was then carbonised at different temperatures (300 °C, 400 °C, 500 °C, 600 °C, 700 °C and 800 °C) and for different durations of 1 hour and 2 hours to produce CMC carbon aerogel and to study the effect of different experimental parameters on the weight loss in the carbonised CMC aerogel. At low to mid-range temperatures of carbonisation we can observe a decreasing pattern in mass loss as the concentration is increased and this due to the physical properties of CMC aerogel while at higher temperatures it is observed that higher concentration of CMC yielded a higher weigh loss due to the completion of the carbonisation and decomposition of CMC aerogel. The different experimental parameters had a clear effect on the weight loss of the prepared CMC carbon aerogel.

INTRODUCTION

Cellulose is one of the most common organic materials that are found in nature, it is typically found in plants (Brigham 2017), it has been used in many industries due to its availability and eco-friendly nature, but its insolubility in water and most organic solvents has limited the universality in its applications. This insolubility is due to the amphiphilic molecular chains in cellulose as well as the high crystallinity which it possesses (Long et al. 2019). Due the limitations of cellulose the need of a substitute has arisen. Carboxymethyl cellulose is derivative of cellulose that is just as readily available in nature while also being soluble in water and most organic solvents. Due to the eco-friendly nature of CMC as well as its renewability it has been used in many industries such as: medical industries and agricultural industries (Lin et al. 2015). It is because of the factors mentioned above, CMC was chosen as the starting material in this research.

METHODOLOGY

CMC aerogel was prepared at different concentration by mixing different amounts of CMC (5g, 10g, 15g, 20g) with 10g of D-(+)-gluconic acid-lactone and 2.5g of Glycerol and dissolving the mixture in 500mL of deionized water. After a vigorous stirring the solution underwent an ultrasonic bath for 4 hours after which it was kept for 72 hours for the gelation to happen and for the cross-linking process to occur. The solution was then frozen for 24 hours and placed in a freeze dryer for 72 hours. At this point CMC aerogel was produced which was carbonised at different temperatures (300 °C, 400 °C, 500 °C, 600 °C, 700 °C and 800 °C) and different durations (1 hour and 2hours) to produce CMC carbon

aerogel and to study the effects of different experimental parameters on the weight loss of the CMC aerogel.

RESULTS AND DISCUSSION

The prepared CMC aerogel had different physical properties and characteristics based on the concentration of the CMC. Samples with low concentration of CMC had a highly porous structure resembling interconnected strings, while having high elasticity. On the other hand, samples with high concentrations of CMC were solid and brittle with less porous structure. After the carbonisation all the samples produced CMC carbon aerogel which was solid and had a brittle consistency.

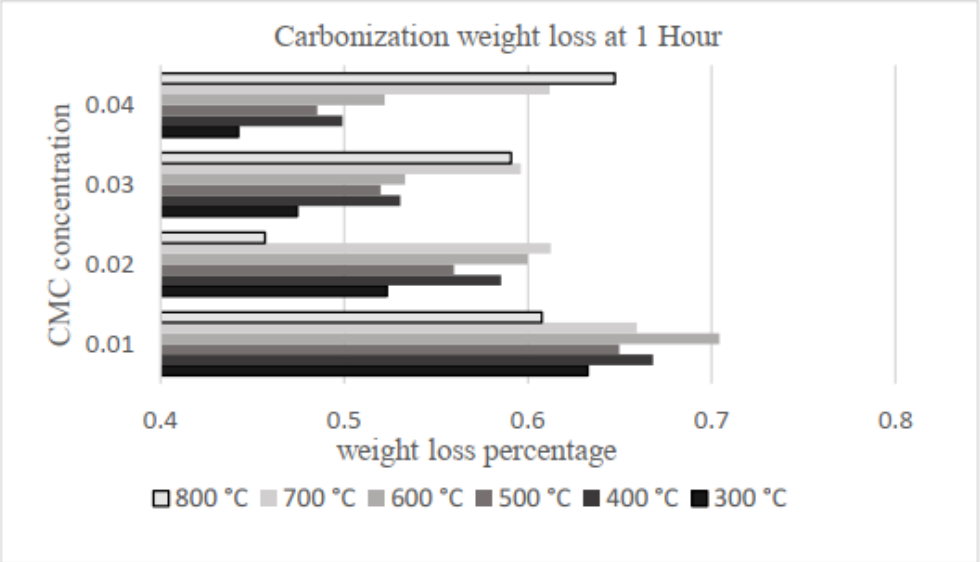

Figure 1. Carbonization weight loss of CMC carbon aerogel at different temperatures and various concentrations of CMC at 1 hour

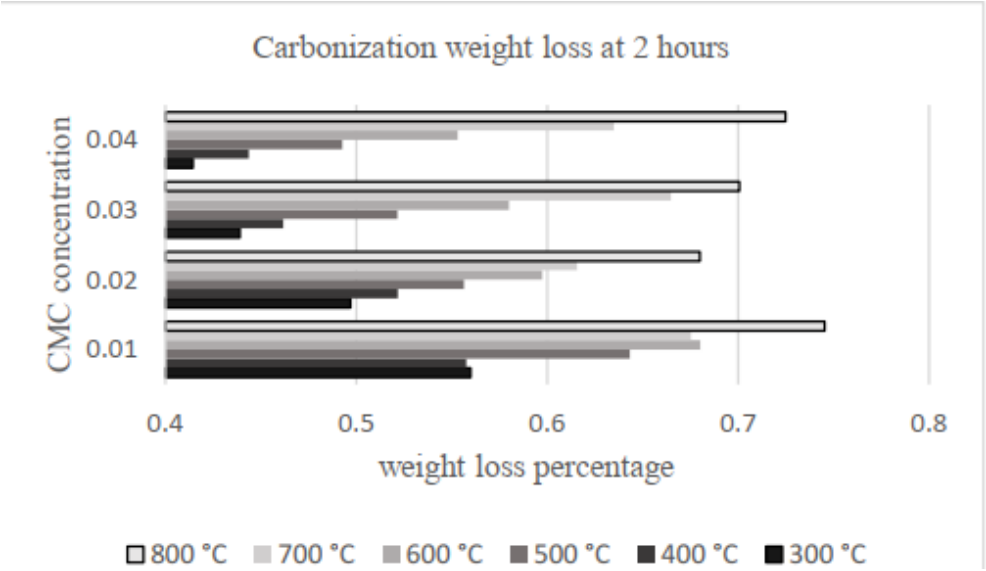

Figure 2. Carbonization weight loss of CMC carbon aerogel at different temperatures and various concentrations of CMC at 2 hours

From the bar graphs above we can observe that the patterns of weight loss for 1 hour and 2 hours are similar but have varying severities. At temperature ranging from 300 °C to 600 °C we can observe a decrease in mass loss as the concentration is increased and this is due to the physical properties of the CMC aerogel that have higher surface area at lower concentration and this leads to higher weight loss (Meng et al. 2015). On the other hand, higher temperatures of carbonisation (700 °C, 800 °C) had a higher weight loss at higher concentrations of CMC and that is due to the complete decompositions of the CMC aerogel into CMC carbon aerogel (Reuß and Ratke 2008).

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ACKNOWLEDGMENT

The authors would like to express appreciation for the support of the sponsors KPT(FRGS/1/2019/STG01/USIM/02/1) and for the support of everyone who assisted in this research.