1 INTRODUCTION

1.1 Background of study

Biomass is organic substances mainly composed of carbon, hydrogen and oxygen. They are living or have recently lived in the world and have solar energy stored in its molecular bonds. The resources included wood and wood wastes, agricultural crops and their waste byproducts, municipal solid waste, animal wastes, waste from food processing, aquatic plants and algae. Biomass consists of any heterogeneous mixture of organic substances and a small amount of inorganic substances (Demirbas, 2001). Biomass could be the source of lignocellulose feedstock as they have high carbohydrate content and have potential for large-scale bioethanol production. Lignocellulose consists of lignin, carbohydrates such as cellulose and hemicellulose, pectin, proteins, ash, salt and minerals (Van Dyk and Pletschke, 2012). Cellulose is the predominant polymer in lignocellulosic biomass and can be converted to ethanol in a two-step process. First process is through hydrolysis to convert cellulose to glucose sugar and then converted to ethanol by fermentation process (El-Zawawy et al., 2011).

Most of the monosaccharidessuch as glucose and xylose are very important for the ingredients in food, pharmaceutical industries and as a source of alternative energy. The pure fractions of a specific monosaccharides are thus needed for the production of xylitol and ethanol but the separation of monosaccharides from each other is quite complex for the industrial scale (Sjoman et al., 2007). The separation is important for the commercial purification of xylose for xylitol production. The uses of xylitol in the food industry keep on increasing because of their several advantages such as anticarcinogenic properties, does not cause acid formation, and having low viscosity and negative heat effect when dissolved in a solution.

Currently, the common method used to separate xylose from glucose is by using liquid chromatography. Chromatography is very efficient method to separate chemical compound (Bi et al., 2010) but sometimes it can involve very complex step. A more cost-effective and easy maintenance technique for sugar separation using nanofiltration (NF) membrane was showed by (Sjoman et al., 2007). However, they are using commercial NF membrane.
In the current study, flat sheet NF membrane was developed to separate xylose from glucose. Polyethersulfone (PES) was used as a polymer material with N-Methyl-2-pyrrolidone (NMP) as a solvent. The effect of organic additives, Polyethylene glycol (PEG-200) and inorganic additives, zinc chloride on the membrane performance was studied.

### 1.2 Motivation

The current method available in the industry to recover xylose is chromatographic separation. While for separation of xylose from glucose by using nanofiltration membrane, currently there is no commercial membrane that is specifically design for sugar separation. During the membrane preparation, some of the crucial factors that need to be controlled are the amount and type of polymer used, type of solvent and additives added into the spinning dope solution (Feng et al., 2013). The blending/additives technique has been considered to be one of the methods for surface improvement of membrane such as hydrophilicity, surface roughness, surface charge, and the pore size (Ahmad et al., 2013). The additives presence in the membrane solution will influence thermodynamic and kinetic properties of membrane solution. It will reduce the strength of polymer-solvent interaction and increase solvent-non solvent exchange rate to enhance the precipitation rate of membrane. By varying the additive concentration and molecular weight, enlarged or suppressed macrovoid can be obtained (Teta et al., 2013). The effect of different PEG molecular weight to PES in the casting solution already being studied on membrane morphologies and permeation properties by Idris et al., (2007). Currently none of the study on the effect of additives focuses on the separation of xylose and glucose.

### 1.3 Objective of the research

The objective of this research is to study the effect of organic and inorganic additives in membrane composition on the properties and performance of NF membrane for xylose and glucose separation.
1.4 Scopes of this research

The following scopes of research were outline in order to achieve the research objectives:

i. To cast flat sheet membrane through casting method using 18 wt. % polyethersulfone (PES) in different amount of additives dissolves in N-Methyl-2-pyrrolidone (NMP) solvent

ii. To study the effect of two different additives composition of PEG 200 (2 wt.%) and ZnCl$_2$ (2wt.%) in PES dope polymer solution

iii. To characterize the properties of NF membrane in terms of water flux and pore size.

iv. To evaluate the performance of NF in terms of retention and separation factor for xylose/glucose under dead end filtration.

1.5 Main contribution of this work

The following are the contributions of this study:

a) The best type of additives that give better morphology, water flux and membrane pore size to be used for xylose and glucose separation.

b) The effectiveness of using 2 different additives in the same dope solution for better retention of glucose and separation factor for xylose and glucose separation.

c) This work will add more research being done to improve the membrane performance for better separation of xylose from glucose.

1.6 Organisation of this thesis

The structure of the reminder of the thesis is outlined as follow:

Chapter 2 provides the literature review for this study. It started with the introduction of biomass where it generally describes the source of biomass and the advantages of utilizing biomass source. This chapter continues to introduce the process involved in biomass processing. Different conversion technologies of biomass are explained briefly. After that, sugar separation technology are being introduces. Currently, there are two methods to separate sugar that is chromatography that already being used commercially and then by using nanofiltration membrane that still in research scale. Membrane technology was discussed next in the literature review which covered