1 INTRODUCTION

1.1 Motivation and statement of problem

Industrial waste water generally can be described as the water or liquid carries waste from industrial or commercial processes, as well known as domestic wastewater. Any process or activity from industry, trade or business and animal operations as feedlots, poultry house or dairies may attributed to these wastes water that contain embrace a wide range of potential contaminant and concentrations (Inc. and Of, 2014; App.leg.wa.gov, 2014).

During mid 18th century, water pollution was located in small areas due to slow development until it comes to 21th century when industrial revolution proposed the development of the internal combustion engine and petroleum fuelled explosion of the chemical industry (SHI, n.d., 2014). The spent water (wastewater) may contain a large variety of organic compound such as acrylic acid, formaldehyde, acetic acid and more but acrylic acid dominate the amount in polymer industrial waste water in range 4-15 wt. % which leading to the range of chemical oxygen demand of approximately 30-60 g/l that could harm the aquatic organisms (Gong et al., 2009; Ahmad et al., 2014).

Acrylic acid (AA) is an important component for the production of acrylate ester with the reaction of alcohol such as methyl acrylate, butyl acrylate and 2-ethyl hexylacrylate. Acrylate ester is a monomer of the acrylate polymer which is applied in the industry of paints, papers, textiles and leather finishes, adhesive and plastics. Currently, the existing method used to treatment the waste water containing acrylic acid is incineration treatment method which is neither environmental friendly and nor economical. Incinerator ashes produce contaminated, unburned chemicals and new chemicals during the burning process. It is buried in landfill or dumped to the environment creating more toxic waste that poses a significant threat to public health and the environment instead of making waste dissapear (Scribd.com, 2014; Natracare.com, 2014).

Reactive distillation in esterification process is one of method to recover the acrylic acid in the industrial waste water. According to Saha, (2000), reactive distillation column that combines both reaction and separation processes have shown its potential to recover the carboxylic acid from wastewater. Esterification reactions is limited by
reaction equilibrium since it is a have its own limitation by reversible reaction. Catalysts accelerate the reaction to achieve the equilibrium state. Without the presence of catalyst, the esterification reaction will proceed extremely slow since this reaction is an equilibrium reaction and it is required in order to accelerate the reaction to achieve the equilibrium state. In this study, acrylic acid will react with 2 ethyl hexanol in the presence of ion exchange resin in order to produce 2-ethyl hexylacrylate and water. The purposed having 2 ethyl hexanol is the widely production of 2-ethyl hexylacrylate in polyester manufacturing industry process that come from reaction between acrylic acid and 2-ethyl hexanol.
1.2 Problem statement

The synthesis of acrylate ester such as 2-ethylhexyl acrylate through esterification process catalysed by homogeneous acid catalysts such as sulfuric acid has been reported in the literature and it is commercially practiced in chemical industry. Homogeneous catalysts are preferred in the conventional esterification reaction due to its higher catalytic activity and cheaper price. However, the use of strong acid in homogeneous system give negative effect towards the reaction since it can cause corrosion, pollution of environment and catalyst recovery problem. Numerous heterogeneous catalysts such as Amberlyst 15, Amberlyst 131, Dowex 50Wx-400 and Phosphotungstic acid could overcome the shortcomings of homogeneous catalysts while maintaining the activity to catalyse the esterification reaction using pure carboxylic acid. To date, the activity of these heterogenous catalysts in the esterification of the dilute acrylic acid (the model waste water) with alcohol has not been reported in the literature. These solid catalysts might facing the problem of leaching in the dilute system (Komo’n et al., 2013). In the present study, Amberlyst 15 is used to catalyse the esterification of dilute acrylic acid with 2-ethyl hexanol. The cause of the catalyst deactivation is ascertained. 2 ethyl hexanol is the widely used in the production of 2-ethyl hexylacrylate for polyester manufacturing industry.

1.3 Objective

The objective of the present study is to investigate the deactivation of Amberlyst 15 in the esterification of dilute acrylic acid with 2-ethyl hexanol.

1.4 Scope of this research

The following are the scope of this research:

a) Amberlyst 15 is tested in the esterification of dilute AA and 2EH at different concentrations of dilute AA (range is varied from 10-90 wt.%) and with/without the presence of inhibitor, Phenothiazine.

b) The fresh and used catalysts are characterized for their morphology chemical compositions, functional groups and surface area. These characteristics are correlated to the catalyst performance during the esterification reaction.