1 INTRODUCTION

1.1 Motivation and statement of problem
Vacuum distillation (VD) is actually an ordinary distillation but operate at lower pressure. The lowered pressure in distillation column reduces the boiling point of the components in the mixture. As the result, VD is commonly used in petrochemical industry to separate high boiling point hydrocarbon mixture. It also used to avoid cracking the long chain hydrocarbon if the mixture is subject to high temperature. Many researchers had produce various research to expand the application of vacuum distillation such as removal of impurities from crude nickel (Liu et al., 2012), removing lead from metallic mixture of waste printed circuit boards (X. Li, Gao, & Ding, 2013) batch operation for sulfuric acid recycling (Jung, Song, Park, Na, & Han, 2014), removal of impurities from crude lead with high impurities (Kong, Yang, Xiong, Liu, & Xu, 2014), separation of Sn-Sb alloy(Wang et al., 2014), recovery of titanium from the slurry formed in crude TiCl₄ (Xiang, Wang, Wang, & Chen, 2014), separation of elemental sulfur from zinc concentrate direct leaching residue (H. Li et al., 2014) and preparation of Te nano powder (Kim et al., 2014). Toluene and benzene are important chemicals because these chemical compounds are used as intermediate to produce other chemicals. Benzene for example is used to produce ethylbenzene, cumene and cyclohexane. Meanwhile, most of toluene converted to benzene and used to produce toluene diisocyanate (TDI).

The development and implementation of new models is hard and expensive task. This is because the complexity and low reusability of process models (Mangold, Motz, & Gilles, 2002). Although with existence advanced modeling in market, model formulation and configuration is still time consuming process in process modeling (Lam, Li, & Xu, 2007).

Modeling of vacuum distillation can be done by using available commercial software such as MatLab. This software requires the modeler to have extensive knowledge of process and prone to produce error due to long and complicated codes. Other software like AspenPlus is more to simulation of the chemical process rather than modeling and cannot be used to produce custom models.
The introduction of MOSAIC modeling software had been a great help for the modeler to create mathematical models for chemical processes. The unique feature such as latex enables the user to key in mathematical expression as close as possible to the literatures. Besides that, MOSAIC enables the code generation and translates it into different kinds of program code such as C++.

1.2 Objectives
The following are the objectives of this research:
   o To explore the modelling of VD of benzene/toluene separation by using MOSAIC

1.3 Scope of this research
The following are the scope of this research:
 i) Modelling of equilibrium(EQ) model of VD by using MOSAIC based on the given parameters of benzene/toluene separation
 ii) Validation of the modelled VD with results from Aspen Plus
 iii) Comparison between MOSAIC and other modelling environments.
2 LITERATURE REVIEW

2.1 Vacuum Distillation Column

2.1.1 General Introduction
Vacuum distillation (VD) is one of the separation unit found in refinery plant. The function of VD is to increases the amount of middle distillates and produces lubricating oil base stock and asphalt. VD is used to prevent cracking long chain hydrocarbons present in feed (Matar & Hatch, 2000).

![Diagram of Vacuum Distillation Column]

Figure 1: The products from VD in refining plant (U.S. Energy Information Administration, 2012)

The working principles of VD is the boiling point of mixture will be decrease when the pressure is low. The lower boiling point that can achieve in VD compare to atmospheric distillation had made VD preferable as separation method for heat sensitive material such as foods, fruit juices, drugs and plant extracts.

2.1.2 Advantages of VD
Besides the reduction of boiling point of mixture, VD also increases the relative volatility. In vacuum condition materials are more volatile hence more evaporation takes place. More products will be collected at distillates, hence higher production rate.
By using VD, reduction of energy consumption can be achieved as the result of lower boiling point of mixtures. Atmospheric distillation column tends to use huge amounts of energy because of the evaporation process. According to Kunesh et. al (1995), the