

## CHAPTER I

### INTRODUCTION

Crude oil is the main material of being a source of energy and an initial substance to produce a lot of chemicals. Its composition can be divided into four major fractions: saturates, aromatics, resins and asphaltenes (SARA). One of the major problems commonly found in petroleum industry is asphaltene precipitation and deposition in production facilities as a result of changes in temperature, pressure or composition (Hirschberg, 1984; Maqbool *et al.*, 2009; Maqbool *et al.*, 2010). Asphaltenes are the most chemically complex portion in crude oil. They are composed of aromatic polycyclic clusters variably substituted with alkyl group and contain heteroatom (N, S, and O) and metals (e.g., Ni, V, and Fe) (Mullins, 2007). They also have high polarity and aromaticity. Due to their complex structure, they are operationally defined as the compounds which are soluble in aromatic solvents, such as toluene, but are insoluble in normal alkane, such as n-heptane (Speight, 1999). Asphaltenes normally exist and disperse in crude oil or solvents as colloidal nanoaggregates which can form clusters and eventually precipitate out of solution upon destabilization with precipitant (Mullins, 2012).

The asphaltene deposition is dependent on the flow hydrodynamics, heat and mass transfer, as well as particle-particle and surface-particle interactions (Mullins, 2007). Therefore, the basis assumption of asphaltene deposition in this research is consist of two stages. The first stage is where asphaltene particles interact or adsorb directly onto the surface. In fact, asphaltene adsorption had been study on many kinds of surface morphology and also surface material such as glass, metals and polymers. Each kind of surface material provides different asphaltene adsorption behaviour and capacity (Alboudwarej, 2005; Xie *et al.*, 2005; Adams, 2014). The second stage occurs when the asphaltene particles have already occupied all sites of the surface then the next asphaltene particles deposit onto the previously deposited asphaltenes.

Many techniques were used to investigate asphaltene deposition behaviour such as capillary techniques, quartz crystal microbalance, packed-bed microreactor, and couette device (Wang *et al.*, 2004; Boek *et al.*, 2008; Akbarzadeh *et al.*, 2010; Eskin *et al.*, 2012; Hoepfner *et al.*, 2013; Tavakkoli *et al.*, 2013; Hu *et al.*, 2014). Each

technique has particular benefits and downfalls for investigating asphaltene deposition in different aspects. Asphaltene deposition is dominated by submicrometer asphaltenes which occur before the asphaltene precipitation (Eskin *et al.*, 2012; Hoepfner *et al.*, 2013). In addition, the asphaltene deposition rate was inspected to be sensitive to shear rate (Nabzar *et al.*, 2008). Many investigations have observed that the deposited asphaltenes from oil field have higher aromaticity, greater amount of metals and higher heteroatom content especially oxygen atom when comparing with the asphaltenes extracted from the matching crude oils (Wattana *et al.*, 2005; Klein *et al.*, 2006). However, the explicit mechanism of asphaltene deposition on surface with regard to hydrodynamic of the flow and colloidal interaction of asphaltenes has not yet established.

The aim of this research is to design, build, and develop the apparatus for investigating the asphaltene deposition behaviour on surface in a control hydrodynamic of the flow. The desired apparatus has to be able to provide a measurement of specific deposition rate of asphaltenes. Moreover, the amount of deposit in the apparatus has to be large enough for further characterization. In addition, the basic mechanism underlying asphaltene deposition in the flow condition will be determined.