1. Introduction

Conversion of heavy oils still attracts a lot of attention from researchers in the refining industry since it faces major challenges in the next future. Indeed, this field is strongly stimulated by several incentive factors such as more stringent specifications, increasing overall naphtha and middle distillates demand, the decline of the production of light crude oil gradually replaced by heavier non-conventional resources. These challenges highlight the need to improve efficiency of the existing processes in order to meet these goals. Different options are available to upgrade heavy oils containing high level of asphaltenes such as solvent deasphalting by liquid–liquid extraction, contacting the feed with a non polar solvent, or converting them to coke through a thermal cracking process like coking [1,2]. However, such routes are not fully satisfactory since a lot of raw material is not converted into valuable products. Among the existing solutions, deep hydropyrolysis is nowadays well established and is widely spread in the refining industry worldwide. In the specific case of vacuum residue conversion containing high metal (Ni, V) and asphaltenes loadings, ebullated bed technology is particularly suitable to convert up to 60–70% of the 540 °C fraction [3–5]. The reaction is performed at high temperature and pressure with continuous addition and withdrawal of catalyst which enable to control the deactivation by coke formation as well as thermal exchanges in the reactor. Nevertheless, improvements of such processes need to overcome a tricky limitation due to the instability of effluents leading to sedimentation at high residue conversion. Indeed, these carbonaceous sediments promptly deposit on the equipment causing severe operability issues as well as on the catalyst deactivation [5,6]. Many attempts have been made in order to get a better understanding on the instability phenomenon observed at high hydroconversion levels [7]. Asphaltenes are known to be the major precursors of sediments [8]. Structure and chemical composition of asphaltenes such as hydrogen content and aromaticity factor are parameters governing the self-aggregation [9]. Recently, Mullins [10] revisited the