Petroleum 2 (2016) 369–380

Ke Ai
ADVANCING RESEARCH
EVOLVING SCIENCE

Contents lists available at ScienceDirect

Petroleum

journal homepage: www.keaipublishing.com/en/journals/petlm

Original article

Developing grey-box model to diagnose asphaltene stability in crude oils: Application of refractive index

Mahdi Zeinali Hasanvand [a, c], Mohammad Ali Ahmadi [b], Reza Mosayebi Behbahani [a, *], Farzaneh Feyzi [c]

[a] Department of Chemical Engineering, Ahwaz Faculty of Petroleum Engineering, Petroleum University of Technology, Ahwaz, Iran
[b] Department of Petroleum Engineering, Ahwaz Faculty of Petroleum Engineering, Petroleum University of Technology, Ahwaz, Iran
[c] Department of Chemical Engineering, Iran University of Science and Technology, Tehran, Iran

ARTICLE INFO

Article history:
Received 7 July 2015
Received in revised form
28 December 2015
Accepted 30 December 2015

Keywords:
Asphaltene
Refractive index
Stability
Evolutionary algorithm
Neural network

ABSTRACT

Asphaltene precipitation can cause serious problems in petroleum industry while diagnosing the asphaltene stability conditions in crude oil system is still a challenge and has been subject of many investigations. To monitor and diagnose asphaltene stability, high performance intelligent approaches based bio-inspired science like artificial neural network which have been optimized by various optimization techniques have been carried out. The main purpose of the implemented optimization algorithms is to decide high accurate interconnected weights of proposed neural network model. The proposed intelligent approaches are examined by using extensive experimental data reported in open literature. Moreover, to highlight robustness and precision of the addressed approaches, two different regression models have been developed and results obtained from the aforementioned intelligent models and regression approaches are compared with the corresponding refractive index data measured in laboratory. Based on the results, hybrid of genetic algorithm and particle swarm optimization have high performance and average relative absolute deviation between the model outputs and the relevant experimental data was found to be less than 0.2%. Routs from this work indicate that implication of HGAPSO-ANN in monitoring refractive index can lead to more reliable estimation of addressed issue which can lead to design of more reliable phase behavior simulation and further plans of oil production.

Copyright © 2016, Southwest Petroleum University. Production and hosting by Elsevier B.V. on behalf of KeAi Communications Co., Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

In the lifetime of petroleum industry, Asphaltene precipitation has the capability to be one of the most challenging issues in the process of petroleum production [1]. As the asphaltene deposition can occur in several places in the process of production: in the reservoir, near the wellbore, in the tubing, in surface production facilities and transportation systems, therefore it increases the expenditures and technical problems for development stage of a reservoir [2]. As the investigation gets deeper, the most probable place for occurrence of asphaltene deposition is near-well bore [3].

The first step for development of asphaltene precipitation model is the accurate knowledge of how asphaltene exist in the oil [4], therefore, it is useful to identify the crude composition and then explore asphaltene stability in the fluid.

There are several methods that describe crude oil composition [5]. SARA analysis is one of the simple approaches that commenced with the study of Jewell et al. [6]. This analysis divides crude into four categories: saturate, aromatic, resin, and asphaltene (SARA) fractions. The saturate fraction is formed of nonpolar material like: linear, branched, and cyclic saturated hydrocarbons. Aromatics are more polarizable that include one or more aromatic rings [5]. Resins are known as the fraction of the desasphalted oil that is strongly taken in surface-active materials such as Fuller's earth, alumina, or silica, and can be desorbed by a particular solvent such as pyridine or a

* Corresponding author.
E-mail address: ahmadi6776@yahoo.com (M.A. Ahmadi).
Peer review under responsibility of Southwest Petroleum University.

Production and Hosting by Elsevier on behalf of KeAi

http://dx.doi.org/10.1016/j.petlm.2015.12.004
2405-6561/Copyright © 2016, Southwest Petroleum University. Production and hosting by Elsevier B.V. on behalf of KeAi Communications Co., Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

combination of toluene and methanol [7]. Asphaltenes can be introduced as a fraction of crude oil that which have the maximum molecular weight and/or by the highest degree of polarity [8] and obvious aromatic features [9]. Recently, they are defined by scientist as the part, precipitated by addition of low-boiling alkane (paraffin) solvent such as normal heptane but soluble in aromatic solvent like toluene or benzene [10]. SARA classification can help us in identifying oil with the potential for asphaltene problems because it divides oil into fractions that related to asphaltene stability. Of course Wang and Buckley emphasized that measurement of SARA fractions are considerably related to the extraction methodology [5].

Despite, there are comprehensive studies in literatures about asphaltene stability and precipitation, but scientists can't describe the real mechanism of asphaltene agglomeration, flocculation and precipitation, yet [11–14].

Andersen [15], Fotland et al. [16] and others [17,18] realized that there are some factors affecting asphaltene stability including pressure, temperature and fluid composition in the media. Moreover they mention that the effect of surrounding fluid composition and pressure are more remarkable than temperature influence. Likewise, Field experience [19,20] corroborates their results. Buckley hinted to this point that it is helpful to differentiate between surrounding fluids that can compel asphaltene precipitation and those that do not [21]. Here upon others tried to quantify oil solvent properties and they found that pressure, temperature and oil composition can change oil solvent properties and effect on asphaltene stability [22,23]. Thermodynamic models follow these alterations by allocating solubility parameters to oil and asphaltenes [24–26].

Colloidal models propose a colloidal suspension of asphaltene in the oil and assume that they (asphaltene) are stabilized by resines in the mixture [27,28]. The disperse phase of the crude oils is formed by asphaltenes, and resins, while maltenes are the continuous phase [29] and the colloidal stability of this mixture determines asphaltene precipitation [30].

Resins (naturally occurring inhibitors) have a considerable propensity to amalgamate with asphaltenes [14,31]. Such association specify their solubility in crude oil [32]. Even though the association between asphaltene and resins has never been irrefutably manifested [9] but some studies offered methods to indicate asphaltene stability based on presence of resin. For example, Resin to asphaltene ratio can be applied to disclose asphaltene stability according to an idea that assumes resins impart asphaltene stability by peptizing (coating) asphaltene particles [28]. Experimental observation of Fan et al. [5] discovered that each of SARA fractions is pertained to asphaltene stability.

Colloidal instability index (C.I.I.) can be calculated from SARA analysis and be used to estimate asphaltene stability. This index is defined below. Indeed CII is a monitoring criterion to distinguish the potential of asphaltene deposition in a crude sample [33].

$$C.I.I : \frac{saturated + asphaltene}{resine + aromatic} \tag{1}$$

De Boar [19] prepared some diagram for fast screening the risk of asphaltene precipitation. In addition, Jamaluddin et al. [34] putted forward an asphaltene stability index based on the oil density at initial and bubble point pressures and there are some other notes in literatures to screen asphaltene stability [35,36].

2. Literature review

The refractive index has an indispensable situation in many branches of physics, biology and chemistry [37]. for a non-absorbing medium, the refractive index is the ratio of the velocity of light in the vacuum to the velocity of light in the medium [38]. The refractive index (RI) has been manifested to describe several prominent properties of multicomponent native petroleum, like: PVT behavior and surface tension [39,40] also asphaltene precipitation [41]. Refractive index of materials varies with the wavelength. This is called dispersion [42].

Buckley assumed that if the London dispersion contribution to the van der Waals forces is considered as the main intermolecular interaction energy in which it (London dispersion) controls asphaltene precipitation, then we can use refractive index dispersion to characterize London dispersion properties [39]. Wattana et al. concluded similar result as Buckley's conclusion and proposed that refractive index is an indicator of the quantity of the intermolecular attraction among the asphaltene molecules [43].

Although, the refractive index of light crudes can be directly assessed by common refractive-meters, but RI measurements of heavy oils and naturally bitumen are not possible, because of their turbid colors. In these cases, it is communal assumption to consider that a mixture of crude oil and a non-precipitant solvent behaves as an ideal binary mixture [44] where the crude oil is treated as a single component and the solvents are treated such as the second in the mixture. Then the real RI value of crude oils can be achieved by applying an easy-to-use mixing rule and extrapolation data [39]. For instance, Wattana et al. applied a very simple mixing rule as below equation:

$$n_{mix} = n_{oil} \times \varnothing_{oil} + n_{solvent} \times (1 - \varnothing_{oil}) \tag{2}$$

where n show refractive indices and $\varnothing_{oil}$ is a volume fraction of a crude oil [43].

When the mixture refractive index was measured, its value reflects a proportion between all the blend components and their volume fractions. Furthermore Buckley revealed that the paraffinic compounds are among the lowest RI substances in a crude while, asphaltenes, resins, and aromatic hydrocarbons are among the highest [21].

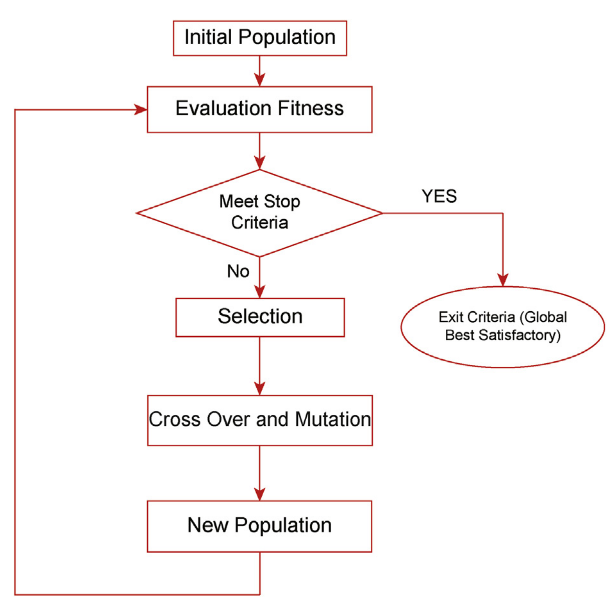

Fig. 1. Flow chart of genetic algorithm for optimization.

Download English Version:

https://daneshyari.com/en/article/5026529

Download Persian Version:

https://daneshyari.com/article/5026529

Daneshyari.com