Bitumen) that has high viscosity and has solids generated when in contact with solvent as in Canadian Patent 2,764,676.

In US Patent, 4,101,415 a process is described that combines a traditional liquid-liquid extractor with a second stage liquid-solid separator. It is disclosed that the performance of a counter-current contactor can be improved by using a second separation stage to separate solid asphaltenes. It is clear that this separation is effected at high pressures (550 psig), high temperatures (over 500°F) and high solvent to oil ratios of 40:1. At these conditions, separators will be extremely large. The process is oriented towards processing lube oil stocks with reduced fouling tendencies and is generally limited to low or moderate yields of deasphalted oil, negatively impacting the economics if applied to target feedstocks.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 depicts an illustrative 3-D view of an IAS vessel of this invention

FIG. 2 depicts an IAS vessel of this invention with a top feed illustrating the pumparound zone including support solvent recovery vessels to improve the solvent deasphalting process with an inertial separator to enhance solid asphaltene segregation, according to one or more embodiments described.

FIG. 3 depicts an IAS vessel of this invention with a top feed illustrating the pumparound zone including support solvent recovery vessels to improve the solvent deasphalting process with an inertial separator to enhance solid asphaltene segregation, according to one or more embodiments described.

FIG. 4 depicts a preferred embodiment for the mixing zone and nozzles in the middle section of an IAS vessel of this invention.

SUMMARY OF THE ~~INVENTION~~DISCLOSURE

It is to be understood that other aspects of the present ~~invention~~ disclosure will become readily apparent to those skilled in the art from the following detailed

description, wherein various embodiments of the ~~invention~~ disclosure are shown and described by way of illustration. As will be realized, the invention is capable of being practiced with other and different embodiments and its several details are capable of modification in various other respects, all without departing from the spirit and scope of the present disclosure~~invention~~ described here and limited by the claims. Accordingly the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

An improved asphaltene separator (IAS) has been developed to support a continuous, reliable process to generate an essentially oil-free solid asphaltene by-product stream thus enabling a high DAO recovery and yield economically. The IAS with three sections and pumparound scheme provides the necessary separation, mixing, and counter-current mass transfer in a single vessel arrangement without the requirement for internal mass transfer or mixing devices. The vessel has specific geometry to mitigate the settling and plugging of solid asphaltenes in the vessel.

The proposed design has 3 distinct sections within one vessel providing specific process objectives to create an oil-free solid asphaltene without the need for internal mass transfer devices. The upper section is a primary DAO/ solid asphaltene separation zone with asphaltene de-entrainment via temperature gradient above feed and up to one mass transfer stage via counter current flow below feed. The middle section injects fresh solvent for complete mixing with downward flowing solid asphaltenes while segregating the upper and lower sections by limiting the downward flow of essentially all the DAO from the upper section and simultaneously permitting downward travel of the solid asphaltenes through the middle section and into the lower section. The lower section is a primary clarification zone for the asphaltene solids with up to one mass transfer stage achieved from counter current upward flow of solvent introduced at the bottom of the lower section. With a preferred described vessel arrangement, fresh solvent injection points at the bottom of the lower section and at the middle section and a "pumparound" of solvent from the top of the lower

section to the feed of the upper section to promote counter-current solvent flow within the system solvent interaction is maximized with the "Target Feedstock" reducing the overall solvent to oil ratio requirements.

By using a variety of lighter hydrocarbon mixtures as a solvent an essentially oil-free solid asphaltene stream can be generated in the proposed device and process scheme to create a high yield deasphalted oil (DAO) stream from a target feedstock like heavy asphaltene-rich hydrocarbon residue (ex. Canadian Bitumen).

In one aspect, there is provided an improved Asphaltene Separation process, comprising the steps: a. A target feedstock is mixed with a Solvent; b.The feedstock/solvent mix is introduced near to the top of a Separator having three parts in fluid communication, spaced vertically: i. An upper section; ii. A middle section, and iii. A lower section; c.Fresh solvent is introduced to the middle section; d.Fresh solvent is introduced to the lower portion of the lower section; e.A DAO-rich solvent/DAO solution is removed from near the top of the upper section; and f. A slurry of particulate asphaltene solid precipitate and solvent is removed at an outlet near or at the bottom of the lower section.

In one aspect, there is provided an improved solid asphaltene separator apparatus comprising: a. An upper section which comprises i. Means to receive a mixture of target feedstock and a solvent; ii.Means to remove DAO rich DAO/solvent mixture; iii.Means to remove solid asphaltene suspension; and b.A middle section i. Operatively connected with the upper and lower section with ii. Means to receive fresh solvent for 1.Mixing to provide additional mass transfer in the middle section; 2. Providing sufficient solvent flow to the upper section to provide additional mass transfer, and prevent the downward flow of DAO while permitting the downward flow of materials comprised essentially of solid asphaltene precipitate; 3. Some downward flow of solvent; and c. A lower section i. Operatively connected with the middle section to receive downward flows of solvent introduced in the middle section and to receive downward flow of solid asphaltene precipitate from the upper section through the middle section and into the lower section with: 1. Means to receive fresh solvent at or near the bottom of the lower section with solvent flow rates sufficient to be counter-current to downward flow of the materials from the upper section; and 2. Means to remove the solid asphaltenes from the downward flowing materials together with some solvent.

DESCRIPTION OF VARIOUS EMBODIMENTS

The detailed description set forth below in connection with the appended drawings is intended as a description of various embodiments of the present invention and is not intended to represent the only embodiments contemplated by the inventors. The detailed description includes specific details for the purpose of providing a comprehensive understanding of the present invention. However, it will be apparent to those skilled in the art that the present invention may be practiced without these specific details.

Known methods of countercurrent liquid-liquid extraction of mixtures are generally of two types. The first type is designated as the batch countercurrent multiple contact method and employs a multiple of one-stage steps. It requires an apparatus consisting of a multiple of separate, external and alternate mixing and settling units connected by pipes and pumps to circulate the liquids. A pair of mixing and settling steps is known as a "stage" with solvent and separated components passing in opposite directions (counter current flow). In this arrangement, large quantities of equipment are required. Many pumps, tanks, agitators, mixers, and vessels with internals (static and mechanical) are needed requiring a lot of capital investment including a lot of plot space to operate. The second type is more readily practiced and is carried out by allowing the liquids to flow continuously and counter-currently in a chamber filled with various types of objects, whether static or