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(54) Titre : TRAITEMENT DE PETROLE LOURD OU DE BITUME DEVANT CIRCULER DANS DES OLEODUCS, AU MOYEN D'UN DILUANT COMPOSE D'UN MELANGE DE PARAFFINES ET DE D'OLEFINES D'HYDROCARBURES LEGERS PROVENANT DE GAZ RESIDUELS DE RAFFINERIES

(54) Title: TREATMENT OF HEAVY OIL OR BITUMEN FOR PIPELINE USING PARAFFIN/OLEFIN MIXTURE OF LIGHT HYDROCARBONS FROM REFINERY OFF GASSES AS DILUENT

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(57) Abrégé/Abstract:
A process and resulting substance for transport of heavy oil or bitumen through conventional pipeline as a mixture of paraffin/olefin as diluent with the bitumen or heavy oil (and the recovery of the diluent after transport). Diluent must have less than 1% hydrogen/methane and less than 10% ethane/ethylene by volume, and must be less than 50% of the mixture.

ABSTRACT

A process and resulting substance for transport of heavy oil or bitumen through conventional pipeline as a mixture of paraffin/olefin as diluent with the bitumen or heavy oil (and the recovery of the diluent after transport). Diluent must have less than 1% hydrogen/methane and less than 10% ethane/ethylene by volume, and must be less than 50% of the mixture.

TREATMENT OF HEAVY OIL OR BITUMEN FOR PIPELINE USING PARAFFIN/OLEFIN MIXTURE OF LIGHT HYDROCARBONS FROM REFINERY OFF GASSES AS DILUENT

FIELD OF THE INVENTION

The present invention relates generally to the field of pipeline transport of bitumen or heavy oil from oil-sand or similar sources.

More particularly, the present invention relates to a novel process, and resulting substance, useful to alter raw bitumen or heavy oil to become pipeline-transportable.

BACKGROUND OF THE INVENTION

Bitumen in raw form exists as a semi-solid material. Even after separation from sand and water, it exists as a solid or close to solid at ambient temperature. The primary method of preparing bitumen as a marketable product is to build an up-grader which essentially produces three products, synthetic light oil, a gaseous stream (usually used as site fuel) and petroleum coke. Bitumen like that found in the Athabasca tar sands can be transported in a pipeline by several different methods; a) heated bitumen can be pumped down an insulated pipeline, b) adding water to the bitumen to create a slurry or an emulsion, or c) adding a lighter oil as a diluent to the bitumen to produce a less viscous mixture. All these techniques have been successfully employed.

Historically, the preferred hydrocarbon diluents have included either the primary product of an upgrader ("synthetic oil") or mixes of butanes, pentanes, hexanes, heptanes and octanes ("condensate"). These diluents were selected because they can be stored in a tank at atmospheric pressure and they can be introduced into a crude oil transport system with minimum requirement to retrofit ambient pressure pipelines and storage tanks. However, the amount of condensate or synthetic oil available in a producing area can be constrained and/or expensive, hence, low cost alternatives are of economic value.

The light gases are produced from upgraders and typical refinery processes such as coking or hydrogenation. These light gases contain hydrogen, methane, ethane,

ethylene, propane, propylene, butane, and butylene. Due to their existence as complex blends in relatively small volumes, these "refinery off gases" ("ROG") are typically consumed as part of the refinery's fuel gas stream. The olefinic portion of the stream makes poor fuel because it is prone to incomplete combustion, but not enough olefins exist in the typically stream to prevent their use as fuel. However, these off-gases can be processed and portions of them can be employed as a diluent for the purposes of pipeline transportation of heavy oil or bitumen if the pipeline is designed to handle these kinds of high vapor pressure diluents.

Research indicates that the existing art (the Peng Robinson Equation of State) is not very accurate in predicting the bubble point pressure of these complex fluids. The current methods typically underestimate the bubble point pressure by about 10%, which would be a major problem to any system employing the existing art. Research shows that one has to physically measure the bitumen/off-gas mixture to accurately predict the bubble point pressure. Research also indicates that in this diluent application, the hydrogen and methane are of little or no value as diluents because the vapor pressure of the resulting mix is too high for reasonable pipeline applications. The use of hydrogen and methane as diluents, would result in two phase flow and this is not acceptable in normal long distance crude oil pipeline applications. Physical measurements show that the C2 components (ethane and ethylene) must also be restricted in a typical pipeline because the vapor pressure of the diluent mixes with more than about 5% C2 by volume exceeds reasonable limits. The diluent prior to blending has been measured to have a bubble point pressure of 255 psia (13.3 °C) to 431 psia (50 °C) for a ROG containing 25% C2s by volume.

The bubble point issue is very apparent when heating is used in addition to dilution to reduce the viscosity of the oil within the pipeline as has been previously described in US Patent Application No. 11/260,067 (Publication No. US-2007-0089785-A1, April 26, 2007) and its Canadian counterpart: Canadian patent application #2,524,544. The C3s (propane and propylene) and other heavier gases make good diluents for bitumen and heavy oil because their vapor pressures are much less. In addition, it is more likely that that the demand for these heavier gases will exist in the same market that exists for the bitumen. Hence, the value of these products exceeds their value as fuel gas.

Testing indicates that after the hydrogen and methane are removed, in a typical refrigeration system, a typical coker or refinery off-gas contains approximately 40% C2, 40% C3 and 20% C4 (by liquid volume). A typical 10 API bitumen requires approximately 20% diluent (by volume) to meet pipeline specification, implying that the C2 components would be approximately 8% of the blend. This example illustrates how an additional component of the C2 and C2=, equal to approximately 50% of the total C2's, must then be removed from the liquid production component of the off-gas. This is usually accomplished using the same fractionation tower that is used to separate the hydrogen and methane, thus involving no additional processing steps.

By separating out the low value gases (hydrogen, methane and, approximately 50% of the ethane and ethylene) in a deep cut facility or lean oil plant with delivery of these products back to the fuel gas stream, the more valuable propane, propylene, butane (normal and iso), and butylene are available as diluent and exhibit a reasonable vapor pressure. These products can then be employed as a bitumen diluent in a high vapor pressure pipeline.

Prior patent art is described in the following paragraphs to identify the state of the prior art, the area of general concern approached by this invention, and some of the shortcomings of the prior art.

US Patent 4,285,356: Method of Transporting Viscous Hydrocarbons. This patent discloses a method of improving the transport of viscous hydrocarbons by adding water to form an oil in water emulsion, an anionic alkyl polyether ethoxylated sulfate or a combination of material with an alcohol ether sulfate. This patent acknowledges that the use of oil-in-water emulsions, which use surfactants to form the emulsion, is known in the art.

US Patent 4,355,651: Method of Transporting Viscous Hydrocarbons US Patent 4,570,656 Method of Transporting Viscous Hydrocarbons US Patent 4,570,656 Process for Transporting Heavy oils. Like Patent 4,285,356 above, this patent relies on the addition of water to an oil.

US Patent 6,402,934 Recovery and Transportation of Heavy Crude Oils deals with the addition of amine-chelate complexes to reduce the viscosity of heavy oil for the purposes of transportation.

US Patent 6,518,321 Method of Transporting Fisher-Tropsch Products. The Fisher-Tropsch process produces hydrocarbons and these hydrocarbons can be transported as blends or added to petroleum products and then transported using marine tankers, rail cars, pipelines, trucks, barges and combinations thereof. An important part of the patent is the fact that it relies on the fact the vapor pressure of the blend and Fisher-Tropsch products is less than 15 psia. By employing a high vapor pressure pipeline, hydrocarbons which have much higher vapor pressures can be employed.

US Provisional Patent Application No. 60/946,335 Batch Interface Reducing Agent deals with the addition of controlling the amount of interface mixing in batches as they travel in a pipeline by adding ethane, ethylene, propane, propylene, i-butane, n-butane, butane, butylene, butadiene and the entire class of C5 hydrocarbons including n-pentane and i-pentane and includes mixtures thereof at the interface point between the batches of bitumen.

SUMMARY OF THE INVENTION

It is an object of the present invention to obviate or mitigate at least one disadvantage of prior art.

After extensive laboratory testing, it has been found that ethane, ethylene, propane, propylene, butane, and butylene are excellent bitumen diluents either in pure form or as mixes so long as the amount of diluent is less than the amount that triggers asphaltene flocculation and precipitation. This precipitation occurs at approximately 50/50 (by volume) bitumen/diluent ratio. Further, there is virtually no transfer of any product between the two basic components after they are separated using a distillation process by adding heat and boiling the fluid such that the high vapor pressure off-gases are boiled out of the bitumen solution.

The prior art fully describes how using paraffin components in mixes (ethane all the way up to decane and even heavier in small volumes) as diluent reduces viscosity in a

bitumen or heavy oil pipeline. The prior art also describes how olefins (ethylene, propylene, butylene) themselves have a viscosity slightly lower than the paraffin component with an equal carbon number (see GPSA Figure # 23-30 "Olefins are approximately 15% less viscous than the corresponding normal paraffin hydrocarbons"). This art does not deal with the effects or benefits associated with the olefins (ethylene, propylene and butylene) when used in mixtures that involve both the paraffins and the olefins. Research has now indicated that paraffin/olefin mixes also show this desirable characteristic and that they reduce the viscosity of a bitumen or heavy oil to a greater degree than a pure paraffin mix. There are limits to the use of this invention that define the zone of economic utility. Due to the vapour pressure issue, the diluent must contain less than 1% hydrogen or methane and the ethane and ethylene component must be less than 5% of the blend (by volume). The overall level of diluent must be less than 50% by volume of the blend because of the asphaltene deposition issue. This invention identifies a process that creates and handles this fluid and involves the following steps:

1. capturing the coker off-gases prior to combustion,
2. removing impurities from the gas such as sulphur and water through known processes and increasing the gas pressure through the use of compression,
3. extracting the C2+ hydrocarbons with a refrigeration process such as a turbo-expander or a lean oil process,
4. optimizing the amount of ethane and ethylene recovered via control of the fractionation tower operating conditions,
5. leaving the paraffins and the olefins in a common mixture,
6. mixing this NGL mixture with a bitumen or heavy oil to create a pipeline product,
7. transporting the bitumen/diluent mixture through a pipeline/storage system that has a vapour pressure higher than ambient, and

8. separating the diluent from the bitumen in a distillation process using heat to boil the vapor out of the liquid at the delivery end of the pipeline.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

Fig. 1 is a block diagram showing the process claimed

DETAILED DESCRIPTION

Generally, the present invention provides a method and system for the treatment of heavy oil or bitumen to prepare it for pipeline transport comprising the steps of:

1. capturing the coker off-gases 10 prior to combustion and increasing their pressure through the use of compression 20,
2. removing impurities such as sulphur and water through known processes 30,
3. extracting the C2+ hydrocarbons with a refrigeration process such as a turbo-expander or a lean oil process 40,
4. optimizing the amount of ethane and ethylene recovered via control of the fractionation tower operating conditions 50,
5. leaving the paraffins and the olefins in a common mixture 60,
6. mixing 70 this NGL mixture 60 with a bitumen or heavy oil 80 to create a pipeline product 90,
7. transporting the bitumen/diluent mixture through a pipeline/storage system that has a vapour pressure higher than ambient 100, and

8. separating the diluent from the bitumen in a distillation process using heat to boil the vapor out of the liquid at the delivery end of the pipeline 110.

The result of that treatment is to arrive at a substance useful for the transport of heavy oil or bitumen by pipeline comprised of a mixture of:

1. heavy oil or bitumen;
2. a diluent comprising;
    i. olefins;
    ii. paraffins;
    iii. less than 1% hydrogen or methane alone or in combination (by volume);
    iv. less than 10% ethane and ethylene together (by volume);

where the diluent is itself less than 50% by volume of the mixture.

In the preceding description, for purposes of explanation, numerous details are set forth in order to provide a thorough understanding of the embodiments of the invention. However, it will be apparent to one skilled in the art that these specific details are not required in order to practice the invention.

The above-described embodiments of the invention are intended to be examples only. Alterations, modifications and variations can be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.

CLAIMS:

1. A process that creates and handles this fluid and involves the following steps:

   a. capturing the coker off-gases prior to combustion and increasing their pressure through the use of compression;

   b. removing impurities such as sulphur and water through known processes;

   c. extracting the C2+ hydrocarbons with a refrigeration process such as a turbo-expander or a lean oil process;

   d. optimizing the amount of ethane and ethylene recovered via control of the fractionation tower operating conditions;

   e. leaving the paraffins and the olefins in a common mixture;

   f. mixing this NGL mixture with a bitumen or heavy oil to create a pipeline product;

   g. transporting the bitumen/diluent mixture through a pipeline/storage system that has a vapour pressure higher than ambient; and

   h. separating the diluent from the bitumen in a distillation process using heat to boil the vapor out of the liquid at the delivery end of the pipeline.

2. substance useful for the transport of heavy oil or bitumen by pipeline comprised of a mixture of:

   a. heavy oil or bitumen;

   b. a diluent comprising;

      i. olefins;

      ii. paraffin's;

      iii. less than 1% hydrogen or methane (by volume);

      iv. less than 10% ethane and ethylene together (by volume),

where the diluent is itself less than 50% by volume of the mixture.

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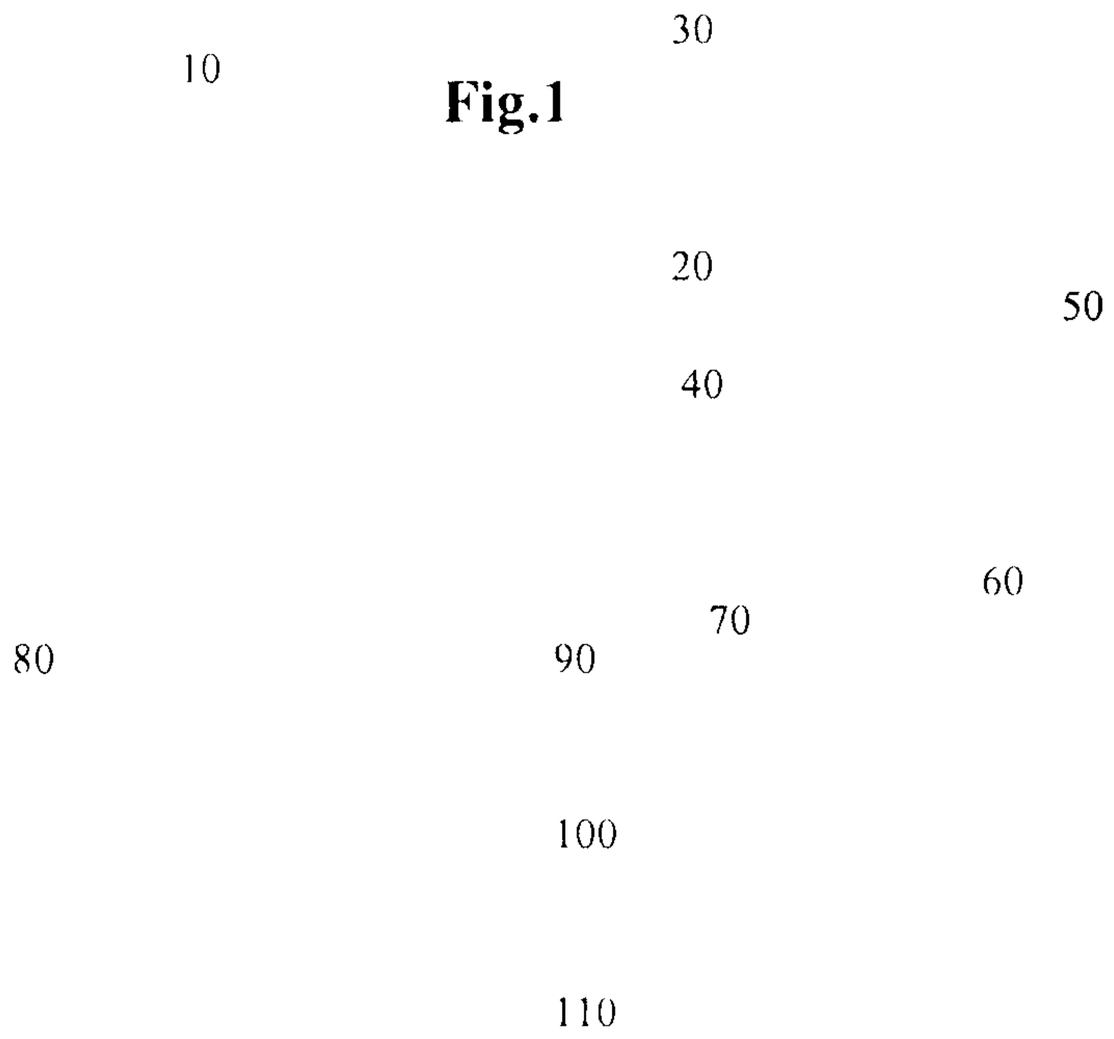

Fig.1

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