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IMPROVED CRUDE OIL BLENDING TO REDUCE ORGANIC-BASED FOULING OF PRE-HEAT TRAIN EXCHANGERS AND FURNACES

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to processing of whole crude oils, blends and fractions in refineries and petrochemical plants. In particular, this invention relates to thermal processing in pre-heat train exchangers, furnaces, and other refinery process units and the associated issues relating to fouling of the equipment.

DISCUSSION OF RELATED ART

[0002] Fouling is generally defined as the accumulation of unwanted materials on the surfaces of processing equipment. In petroleum processing, fouling is the accumulation of unwanted hydrocarbon-based deposits on heat exchanger surfaces. It has been recognized as a nearly universal problem in design and operation of refining and petrochemical processing systems, and affects the operation of equipment in two ways. First, the fouling layer has a low thermal conductivity. This increases the resistance to heat transfer and reduces the effectiveness of the heat exchangers – thus increasing temperature in the system. Second, as deposition occurs, the cross-sectional area is reduced, which causes an increase in pressure drop across the apparatus and creates inefficient pressure and flow in the heat exchanger.

[0003] Fouling in heat exchangers associated with petroleum type streams can result from a number of mechanisms including chemical reactions,

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corrosion, deposit of insoluble materials, and deposit of materials made insoluble by the temperature difference between the fluid and heat exchange wall.

[0004] One of the more common root causes of rapid fouling, in particular, is the formation of coke that occurs when crude oil asphaltenes are overexposed to heater tube surface temperatures. The liquids on the other side of the exchanger are much hotter than the whole crude oils and result in relatively high surface or skin temperatures. The asphaltenes can precipitate from the oil and adhere to these hot surfaces. Prolonged exposure to such surface temperatures, especially in the late-train exchanger, allows for the thermal degradation of the asphaltenes to coke. The coke then acts as an insulator and is responsible for heat transfer efficiency losses in the heat exchanger by preventing the surface from heating the oil passing through the unit.

[0005] Blending of oils in refineries is common, but certain blends are incompatible and cause precipitation of asphaltenes that can rapidly foul process equipment. Improper mixing of crude oils can produce asphaltenic sediment that is known to reduce heat transfer efficiency. Although most blends of unprocessed crude oils are not potentially incompatible, once an incompatible blend is obtained, the rapid fouling and coking that results usually requires shutting down the refining process in a short time. To return the refinery to more profitable levels, the fouled heat exchangers need to be cleaned, which typically requires removal from service, as discussed below.

[0006] Heat exchanger in-tube fouling costs petroleum refineries hundreds of millions of dollars each year due to lost efficiencies, throughput, and additional energy consumption. With the increased cost of energy, heat exchanger fouling has a greater impact on process profitability. Petroleum refineries and petrochemical plants also suffer high operating costs due to cleaning required as

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a result of fouling that occurs during thermal processing of whole crude oils, blends and fractions in heat transfer equipment. While many types of refinery equipment are affected by fouling, cost estimates have shown that the majority of profit losses occur due to the fouling of whole crude oils, blends and fractions in pre-heat train exchangers.

[0007] Heat exchanger fouling forces refineries to frequently employ costly shutdowns for the cleaning process. Currently, most refineries practice off-line cleaning of heat exchanger tube bundles by bringing the heat exchanger out of service to perform chemical or mechanical cleaning. The cleaning can be based on scheduled time or usage or on actual monitored fouling conditions. Such conditions can be determined by evaluating the loss of heat exchange efficiency. However, off-line cleaning interrupts service. This can be particularly burdensome for small refineries because there will be periods of non-production.

[0008] Mitigating or possibly eliminating fouling of heat exchangers can result in huge cost savings in energy reduction alone. Reduction in fouling leads to energy savings, higher capacity, reduction in maintenance, lower cleaning expenses, and an improvement in overall availability of the equipment.

[0009] Some refineries and crude schedulers currently follow blending guidelines to minimize asphaltene precipitation and the resultant fouling of pre-heat train equipment. Such guidelines suggest blending crude oils to achieve a certain relationship between the solubility blending number (SBN) (also symbolized by S_{bn}) and insolubility number (I_n) (also symbolized by I_n) of the blend. The SBN is a parameter relating to the compatibility of an oil with different proportions of a model solvent mixture, such as toluene/n-heptane. The SBN is related to the I_n , which is determined in a similar manner, as described in U.S. Patent No. 5,871,634, which is incorporated herein by reference. Some

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blending guidelines suggest a SBN/I_n blend ratio >1.3 and a delta ($SBN-I_n$) >10 to minimize asphaltene precipitation and fouling. However, these blends are designed for use as a passive approach to minimizing asphaltene precipitation.

[0010] Attempts have been made to improve the method of blending two or more petroleum oils that are potentially incompatible while maintaining compatibility to prevent the fouling and coking of refinery equipment. U.S. Patent No. 5,871,634 discloses a method of blending that includes determining the insolubility number (I_n) for each feedstream and determining the solubility blending number (SBN) for each stream and combining the feedstreams such that the SBN of the mixture is greater than the I_n of any component of the mix. In another method, U.S. Patent No. 5,997,723 uses a blending method in which petroleum oils are combined in certain proportions in order to keep the SBN of the mixture higher than 1.4 times the I_n of any oil in the mixture.

[0011] It would be desirable to improve guidelines for crude oil blending to reduce or eliminate the need to physically remove and/or clean affected equipment. There is a need, therefore, for improved blending guidelines to ensure stable solutions during processing for the prevention of pre-heat train equipment fouling. There is also a need for developing a proactive approach to addressing asphaltene precipitation and thereby minimize the associated foulant deposition and/or build up.

BRIEF SUMMARY OF THE INVENTION

[0012] Aspects of embodiments of the invention relate to blending crude oils to result in a stable solution that is effective in dissolving asphaltenes.

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[0013] Another aspect of embodiments of the invention relates to providing guidelines for blending crude oils for use during processing for reducing equipment fouling.

[0014] An additional aspect of embodiments of the invention relates to providing a process for maintaining a regime of reducing or eliminating foulant deposition.

[0015] These and other aspects can be realized by the present invention, which is directed to a process for blending petroleum crude oils that reduces organic-based fouling of heat exchange equipment. The process comprises blending two or more crude oils that have a proportion of the oils that precipitate asphaltenes and adding a high solvent power (HSP) crude oil. An HSP crude oil is defined as a crude oil having a solubility blending number (SBN) greater than 80 to dissolve the precipitated asphaltenes. Preferably, the HSP crude oil comprises at least 5% by volume of the blend. The process can further comprise feeding the blended crude oils including the HSP oil through a heat exchanger, such as a pre-heat train exchanger or furnace.

[0016] The invention also relates to a process for treating a heat exchange surface in a heat exchanger used for effecting thermal exchange on a process fluid comprising asphaltenic compounds, comprising flushing the heat exchanger by feeding a stream of high solvent power (HSP) crude oil having a solubility blending number (SBN) of at least 80 through a heat exchanger to dissolve asphaltenic compounds precipitated from the process fluid. According to the process, the flush is repeated on a periodic basis to prevent prolonged exposure of deposited asphaltenes and waxes to heated surfaces. Flushing the heat exchanger with the HSP crude oil stream occurs at least four times per year, more preferably at least six times per year, and most preferably every month.

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According to the process, the heat exchange surface is contacted for a period of time of between one to five days for a cleaning soak.

[0017] The invention can include using a blend having an HSP component in the flushing process.

[0018] These and other aspects of the invention will become apparent when taken in conjunction with the detailed description and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will now be described in conjunction with the accompanying drawings in which:

FIG. 1 is a graph illustrating test results showing reduced fouling with use of a blend formulated in accordance with this invention;

FIG. 2 is a graph illustrating test results showing reduced fouling with several different blends formulated in accordance with this invention;

FIG. 3 is a graph illustrating test results from an on-line cleaning simulation;

FIG. 4 is a profilimetry analysis of a whole crude oil fouling run;

FIG. 5 is a profilimetry analysis of a blended crude oil cleaning run; and

FIG. 6 is a profilimetry analysis of another blended crude oil cleaning run.

In the drawings, like reference numerals indicate corresponding parts in the different figures.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0020] This invention is directed to a method of mitigating fouling in heat exchangers, in general. In a preferred use, the method and devices are applied to heat exchangers used in refining processes, such as in refineries or petrochemical processing plants. The invention is particularly suited for use in the pre-heat train equipment, but is also useful for other heat exchangers. Additionally, the invention can be used in pipestills (crude units), cokers, visbreakers, and the like. Of course, it is possible to apply the invention to other processing facilities and heat exchangers, particularly those that are susceptible to fouling in a similar manner as experienced during refining processes and are inconvenient to take off line for repair and cleaning.

[0021] This invention is based on the recognition that it is desirable to clean the heated surfaces of heat exchange equipment before precipitated and/or adhered asphaltenes become thermally degraded and converted to coke. Since coking requires both temperature and time, re-dissolving the asphaltenes before they are converted fully to coke is an effective non-mechanical method of cleaning. It has been found that selected crude oils have a higher solvent power for asphaltenes and that streams of these selected crude oils may be used to remove the precipitated asphaltenes from heat exchanger surfaces before solid, adherent coke deposits can be formed. It is possible to achieve the re-dissolution of the asphaltenes while keeping the exchanger connected to the process unit. This eliminates the need to physically remove and clean the exchanger. In practice, heat exchangers are cleaned on-line by the use of high solvent power (HSP) oil that is admitted to the exchanger and allowed to soak the surfaces for a sufficient period of time to dissolve the asphaltenes. After the period of time, the oil is removed with the dissolved asphaltenes and any loosened deposits,

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recovered and processed in the refinery by conventional refining operations, e.g., by sending to the coker. This concept is disclosed in related application U.S. Serial No. 11/391,258 entitled On-Line Heat Exchanger Cleaning Method, which was filed March 29, 2006, and is now pending. The contents of this related application are incorporated herein by reference.

[0022] The invention disclosed herein uses this basic concept and applies it to blending and maintenance guidelines. According to this invention, an additional step is practiced during blending by adding a high solvent power (HSP) oil to a potentially incompatible blend of oils. By this, instead of avoiding a mixture that will result in asphaltene precipitation, the mixture includes a select component that promotes the dissolution of asphaltenes resulting from an incompatible mix and thereby avoids formation of asphaltenic sediment. The select component includes crude oils that are defined as excellent asphaltene solvent crude oils, referred to herein as high solvent power (HSP) crude oils. HSP crude oils are defined as those with solubility blending numbers (SBN) greater than 80 (SBN>80), preferably SBN>100, and most preferably SBN> 120.

[0023] The inclusion of sufficient volumes of HSP crude oil(s) in a crude blend dissolves asphaltenes that may be out of solution and maintains the state of solubility. When the asphaltene portion of the feed precipitates resulting in solids that can settle and/or be suspended in the oil, the HSP crude oil additive forms a blend in which the asphaltene precipitates are dissolved. Such blending results in overall reduced fouling and a reduction in the associated costs for equipment cleaning, shutdowns, lost efficiencies, etc. As demonstrated below, HSP levels of 50% by volume and greater are quite effective to maintain a state of solubility. Of course, higher HSP levels will realize more effective cleaning results. So, up to 100% HSP oil can be used if desired. For soaking

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applications, concentrations of 50-100% HSP by volume would be suitable. However, it has been shown that even low levels of HSP oil will render benefits. For example, as little as 5% by volume of an HSP crude oil blend has been shown to be effective in field tests in on-line runs in both fouling prevention and on-line cleaning in refineries. In another example, concentrations of 5-20% also produced these beneficial results. Thus, for on-line flushing, low concentrations of 5% and up are effective.

[0024] For soaking applications where the HSP oil, especially a blended HSP oil, is exposed to the tank surface for extended periods to effect deep cleaning, it has been seen in field tests that 24 hours is an effective soaking time. The preferred soak time is between 1 to 5 days, most preferably three days. However, beneficial cleaning results and anti-fouling tendencies have been shown to take effect within 30 minutes of exposure. Thus, flushing times could be less for running an HSP oil or HSP blend through the system and still experience the benefits of the HSP oil.

[0025] To evaluate the relative fouling potentials of crude oils and blends, the commercially available Alcor Hot Liquid Process Simulator (HPLS) is used by these inventors. Alcor runs are carried out by charging the one-liter reservoir with a crude oil or blend, heating the liquid up to 150°C (302°F), and pumping it across a vertically positioned, carbon-steel rod with a flow rate of 3.0 mL/minute. The spent oil is collected in the top section of the Alcor reservoir, which is separated from the untreated oil by a sealed piston, thereby allowing for once-through operation. The system is pressurized with nitrogen at 400-500 psig prior to each test run to ensure gases remain dissolved in the oil during the test. The rod is electrically heated to preset temperatures and held constant throughout the run. The rod surface temperature for the tests is 370°C (698°F). Thermocouple readings are recorded for the bulk fluid inlet and outlet

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temperatures and for the surface of the rod. The heated surface thermocouple is positioned inside the rod.

[0026] During the fouling tests, asphaltenes deposit on the heated surface and are thermally degraded to coke, which builds up on the surface of the test rod. The coke deposit causes an insulating effect that reduces the efficiency and/or ability of the heated surface to heat the oil passing over it. The resulting reduction in temperature is referred to as the outlet liquid Delta T and is dependent on the type of crude oil/blend, testing conditions and other effects. The test time for these runs is 180 minutes. The test allows 30 minutes of stirring and pre-heat within the reservoir prior to the start of the run. The total fouling, as measured by the total reduction in outlet liquid temperature, is referred to as "Delta T₁₈₀." It should be noted that the flow regime for the Alcor system is laminar and therefore direct correlation with field experiences is difficult. However, the unit has been proven to be effective in evaluating differences in relative fouling potentials between crude oils and blends.

[0027] The Alcor unit standard fouling test parameters are as follows:

Flow Rate/Type:	3.0 mL/minute/once through operation
Metallurgy:	Carbon-Steel (1018) heater rods
System Pressure:	400-500 psi
Rod Surface Temperature(s):	370°C (698°F) or 400°C (752°F)
System Temperature Setting (reservoir, pump, lines):	150°C (302°F)
Actual Bulk Fluid Inlet Temperature:	105-120°C (221-248°F)

Example 1

[0028] An incompatible blend of two crude oils (Blend A) was prepared. The SBN and I_n values for Blend A were 30 and 38, respectively. This

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represents an SBN/ I_n ratio of 0.81 and is considered to be a “high-fouling” crude oil blend that has precipitated asphaltenes that can deposit onto heated surfaces and thermally degrade to form foulant. Testing of Blend A in the Alcor unit according to the procedure above resulted in a Delta T_{180} of -92°C. In other words, the liquid outlet temperature was reduced by 92°C as a result of the build up of coke on the rod surface.

[0029] Then, an HSP crude oil with an SBN of 158 was mixed with Blend A in increasing volume proportions. The HSP crude oil had zero Delta T_{180} , or is virtually a non-fouling crude oil under Alcor conditions. Each of the Blend A/HSP crude oil blends was tested in the Alcor unit to determine the changes in Delta T_{180} . The final Delta T_{180} data from each of the runs are plotted in Figure 1 as a function of the amount of HSP crude oil added. The plot shows that as the concentration of HSP crude increases, the relative fouling decreases to significantly lower Delta T_{180} values. With greater than 50% by volume HSP present, the fouling potential was reduced to virtually non-fouling levels. These results demonstrate that the addition of HSP crude oil has a significant effect on reducing the fouling potential of asphaltene-containing crude oils and blends.

Example 2

[0030] The same high-fouling crude Blend A described in Example 1 was also mixed at 50% by volume with other HSP crude oils with differing SBN levels and tested in the Alcor unit. The results are summarized in Figure 2. The curve shows the reduction in fouling from the base case as equal volume amounts of increasing SBN crude oils are present. The bars show the actual SBN values for each of the individual HSP crudes used for each test. These results show that the higher SBN HSP streams have a beneficial impact on the relative degree of fouling.

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[0031] Thus, it can be appreciated that the blends disclosed herein actively promote asphaltene precipitate removal and act as an in-line cleaning force that occurs during processing. Such blends can mitigate the occurrence of fouling by dissolving the asphaltene precipitates before there is an opportunity to foul the heat exchange elements. This eliminates the need for cleaning and promotes efficiency in the heat exchange process.

[0032] Another aspect of this invention uses HSP crude oil in a proactive maintenance schedule to avoid build up of precipitates and possible coking in heat exchange equipment. As described above, fouled heat exchange equipment is generally cleaned off-line by mechanical means or, as in the related application, can be cleaned by soaking with an HSP crude oil. Cleaning is generally preformed once the exchanger's efficiency is reduced to non-profitable levels as a result of coke build up. Off-line cleaning by mechanical means is typically required to remove heavy deposits. The component must be taken out of service and isolated for cleaning. This is also required for cleaning by soaking with an HSP oil. During cleaning, the crude oil blends being processed are re-routed to other exchangers so that the fouled exchanger can be isolated for cleaning. The costs associated with cleaning include the down time of the specific unit, and if necessary the mechanical cleaning, and jet wash flushing with water and other solvents before the exchanger can be returned to service.

[0033] In this invention, an HSP crude oil is periodically flushed through the heat exchangers, preferably the pre-heat train exchangers, to prevent fouling. In operation, a stream of HSP crude oil is fed through a heat exchanger in order to contact the heated surfaces of the heat exchanger to dissolve asphaltenic compounds precipitated from the process fluid. The stream of HSP crude oil can be whole crude having an SBN of at least 80 or can be a blend having an HSP

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component, as described above. The SBN and concentration of HSP will depend on the desired effect and extent of cleaning in combination with the intended flush time. For on-line cleaning and anti-fouling tendency, a blend of 5% by volume or greater of HSP oil will be effective for a flush, while for extended cleaning with a soak of at least 24 hours, a blend of at least 50% HSP by volume would be effective.

[0034] The flush can occur in the entire pre-heat train, in select banks of exchangers, or in individual exchangers. The flush is effected on-line, which reduces or eliminates the need to physically remove and clean affected heat exchangers. Flushing can also be accomplished in pipestills, cokers, and visbreakers, for example.

[0035] The flush occurs on a periodic scheduled basis, rather than when the exchanger's efficiency is compromised, by coke for example. Such an approach will prevent prolonged exposure of deposited asphaltenes and waxes to heated surfaces that would otherwise allow for thermal degradation of the organics to coke, which is difficult to remove with solvents alone. The scheduled flushing should occur at least four times per year, preferably six times per year, and most preferably every month. The flush is effective at a short duration with results seen within 30 minutes or may be designed as a soak for three days, for example.

Example 3

[0036] To demonstrate the benefits of a flush, additional testing was carried out using the Alcor fouling simulation unit. A standard fouling run was made using 370°C (698°F) rod surface temperatures to obtain base case data. It required 15 minutes to heat the rod to this temperature. The same fouling run was repeated, and the fouled rod was kept in place for follow-up cleaning

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testing. First, an HSP whole crude oil with an SBN of 112 was run over the pre-fouled rod. Second, a poor-solvent whole crude oil (SBN=40) was run for comparison. Both of the crude oils are non-fouling crude oils under the conditions used. Fig. 3 shows the results of both test runs. The outlet temperatures obtained as a result of the Alcor rod heating the liquid are plotted. Both base case tests show the crude oil being heated at a linear rate to a maximum of 270-277°C (518-531°F). The HSP cleaning test shows that the crude was heated to 261°C (502°F), or 97% of the base case 270°C, even though the foulant was initially present on the rod. Such foulants normally insulate the heating effect, thereby reducing the efficiency of the surface to heat the liquid. Examining the data from the HSP cleaning run shows that the slope of the outlet temperature increases significantly after 5 minutes, or after reaching 100°C. This is due to the physical removal of the foulant deposit, thereby exposing more of the rod surface and allowing the heat to transfer to the liquid.

[0037] The second cleaning test with the low SBN crude oil shows that the slope did not increase and only a maximum temperature of 232°C (450°F) was achieved. This is due to the non-removal of the pre-formed foulant deposit, or the inefficiency of the heat transfer due to the presence of the foulant deposit. The inset bar graph of Fig. 3 shows the difference in outlet temperature between the high and low SBN whole crude oils. After 5 minutes, the difference between these is only 8°C, whereas after 10 and 15 minutes of heat up time, the difference in outlet temperature is 26 and 29°C, respectively. This reflects the difference in the amount of deposit remaining on the heater rods. In this case in the laboratory environment, the optimum cleaning time or flush time was between about 5 to 20 minutes, preferably between 5 and 15 minutes.

[0038] Figs. 4-6 illustrate additional evidence of selective solvent foulant removal. The results shown in these figures were obtained by testing using

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profilometry, which is an analytical technique that allows the examination of the physical shape of the foulant deposit on the rod. Fig. 4 shows the profile for the base case rod after a whole crude oil fouling run. Fig. 5 shows the profile for the base case rod after a high SBN (SBN=112) crude oil cleaning run. The circled portions having a lower profile show the cleaned portions of the Alcor rod deposit. Fig. 6 shows the profile for the base case rod after a low SBN (SBN=40) crude oil cleaning run. Fig. 6 shows that there is no effect compared to the profile shown in Fig. 4. The results confirm those obtained from the Alcor testing in which only the HSP whole crude oil was capable of removing the foulant deposit and improving the heat transfer efficiency of the system.

[0039] Thus, flushing a heat exchange surface that has been fouled with asphaltene precipitates using an HSP crude oil or an HSP blend for a relatively short period of time will remove a significant amount of deposits and will dissolve those precipitates in solution before deposits occur. Such flushing when conducted on a periodic basis will prevent the surfaces from becoming fouled to an extent that requires off-line cleaning. Implementing a maintenance schedule will ensure that the efficiency of the heat exchanger is not compromised and will reduce or eliminate the need for off-line cleaning. It can be appreciated that significant labor and time savings will be realized.

[0040] It will be recognized by those of ordinary skill in the heat exchanger art that the invention can be applied to any heat exchanger surface in various types of known heat exchanger devices.

[0041] Various modifications can be made in the invention as described herein, and many different embodiments of the device and method can be made while remaining within the spirit and scope of the invention as defined in the claims without departing from such spirit and scope. It is intended that all

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matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

WHAT IS CLAIMED IS:

1. A process for blending petroleum crude oils that reduces organic-based fouling of heat exchange equipment, comprising:

blending two or more crude oils that have a proportion of the oils that precipitate asphaltenes; and

adding a high solvent power (HSP) crude oil defined as a crude oil having a solubility blending number (SBN) greater than 80 to dissolve the precipitated asphaltenes, wherein the two or more crude oils and the HSP crude oil form a blend, wherein the HSP crude oil is at least 5% by volume of the blend.

2. The process of claim 1, wherein the step of blending the two or more crude oils includes:

determining the insolubility number (I_n) for the two or more crude oils,

determining the solubility blending number (SBN) for the two or more crude oils, and

combining the two or more crude oils into a blend such that the SBN/I_n ratio is less than 1.3 and the delta of $SBN - I_n$ is less than 10 such that the blend has a high fouling tendency.

3. The process of claim 1, further comprising feeding the blended crude oils including the HSP oil in a refining process.

4. The process of claim 1, further comprising feeding the blended crude oils including the HSP oil through a heat exchanger.

5. The process of claim 4, wherein the heat exchanger is a pre-heat train exchanger or furnace.

6. The process of claim 4, wherein feeding the blended crude oils through a heat exchanger includes feeding the blend according to a periodic schedule.

7. The process of claim 4, wherein feeding the blended crude oils through a heat exchanger includes contacting a surface of the heat exchanger for at least 30 minutes with the blended crude oils.

8. The process of claim 4, wherein feeding the blended crude oils through a heat exchanger includes contacting a surface of the heat exchanger for at least 24 hours with the blended crude oils.

9. The process of claim 4, wherein feeding the blended crude oils through a heat exchanger includes contacting a surface of the heat exchanger for a period of between one to five days with the blended crude oils.

10. The process according to any one of the preceding claims, wherein the two or more crude oils are incompatible crude oils.

11. A process for treating a heat exchange surface in a heat exchanger used for effecting thermal exchange on a process fluid comprising asphaltenic compounds, comprising:

flushing the heat exchanger by feeding a stream of high solvent power (HSP) crude oil having a solubility blending number (SBN) of at least 80 through a heat exchanger to dissolve asphaltenic compounds precipitated from the process fluid, wherein the stream of HSP crude oil is a blend of an HSP crude oil at 5% by volume and at least two crude oils; and

repeating the flush on a periodic basis to prevent prolonged exposure of deposited asphaltenes and waxes to heated surfaces of the heat exchanger.

12. The process of claim 11, wherein flushing the heat exchanger with the HSP crude oil stream occurs at least four times per year.

13. The process of claim 11, wherein flushing the heat exchanger with the HSP crude oil occurs at least six times per year.

14. The process of claim 11, wherein flushing the heat exchanger with the HSP crude oil occurs every month.

15. The process of claim 11, wherein feeding the stream includes contacting heated surfaces of the heat exchange surface for a period of time of at least 30 minutes.
16. The process of claim 11, wherein feeding the stream includes contacting heated surfaces of the heat exchange surface for a period of time of at least 24 hours.
17. The process of claim 11, wherein feeding the stream includes contacting heated surfaces of the heat exchange surface for a period of time of between one to five days.
18. The process of claim 11, wherein the stream includes two or more incompatible crude oils.
19. The process according to anyone of claims 1-18, wherein the stream of HSP crude oil is a blend of an HSP crude oil at 50% by volume and at least two incompatible crude oils.
20. The process of claim 11, wherein the flushing occurs on-line in a refinery.
21. The process of claim 11, wherein the heat exchanger includes an entire pre-heat train.
22. The process of claim 11, wherein the heat exchanger is a component of a pre-heat train.
23. The process according to anyone of claims 1-18, wherein the HSP crude oil has an SBN of at least 100.
24. The process according to anyone of claims 1-18, wherein the HSP crude oil has an SBN of at least 120.