A fluid heating system and method are disclosed. The apparatus incorporates a two-stage heating system. The first stage uses heat produced by a large, primary heat source, such as a diesel engine. The primary heat source is used to heat a coolant solution contained within a closed loop. The first stage uses one or more high-efficiency liquid-to-liquid heat exchangers. The second stage transfers thermal energy from the heated coolant solution to a secondary fluid. The second stage uses a high-efficiency liquid-to-liquid heat exchanger. The secondary fluid is heated to a temperature suitable for an intended purpose. The secondary fluid may contain petroleum products that may coagulate at low temperatures. Heating such a fluid may be needed for processing of the fluid. By using an intermediary closed coolant loop, the primary heating fluid or fluids are contained in a separate flow loop from the secondary fluid.
OILFIELD HEAT EXCHANGER

BACKGROUND OF THE INVENTION

[0001] Oilfield exploration and production are important to the economies of many countries. Oilfields have been explored and developed all over the world. As time has passed, the search for petroleum has led to a variety of challenging settings. For example, the north slope of Alaska (i.e., the northern-most area of Alaska) has been an important source of petroleum for over 30 years. Conditions in this region can be quite challenging, and are always cold. The petroleum produced in this region is cold. This fact presents certain challenges.

[0002] Offshore oil production has moved into deeper and deeper water over the years. Deepwater drilling and production are now common in the Gulf of Mexico and other areas. Wells in water over 5,000 feet deep are no longer unusual. The water at such depths is very cold. When petroleum products pass through thousands of feet of drill pipe located in very cold water, the result is substantial chilling of the petroleum. By the time the petroleum products reach the surface, the products may be cold enough to coagulate some of the compounds within the mixture produced from the well.

[0003] Tar sands are another source of petroleum. Large tar sands fields exist in Canada. To recover the tar from these fields, steam is pumped into the ground to warm the tar until it will flow. This warmed, liquefied tar is then recovered. In some tar sands operations, the drill pipe runs can extend for many thousands of feet. The heated tar can become cool and quite thick by the time it is recovered from such a site.

[0004] In each of these settings, challenges are created by the cold temperature of the petroleum products. Some petrochemicals will solidify at low temperatures. Gases in solution may become entrained or entrapped within such solids. Water and oil may emulsify at low temperatures, making it difficult to separate the two. These conditions can pose problems ranging from clogging of pipes and pumps to difficulty in separating the components recovered from the well. To eliminate these problems, it is helpful to heat the fluids recovered from the well. Heating can liquefy components that have solidified and can allow gaseous materials to be released. A number of post-recovery processes are inhibited if the petroleum fluids are too cold. Heating provides numerous benefits.

[0005] There are many ways to heat such petroleum fluids. Early efforts involved directly heating the recovered fluids. Heating trucks can be deployed to land-based wells. Such methods may be a variety of means for heating the fluids, including applying direct flame heat to the fluids. Heating the recovered fluids using open flame heat sources is highly effective in that the recovered fluids can be quickly heated to temperatures suitable for processing.

[0006] There are, however, serious risks posed by using open flame heat in this setting. The petroleum fluids may be heated too much, resulting in flashing off (i.e., spontaneous combustion) and possibly an explosion. In addition, if there is a leak in the tubing or piping, the petroleum fluids may be directly exposed to an open flame, which could result in fire or explosion. Moreover, if the petroleum fluid ignites, there is a real risk that the entire production could become engulfed in fire.

[0007] At least partly because of the risks posed by these types of heating systems, such systems are rarely, if ever, used in offshore oil production. For this reason, other heating methods have been developed to eliminate such risks. One such method incorporates a diesel engine as a heat source for fluids to be injected into a wellbore. Certain oilfield operations require the injection of fluids into the wellbore. When this is done, it is sometimes desirable to heat the treatment fluids.

[0008] The diesel engine in this system is used to heat the treatment fluids. The gas exhaust of the engine is used to directly heat the treatment fluids. The hydraulic system of the diesel engine also may be used to heat the treatment fluids. The heated treatment fluids are pumped into the wellbore. This system is disclosed in U.S. Pat. No. 6,073,695. This system is not disclosed as a means for heating petroleum fluids recovered from the well. It is limited to heating treatment fluids to be injected into the well.

[0009] Though this system eliminates the use of an open flame heating process, it does not eliminate all risks. By exposing the working fluid (i.e., the fluid to be heated by the system) directly to the diesel engine components, there is a risk of contamination of either system in the event of a leak in a heat exchanger. The treatment fluids are often acidic and, therefore, corrosive. Such fluids pose a real risk of causing a corrosion-based leak in a heat exchanger. If a leak were to occur in a heat exchanger with the engine's gas exhaust on one side and the treatment fluid on the other side, the flammable treatment fluid could flash off and thus cause a fire or explosion.

[0010] If a leak were to occur in a heat exchanger with hydraulic fluid on the other side, either the hydraulic fluid or the well treatment fluid may be contaminated. This situation could damage the engine-powered hydraulic system. Or such a leak could alter the composition of the well treatment fluid and possibly reduce its effectiveness. The same result could follow if a leak occurred in a heat exchanger with engine coolant or water on one side and well treatment fluid on the other side. Such a leak could contaminate the well treatment fluid and result in a failed treatment.

[0011] A leak of the type mentioned above can create a very costly delay in operations. As petroleum drilling operations move into deeper water and other challenging settings, the daily operating expenses become extremely high. Any breakdown that stops operations, therefore, imposes huge financial costs in these settings. A leak in a heat exchanger caused by exposure to corrosive fluids can lead to a shut down and, thus, can cause substantial economic damage. The lost revenue from production also can be enormous, making the total cost of such a shut down extremely high.

[0012] Using the engine gas exhaust to directly heat the secondary fluid results in less efficient heat transfer than that obtained using high-efficiency liquid-to-liquid heat exchangers. The gas exhaust could experience rapid and large changes in temperature. This fact could lead to a somewhat uncontrolled heating of the secondary fluid. The secondary fluid might be heated very quickly to a temperature higher than that desired.

[0013] These characteristics may not pose problems when the system is used to heat certain well treatment fluids. But these same characteristics could be problematic if used to heat the petroleum products recovered from a producing well. The exact composition of such recovered fluids cannot be controlled. Such fluids might have a lower flash point than well treatment fluids. This difference could result in fire or explosion risks if the heating system were used to heat recovered petroleum products rather than well treatment fluids.
Running recovered petroleum fluids through a heat exchanger with a diesel engine gas exhaust on the other side of the heat exchanger also poses risks. The less-controlled heating produced by such a configuration could lead to too much heating of the recovered petroleum fluid, and thus result in flash off. A leak in such a heat exchanger could result in recovered petroleum fluids entering the diesel engine exhaust system. This could result in fire or other problems.

Other industries may also need a means to safely heat a thick fluid in a controlled manner. For example, in some food industries, thick fluids are easier to process if heated. Some processing steps may require a particular viscosity that can only be obtained by heating the fluid. Because of the need to maintain cleanliness in such a setting, any heating system used must reduce the risk of contamination of the food products.

For these reasons explained above, neither the direct flame-heating systems nor the well treatment fluid heating system are well suited for heating of recovered petroleum products. A better heating system is needed, one that provides controlled heating of the secondary fluid and that reduces risks of contamination, fire, or explosion.

SUMMARY OF THE INVENTION

The present invention addresses the issues identified above. A fluid heating system is disclosed that produces controlled heating of a secondary fluid, while reducing the risks of fire, explosion, or cross-contamination. The invention makes use of a two-stage heating process and a closed coolant loop. The coolant contained within the closed loop flows through one or more primary heat exchangers and through a secondary heat exchanger. Primary heat source liquids flow through the primary heat exchangers and then heat the coolant. The coolant then heats a secondary fluid in the secondary heat exchanger. The secondary fluid, in a preferred embodiment, contains petroleum products produced from an operating oil or gas well.

The present invention also makes use of highly efficient plate heat exchangers rather than shell and tube heat exchangers. The plate heat exchangers are more efficient than shell and tube exchangers in part because of the greater surface area provided by this design.

The invention also includes a method of heating a secondary fluid in a safe and controlled fashion. The method includes use of a closed coolant loop to keep the secondary fluid separate from the primary heat source. The secondary fluid, in a preferred embodiment, is a liquid recovered from an oil or gas well. This fluid enters a mixing vessel which contains secondary fluid recovered from the well and fluid heated by the secondary heat exchanger. By including the step of mixing these fluids in a vessel, the method of the invention produces a more controlled, less variable heating of the secondary fluid. Fluid is removed from the mixing vessel for further processing.

In a preferred embodiment, the present invention includes a first primary heat exchanger; a first primary liquid heat source; a second primary heat exchanger; a second primary liquid heat source; a secondary heat exchanger; a secondary fluid; a closed coolant loop connected to the first primary heat exchanger, the second primary heat exchanger, and the secondary heat exchanger; and, a liquid coolant contained within the closed coolant loop, such that when the system is in operation, the coolant is heated by the first primary liquid heat source and the second primary liquid heat source, and the secondary fluid is heated by the coolant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a preferred embodiment of the present invention.

FIG. 2 is a schematic diagram of an engine water jacket to closed coolant loop heat exchanger section of a preferred embodiment of the present invention.

FIG. 3 is a schematic diagram of an engine hydraulic system to closed coolant loop heat exchanger section of a preferred embodiment of the present invention.

FIG. 4 is a schematic diagram of an engine gas exhaust to closed coolant loop heat exchanger section of a preferred embodiment of the present invention.

FIG. 5 is a schematic diagram of a closed coolant loop to secondary fluid heat exchanger section of a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

A block diagram illustration of the present invention is provided in FIG. 1. A two-stage fluid heating system 10 is shown with three first stage heat exchangers 14, 18, and 22, and a single second stage heat exchanger 26. A closed coolant loop 12 connects the two stages of the system. In the embodiment illustrated in FIG. 1, the closed loop coolant enters a first primary heat exchanger 22. This heat exchanger also has flow lines 24 from a primary heat source. This source could be the engine water jacket of a diesel engine. This primary heat source heats the closed loop coolant.

In FIG. 1, the closed loop coolant then enters a second primary heat exchanger 18, which is heated by a second primary heat source through flow lines 20. The closed loop coolant, after being heated by the first and second primary heat exchangers 22 and 18, enters a third primary heat exchanger 14. This heat exchanger has flow lines 16 from a primary heat source. The closed loop coolant leaving the three primary heat exchangers flows through a secondary heat exchanger 26. A secondary fluid enters and leaves the secondary heat exchanger 26 through flow lines 28. The secondary fluid is the fluid that requires heating, such as the petroleum fluids recovered from a producing oil or gas well.

The present invention provides a means for transferring heat from one or more primary heat sources to a secondary fluid while keeping the primary flow paths isolated from the secondary fluid flow path. The closed loop coolant receives thermal energy from the primary heat sources and then transports that energy to the secondary heat exchanger 26, where the coolant then transfers thermal energy to the secondary fluid.

This general aspect of the present invention provides two important benefits. It prevents cross-contamination of the primary and secondary fluids. This benefit can be important for different reasons in different contexts. In food processing, such separation may be needed for food safety reasons. In the petroleum industry, this separation can prevent or greatly reduce the risk of fire or explosion, a risk described in the background section above.

The second benefit is the buffering effect the two stage system has on the heating process. Any rapid variations in the heat input on the primary side will be buffered by losses in the primary heat exchanger, thermal losses in the closed
The resulting variation in the temperature of the secondary fluid is dampened substantially compared to the variation seen in the primary heat source fluid. This buffering or dampening effect can reduce sudden temperature changes in the secondary fluid.

When the secondary fluids are petroleum products, such as those recovered from producing oil and gas wells, it may be desirable to avoid sudden drastic temperature changes. Petroleum fluids may have relatively low flash points, which can make sudden, large temperature increases dangerous. In addition, such fluids may contain emulsified oil and water or gas trapped within coagulated petroleum solids. Sudden temperature changes can result in sudden changes in viscosity or gas content of the fluid. This type of uncontrolled change in the nature of the fluid can pose problems to pumps and other equipment. For these and other reasons, it may be desirable to heat such fluids in a controlled manner.

The block diagram shown in FIG. 1 is provided for illustration purposes. The actual configuration of heating systems embodying the present invention may include a single primary heat exchanger or may use two or more secondary heat exchangers. Where multiple primary heat exchangers are used—and use of two or more primary heat exchangers is preferred to use of a single primary heat exchanger—those heat exchangers may be arranged in parallel rather than the series configuration shown in FIG. 1. Various pumps, temperature sensors or thermometers, flow rate sensors, and valves would be used in practice, though such parts are not illustrated in FIG. 1.

In a preferred embodiment, the primary heat source is a diesel engine. FIG. 2 shows one portion of the present invention, namely a primary flow loop. A primary heat exchanger 14 is shown, as is a diesel engine 32. The radiator 42 of the engine 32 receives a liquid (e.g., water, perhaps with an anti-freeze and anti-corrosive agent added) through return liquid line 34. In this context, the radiator 42 represents the diesel engine water jacket. Though shown as a separate item from the engine 32, in reality, the water jacket may be integral to the engine. The water (or other cooling liquid) flows through the engine water jacket to cool the engine. This heated liquid can be used in two ways by the present invention.

First, the cooling liquid from the diesel engine water jacket may flow out of the engine 32 and through the lines 34 and 36 to the primary heat exchanger 14. This configuration is the most efficient, but may require too much modification of the engine’s existing cooling system. The second option is to use a liquid-to-liquid radiator/heat exchanger 42 to transfer heat from the heated engine coolant to a primary loop liquid, where the primary loop liquid would then flow through the primary heat exchanger 14. Either option will work. A heated liquid line thermometer 38 and a return liquid line thermometer 40 are used to monitor the temperatures of the primary heating liquid, which flows through the heat exchanger 14, where it heats the closed loop coolant.

A return coolant line 44 with a thermometer 48 is shown connected to the heat exchanger 14. Heated coolant line 46 and thermometer 50 are also connected to the heat exchanger 14. As the coolant flows through the heat exchanger 14, it receives thermal energy from the primary heated liquid. In the embodiment shown, the primary heated liquid is water heated in the diesel engine radiator. In a preferred embodiment, a second primary heat loop is used with the heat source being a hydraulic system powered by the diesel engine. In the embodiment shown in FIG. 3, six hydraulic pumps 52, 54, 56, 58, 60, and 62 are used. These pumps raise the pressure of the hydraulic fluid to a working pressure needed for other purposes. In the process of raising the hydraulic fluid pressure, the fluid is also heated. It is desirable to cool the heated hydraulic fluid before it returns to the hydraulic pumps. The present invention uses a second primary heat exchanger 18 to cool the hydraulic fluid and thereby heat the closed loop coolant. This configuration is an efficient one, making use of the thermal energy created by the hydraulic pumping process to heat a secondary fluid, such as petroleum fluids recovered from a producing oil or gas well.

A hot hydraulic fluid line 64 enters the heat exchanger 18 and a cooled hydraulic fluid return line 66 connects the heat exchanger 18 to an inlet manifold 67 on the inlet side of the hydraulic pumps. A high-pressure hydraulic fluid manifold 68 may be used to combine the hydraulic fluid from multiple pumps, as illustrated in FIG. 3. An isolation valve 70 may be used in one or more of the hydraulic lines to isolate a pump when it is not in service.

The closed loop coolant flows through line 76 and thermometer 72 into the heat exchanger 18. The coolant return line 78 and thermometer 73 are shown in FIG. 3 connected to a coolant pump 74. The closed loop coolant pump 74 could be positioned at any point within the coolant loop. It is shown in the hydraulic heating portion of the preferred embodiment in FIG. 3 for illustrative purposes only.

In the most preferred embodiment, the present invention uses the diesel engine radiator and the hydraulic system as primary heat sources. These are the two heat sources illustrated in FIGS. 2 and 3. Though it is not the most preferred embodiment, the diesel engine exhaust system also may be used to heat the closed loop coolant. This third possible primary heat source is illustrated in FIG. 4.

A primary heat exchanger 22 receives heated liquid, such as water, from the liquid cooled exhaust manifold 88 of the diesel engine 32. The return liquid line 80 and heated liquid line 82 are connected to the exhaust manifold water jacket. Thermometers 84 and 86 are used in the heated line and return line, respectively. The closed loop coolant return line 90 and heated coolant line 92 are connected to the heat exchanger 22. Thermometers 94 and 96 are used to monitor the temperature of the coolant as it enters and leaves the heat exchanger 22.

FIG. 5 shows a secondary heating loop of a preferred embodiment. Heated coolant from the closed loop flows through a secondary heat exchanger 26 through lines 100 and 102. The secondary fluid, which is a petroleum fluid from an operating well in a preferred embodiment, also flows through the secondary heat exchanger 26, and is thereby heated by the hot closed loop coolant. Thermometers 104 and 106 monitor the temperature of the secondary fluid before and after heating, respectively. A secondary fluid pump 108 is used to circulate the secondary fluid through the heat exchanger 26.

The secondary fluid enters the system through an inflow line 110 and leaves the system through an outflow line 112. In the preferred embodiment shown in FIG. 5, both lines are connected to a secondary fluid mixing vessel 114. Cold fluid enters the mixing vessel 114 through inflow line 110. Secondary fluid is removed from the mixing vessel 114 by the
pump 108, which pumps the fluid through the heat exchanger 26. After being heated, the secondary fluid is returned to the mixing vessel 114. Secondary fluid is removed from the heating system by withdrawing fluid from the mixing vessel 114.

[0043] The mixing vessel 114 provides a number of advantages to using a more direct flow loop system. Fluid from a well may enter at a greater rate than fluid is withdrawn from the system, and the mixing vessel 114 accommodates a certain degree of flow imbalance, as the level in the mixing vessel 114 may vary without impacting the performance of the heating system or downstream processing systems.

[0044] The mixing vessel 114 also mixes the incoming fluid with fluid heated by the heat exchanger 26. This process dampens temperature changes of the secondary fluid, because fluid heated by the heat exchanger 26 will be mixed with cold incoming fluid before any fluid is withdrawn for further processing. The mixing vessel 114, thereby helps smooth out the temperature profile of the secondary fluid. This may be advantageous for downstream processing. Once the heating system of the present invention has reached a steady state, outlet secondary fluid temperatures should be relatively stable.

[0045] The heat exchangers of the present invention could be of any efficient design. Many existing heating systems use shell and tube heat exchangers. In the present invention, plate-type heat exchangers are preferred because they are more efficient (i.e., in terms of thermal energy transfer) and less prone to leaks. In shell and tube heat exchangers, long, thin-walled tubes are used. Such tubing may be more prone to damage—and thus to leakage—that the large plates used in plate-type heat exchangers.

[0046] Plate-type heat exchangers provide another important advantage in some of the settings in which the present invention may be used. Most plate-type heat exchangers are field serviceable. The plates may be disassembled and a damage plate or plates may be removed. If replacement plates are available, damaged plates may be replaced. If not, the heat exchanger may be reassembled with one less, or a few less, plates than before. Because the plate-type heat exchangers likely to be used in the present invention have many plates, removing a single or small number of plates is an acceptable field change, as the heat exchanger would continue to perform at close to rated capacity.

[0047] The present invention is expected to be used in deep water and other cold operating environments. These settings involve very high operating costs and potentially high revenue from production. Use of a field serviceable, plate-type heat exchanger provides two important benefits in these settings. First, these exchangers are less prone to damage, as described above. Second, because these exchangers usually are field serviceable, when a problem does occur, the exchangers can be repaired on site, thus reducing any down time resulting from the problem.

[0048] Suitable plate heat exchangers are made by APV. The APV Type N35 plate heat exchangers may be used for all heat exchangers in the system, with different specific constructions used for different exchangers. For example, the engine radiator to coolant heat exchanger may be an APV Type N35, using 88 plates and having a total surface area for heat transfer of 325 ft². The hydraulic to closed loop coolant heat exchanger may be the same type, but with 90 plates. The closed loop coolant to secondary fluid heat exchanger could be the same type with 45 plates. Two secondary heat exchangers may be used depending upon the volume of secondary fluid flow and the temperature change needed.

[0049] The coolant in the closed loop may be any suitable liquid with good heat transfer characteristics. Glycol is a preferred coolant for these purposes, but other fluids would work well, too. Water could be used, but glycol is preferred.

[0050] In a preferred embodiment, the diesel engine is a Cummins QSK 19 engine with 700 BHP @ 2000 rpm and 2200 lb-ft @ 1500 rpm. This Cummins engine has a good track record for reliable performance in a variety of conditions. Engines of this type of often used in oilfield applications, and it is expected that the Cummins QSK 19 engine would be suitable for other uses on a production well. Using the engine as a primary heat source to heat cold crude recovered from the well is an efficient process, as it uses heat already generated by equipment on the platform to heat cold crude recovered from the well. Other diesel engines, and other heat sources, as well, are suitable for the present invention, and the Cummins QSK 19 is merely one of a many potential primary heat sources.

[0051] The preceding description of the invention is meant to identify the invention without limiting the specific details of construction of the system or specific steps of the method. It is to be understood by those of skill in the art that minor variations on the disclosed configurations are within the scope of the invention, and all such variations are not described in detail here because those of skill in the art are fully familiar with such variations. For these reasons, this description is meant to identify and describe the present invention, and should not be read as limitations on the invention.

1 claim:
1) A fluid heating system comprising:
   a) a first primary heat exchanger;
   b) a first primary liquid heat source;
   c) a second primary heat exchanger;
   d) a second primary liquid heat source;
   e) a secondary heat exchanger;
   f) a secondary fluid;
   g) a closed coolant loop connected to the first primary heat exchanger, the second primary heat exchanger, and the secondary heat exchanger;
   h) a liquid coolant contained within the closed coolant loop, such that when the system is in operation, the coolant is heated by the first primary liquid heat source and the second primary liquid heat source, and the secondary fluid is heated by the coolant.
2) A fluid heating system comprising:
   a) a primary heat exchanger;
   b) a primary heat source;
   c) a secondary heat exchanger;
   d) a secondary fluid that contains petroleum products;
   e) a closed coolant loop connected to the primary heat exchanger and to the secondary heat exchanger;
   f) a liquid coolant contained within the closed coolant loop, such that when the system is in operation, the coolant is heated by the primary heat source and the secondary fluid is heated by the coolant.
3) A fluid heating system, comprising:
   a) a liquid-to-liquid, plate-type primary heat exchanger;
   b) a primary liquid heated by a diesel engine, the primary liquid passing through the primary heat exchanger when the system is in operation;
c) a closed coolant loop connected to the primary heat exchanger and containing a coolant, wherein the coolant passes through the primary heat exchanger and is heated by the primary liquid when the system is in operation;
d) a secondary heat exchanger connected to the closed coolant loop, wherein the coolant passes through the secondary heat exchanger when the system is in operation; and,
e) a secondary fluid that passes through the secondary heat exchanger and is heated by the coolant when the system is in operation, and wherein the secondary fluid contains petroleum products recovered from an operating well.

4) The system of claim 1 further comprising a secondary fluid mixing vessel connected to the secondary heat exchanger through secondary fluid flow lines, such that a mixture of heated secondary fluid and unheated secondary fluid is created in the secondary fluid mixing vessel when the system is in operation.

5) The system of claim 1, wherein the first primary liquid heat source is a liquid heated by a diesel engine.

6) The system of claim 1, wherein the second primary liquid heat source is hydraulic fluid.

7) The system of claim 1, wherein the secondary fluid is a mixture of petroleum products recovered from an operating well.

8) The system of claim 1, wherein the closed loop coolant is a glycol solution.

9) The system of claim 1, wherein all heat exchangers are plate-type heat exchangers.

10) The system of claim 1, further comprising a third primary heat exchanger configured to transfer heat from a diesel engine exhaust system to the closed loop coolant.

11) The system of claim 6, wherein the hydraulic fluid is heated by multiple hydraulic pumps.

12) The system of claim 2, wherein the primary heat source is a diesel engine.

13) The system of claim 12, wherein the heat exchangers are plate-type heat exchangers.

14) The system of claim 2 further comprising a secondary fluid mixing vessel connected to the secondary heat exchanger through secondary fluid flow lines, such that a mixture of heated secondary fluid and unheated secondary fluid is created in the secondary fluid mixing vessel when the system is in operation.

15) The system of claim 4, wherein the first primary liquid heat source is a liquid heated by a diesel engine and the second primary liquid heat source is hydraulic fluid.

16) The system of claim 3, further comprising a second primary heat exchanger that is configured to transfer heat from hydraulic fluid to the closed loop coolant.

17) The system of claim 2, wherein the secondary fluid is recovered from an operating petroleum well.

18) The system of claim 2, further comprising a second primary heat exchanger that is configured to transfer heat from hydraulic fluid to the closed loop coolant.

19) The system of claim 18, further comprising a third primary heat exchanger configured to transfer heat from a diesel engine exhaust system to the closed loop coolant.

20) A method of heating a fluid comprising:
a) operating a diesel engine;
b) removing heat from the diesel engine by transferring thermal energy from the engine to a primary liquid;
c) flowing the primary liquid through a first primary heat exchanger, where the primary liquid transfers thermal energy to a closed loop coolant flowing through the first primary heat exchanger;
d) flowing hot hydraulic fluid through a second primary heat exchanger, where the hot hydraulic fluid transfers thermal energy to a closed loop coolant flowing through the second primary heat exchanger;
e) flowing the closed loop coolant through a secondary heat exchanger, where the closed loop coolant transfers thermal energy to a secondary fluid flowing through the secondary heat exchanger, and wherein the secondary fluid is a mixture of petroleum products recovered from an operating well.