April 13, 1948. H. O. LINDGREN 2,439,434

METHOD AND APPARATUS FOR DEWAXING OILS

Filed April 26, 1946

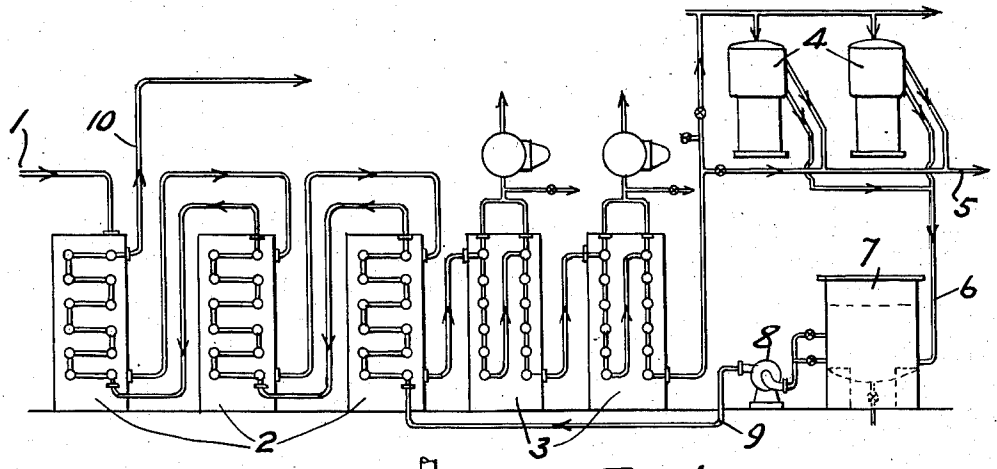


FIG. 1.

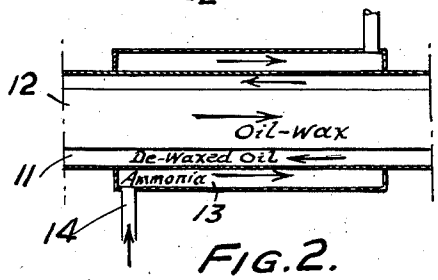


FIG. 2.

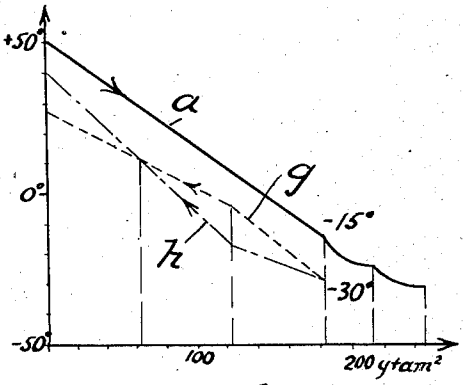


FIG. 4.

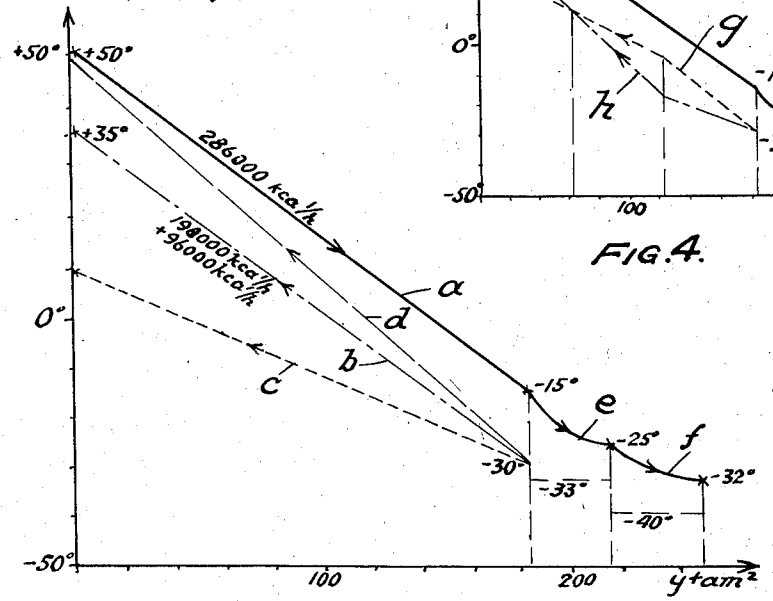


FIG. 3.

WITNESS:
Robt R. Kitchel.

INVENTOR
Hans Olof Lindgren
BY
Bacon and Hardy
ATTORNEYS.

Patented Apr. 13, 1948 2,439,434

UNITED STATES PATENT OFFICE

2,439,434

METHOD AND APPARATUS FOR DEWAXING OILS

Hans Olof Lindgren, Smedslatten, Sweden, assignor to Aktiebolaget Separator-Nobel, Stockholm, Sweden, a corporation of Sweden

Application April 26, 1946, Serial No. 665,238
In Sweden October 8, 1945

13 Claims. (Cl. 196—18)

1

This invention relates to installations for dewaxing mineral oils, tars, distillation products and transformation products thereof, and similar products. From the wax-bearing stock so much wax is removed by centrifuging, filtering or gravity settling that the pour point of the oil is lowered to the point desired. The wax is precipitated by chilling the oil, usually mixed with a solvent. In order to reduce the expense of chilling, the cold dewaxed oil or oil solution is used as a chilling medium in a regenerative installation wherein the wax-bearing stock is chilled. In this way the energy necessary for the corresponding part of the chilling is saved. The further chilling of the wax-bearing stock to the minimum temperature takes place in a separate chiller, working, for instance, with direct ammonia expansion.

As a diluent or solvent, a liquid is used which has a higher solubility for oil than for wax, at low temperature. It may be a solvent lighter than the oil and thus adapted to maintain the specific gravity of the solution substantially below that of the wax, examples of which are any light hydrocarbon liquid, such as naphtha; or it may be a solvent so much heavier than the oil that the specific gravity of the solution will be substantially above that of the wax, examples of which are halogenated hydrocarbons such as ethylene dichloride, trichlorethylene, acetone, butanone (methylethylketone), or mixtures including such solvents. The solvent not only brings about the necessary specific gravity differential between the oil solution and the wax (if the wax is to be removed by centrifuging or gravity settlement), but also facilitates the precipitation of the wax and lowers the viscosity of the chilled liquid. The wax may be removed either as the heavier component, e. g. when using naphtha as a diluent, or as the lighter component, e. g. when using ethylene dichloride as a diluent.

Oil and diluent in suitable proportions, e. g. 1:3 by volume, are usually first mixed at a temperature sufficiently high to bring about complete solution of the oil in the diluent. The solution is then chilled and the precipitated wax is removed.

Some light and thin oils, such as gas oil, spindle oil and transformer oil, may sometimes be dewaxed without using a solvent. For the sake of simplicity both undiluted oil and oil plus solvent, that is oil solution, will be referred to hereinafter as "oil."

When chilling the wax-bearing stock, the temperature differential between the stock and the chilling medium should not exceed certain limits, e. g. 15° C., since the wax may otherwise precipitate in such a condition (crystallize) that it would be difficult to remove. This danger exists especially within a certain temperature range during

2

the chilling. The critical temperature range and the maximum allowable temperature differential vary for different stocks and diluents.

For practical reasons a dewaxing plant will have to be used for different kinds of stock, and the regenerative chilling installation should be arranged so that the chilling surface can be fully utilized under all conditions by maintaining the maximum allowable temperature differential between the oil and the chilling medium. When using a simple regenerative installation this is generally not possible, since the cold dewaxed oil flowing through the regenerative system will be of smaller volume (because of the removal of wax and of some oil and diluent therefrom) than the flow of wax-bearing stock. When these two liquid streams are simply passed in counter-flow through the regenerative system, the temperature differential will thus be smaller at the beginning than at the end of the chilling. Consequently, if the smallest temperature differential is allowed at the end of said chilling, as is often the case, the greater part of the chilling surface of the regenerative system is badly utilized. But even if the stream of cold, dewaxed oil through the regenerative system is equal to or larger than the stream of wax-bearing stock, the chilling surface will be so badly utilized, according to the known methods, that considerable advantages will be obtained by using the process according to this invention.

The present invention relates to a method of dewaxing oils and oil solutions of the kind mentioned above, using a regenerative installation for chilling the wax-bearing stock in direct heat exchange relation in counter-current to cold, dewaxed oil. According to the method, the maximum temperature differential between the heat emitting and the heat absorbing liquid, consistent with the precipitation of the wax in a form favorable for its removal, is maintained in different parts of the regenerative system, by chilling the chilling medium itself. This chilling advantageously takes place at the same time the wax-bearing stock is chilled by means of the wax-free oil.

In the accompanying drawings:

Figure 1 is a diagrammatic view of a dewaxing plant in which the improved process is adapted to be practiced.

Figure 2 is a detail of a suitable arrangement for effecting the chilling of the wax-free oil during the chilling by the latter of the wax-bearing oil.

Figures 3 and 4 show in diagrams how the plant may be made to work under different conditions.

The oil to be dewaxed is fed through the piping 1 to a regenerative system, composed of three heat exchanger chillers 2 provided with scraping machinery for keeping the chilling surfaces free of

precipitated wax and thus ensuring a high heat transfer coefficient. During its passage through the system the stock is chilled (for example) from +50° C. to —15° C., according to the diagram in Figure 3. From the last heat exchanger chiller 2 the oil passes to the two direct ammonia expansion chillers 3, in which the temperature is further reduced to (for example) —32° C. From the last chiller 3, the oil is conducted to the centrifuges 4, working in parallel, where the wax is removed and discharged through the piping 5. The dewaxed oil flows through the piping 6 to the tank 7, and by means of the pump 8 it is taken through the piping 9 into the coldest regenerative apparatus 2 and is passed through the whole regenerative system, in counter-current flow with the wax-bearing stock.

The number of the chillers 2 and 3 and of the centrifuges can of course be varied.

From the warmest regenerative apparatus 2, the dewaxed oil is discharged through the piping 10. The dewaxed oil used as the chilling medium flows in an annular channel 11, whereas the wax-bearing stock passes in counter-current flow through the central channel 12 (Figure 2). The channel 11 is surrounded by a jacket 13 with expanding ammonia introduced through the pipe line 14. Alternatively, another chilling medium than ammonia may be used, and the jacket 13 may be replaced by a cooling coil inserted in the intervening space.

Cooling jackets according to Figure 2 can be inserted at suitable places in one or more or all of the chillers 2 so as to obtain the desired temperature curve of the chilled wax-bearing oil. It is, for instance, possible to fit all the dewaxed-oil pipes with a jacket over their whole length, thereby obtaining a chilling as per diagram in Figure 3, if the chilling medium is introduced at a suitable rate. According to the diagram the wax-bearing stock introduced through the piping 1 gives off 286,000 kg.-cal./hr. in the regenerative system, and the same amount of heat is of course absorbed per hour by the dewaxed oil passing in counter-flow through the heat exchangers. However, the liquid entering through the piping 9 can absorb only 190,000 kg.-cal./hr. The remaining 96,000 kg.-cal./hr. are absorbed through the dewaxed oil by the chilling medium circulating in the jacket 13.

In the diagram, Figure 3, *a* is the temperature curve for the wax-bearing stock, *b* the temperature curve for the dewaxed oil at a constant temperature differential throughout the whole regenerative system, *c* a temperature curve for a temperature differential increasing at higher temperatures and *d* a temperature curve corresponding to a temperature differential decreasing with higher temperatures. In the cases *c* and *d* these curves and the curve *a* will not be, in reality, straight lines.

The curve *d* represents a chilling procedure without a regulation of the temperature according to the invention. As the temperature differential (the vertical distance between the lines *a* and *d*) decreases with higher temperature, the 286,000 kg.-cal./hr. indicated in the diagram cannot be absorbed by the chilling medium, and the rates of flow thus have to be considerably reduced in order to obtain a chilling as per the diagram. The chilling surface will thus be less utilized than if the chilling is carried out according to the invention (the curves *b* and *c*).

If the dewaxed oil is then chilled to such an extent that the curve *c* applies, a still larger amount of heat can be transmitted in the regenerative system, the chilling surface of which is thus still better utilized. This is conditional, however, on an increase of the temperature differential above 15° C. being permitted.

The curves *e* and *f* indicate the drop in temperature of the oil-wax in the chillers 3 in Figure 1, which are operating at ammonia evaporating temperatures of —33° C. and —40° C., respectively.

As already mentioned, the heat exchanger chillers of the regenerative system must be provided with scraping machinery. The price of such chillers per square metre of chilling surface is about 4 to 5 times higher than the cost of ordinary tube and shell chillers. This less expensive type of chiller can be advantageously used for chilling the chilling oil, bearing in mind that the latter is de-waxed and no accumulation of wax on the chilling surfaces need therefore be feared. Furthermore, there is no limitation of the temperature differential between the oil solution and the medium (e. g. ammonia) for chilling it and consequently only a relatively small chilling surface is necessary.

By thus utilizing as far as possible, according to the present invention, the surface of the relatively expensive heat exchanger chillers, the plant investment costs are considerably reduced.

In certain cases it may be advantageous for economical reasons to fit chilling jackets 13 or corresponding chilling coils in the channel 11 or to introduce the chilling medium in such a manner that the temperature curve differs from that according to Figure 3, the minimum or maximum vertical distance between the curves being located somewhere between their extreme ends.

In Figure 4 the curves *g* and *h* represent cases in which the dewaxed oil used as the chilling medium is chilled in the last and the two first chillers 2, respectively, the temperature differential between the two counterflow oil streams thus having a minimum and maximum, respectively, in the piping between the second and the third chillers 2. The best mode of operation will, of course, depend on the temperature differentials which can be allowed at different stages of the chilling, consistently with the precipitation of the wax in the desired form.

The curves *a*, *g* and *h* in Figure 3 will not in reality be straight lines.

As will be seen from Figure 3, the temperature of the dewaxed oil solution conducted to the regenerative system is somewhat (2° C.) higher, due to thermal losses in the centrifuges, pipe lines, etc., than the temperature to which the wax-bearing oil is chilled (in this case —32° C.).

Summarizing.—The essential feature of the invention consists in chilling the dewaxed oil in the course of its flow, in heat exchange relation with the wax-bearing oil, either through the entire course of its flow preceding the ammonia chillers, or through a part of the course of such flow. Further, the amount of heat abstracted from the dewaxed flow in a plurality of loci in which the chilling of the heat absorbing dewaxed oil occurs may be so varied that the flowing dewaxed oil may have any predetermined temperature at each locus so as to maintain at each locus approximately the ideal temperature differential between the direct heat-absorbing medium—the dewaxed oil—and the oil-bearing wax, such ideal temperature difference being as high as is permissible with regard to the size and form of the precipitated wax crystals.

What I claim and desire to protect by Letters Patent is:

1. In the process of dewaxing mineral oils, tars, distillation and transformation products thereof and similar products, in which the wax-bearing oil is chilled in countercurrent heat exchange relation to a flowing heat absorbing liquid and in which wax and substantially wax-free oil are separated from the chilled wax-bearing oil and in which the separated dewaxed oil is utilized as the heat absorbing liquid, the improvement which comprises maintaining throughout the heat exchange system a predetermined temperature differential between the heat-absorbing dewaxed oil and the wax-bearing oil by chilling with a chilling medium the dewaxed oil in the course of its flow in heat exchange relation with the wax-bearing oil.

2. The process defined in claim 1 in which the dewaxed oil is chilled in the course of its flow to the extent required to maintain throughout the heat-exchange system a substantially constant temperature differential between wax-bearing oil and the dewaxed oil.

3. The process defined in claim 1 in which the dewaxed oil is chilled in the course of its flow to the extent required to maintain a temperature differential between the wax-bearing oil and the dewaxed oil that progressively decreases in the course of the flow of the wax-bearing oil.

4. The process defined in claim 1 in which the dewaxed oil is chilled in the course of its flow to the extent required to maintain a temperature differential between the wax-bearing oil and the dewaxed oil that progressively increases in the course of the flow of the wax-bearing oil.

5. The process defined in claim 1 in which the chilling medium for the heat-absorbing dewaxed oil is regulated to absorb different amounts of heat from the dewaxed oil at different loci in the course of the flow of the dewaxed oil in said heat exchange relation with the wax-bearing oil, so as to maintain predetermined temperature differentials between the dewaxed oil and the wax-bearing oil at such different loci.

6. The process defined in claim 1 in which the chilling medium for the heat-absorbing dewaxed oil is regulated to absorb different amounts of heat from the dewaxed oil at different loci in the course of the flow of the dewaxed oil in said heat exchange relation with the wax-bearing oil, so as to maintain approximately the predetermined maximum temperature difference between the dewaxed oil and the wax-bearing oil consistent with the precipitation of the wax in a form favorable to its subsequent removal.

7. The process defined in claim 1 in which the dewaxed oil is chilled during only that part of the course of its flow wherein the desired temperature differential between the unchilled dewaxed oil and the wax-bearing oil is outside a predetermined temperature range.

8. The process defined in claim 1 in which the double chilling, consisting of said chilling of the wax-bearing oil and said chilling of the dewaxed oil, is effected by flowing the dewaxed oil in an annular stream surrounding the flowing wax-bearing oil and by cooling said annular stream with said chilling medium.

9. The process defined in claim 1 in which the double chilling, consisting of said chilling of the wax-bearing oil and said chilling of the dewaxed oil, is effected by flowing the dewaxed oil in an annular stream surrounding the flowing wax-bearing oil and in which the annular stream of dewaxed oil is cooled by surrounding it with said chilling medium.

10. In the process of dewaxing mineral oils, tars, distillation and transformation products thereof and similar products, in which the wax-bearing oil is chilled in countercurrent heat exchange relation to a flowing heat absorbing liquid and in which wax and substantially wax-free oil are separated from the chilled wax-bearing oil and in which the separated dewaxed oil is utilized as the heat absorbing liquid, the improvement which comprises cooling dewaxed oil during its flow through the heat exchange system but after it has passed through part of the system and before it has completed its flow therethrough to thereby, in the earlier part of the heat-exchange between the wax-bearing oil and the dewaxed oil reckoned in the direction of flow of the wax-bearing oil, increase the temperature differential between them above what it would be without such cooling, thereby maintaining a desired temperature differential between the wax-bearing oil and the dewaxed oil through substantially the entire system.

11. The process defined in claim 1 in which the double chilling, consisting of said chilling of the wax-bearing oil and said chilling of the dewaxed oil, is effected by flowing the dewaxed oil in an annular stream surrounding the flowing wax-bearing oil and in countercurrent thereto, and by surrounding said annular stream with an annular stream of said chilling medium flowing in countercurrent to said first annular stream.

12. In an oil dewaxing plant having a device for chilling the wax-bearing oil to a temperature at which the wax precipitates in a form suitable for separation of the wax from the oil, a separator connected to the outlet of said device and operable to separate the chilled product therefrom into wax and dewaxed oil, and a heat exchanger having a duct connected to the inlet of the chilling device for delivering the wax-bearing oil thereto, the exchanger also being connected to the dewaxed oil outlet of the separator, the improvement which comprises two additional ducts in substantially concentric relation to said wax-bearing oil duct, the three ducts defining a central passage, an intermediate annular passage and an outer annular passage, said intermediate passage being connected to flow the dewaxed oil from the separator in countercurrent relation to the wax-bearing oil in one of said central and outer passages, and inlet and outlet connections to the other of said central and outer passages for flowing therethrough a cooling medium in countercurrent relation to the dewaxed oil flow in the intermediate passage.

13. The improvement defined in claim 12, in which said central passage is connected to deliver the wax-bearing oil to the chilling device, the outer passage having said inlet and outlet connections.

HANS OLOF LINDGREN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,748,295	Kelley	Feb. 25, 1930
2,036,374	Tuttle	Apr. 7, 1936
2,085,521	Anderson et al.	June 29, 1937