Patented June 23, 1953

2,642,722

UNITED STATES PATENT OFFICE

2,642,722

LUBRICATION OF STEAM CYLINDERS

Samuel Clyde Vaughn, Berkeley, Calif., assignor to Tide Water Associated Oil Company, San Francisco, Calif., a corporation of Delaware

No Drawing. Application May 25, 1949, Serial No. 95,377

9 Claims. (Cl. 60—64)

1

This invention relates to the lubrication of steam engines and, specifically, to the lubrication of the cylinders and valves of reciprocating steam engines which are operated with "wet" or saturated steam. A particular feature of the invention is the use of a special oil combination in a specific manner with many resulting advantages not hitherto obtained in the art. A specific form of the invention includes the recovery of the steam condensate for re-use.

Briefly, the invention comprises commingling with the steam supplied to the cylinders of an engine a small quantity of a refined low-viscosity oil containing a very small amount of an alkyl acid phosphate sufficient to cause an adequate, though temporary, emulsification of the water present, thereby providing effective preferential wetting and lubrication of the engine parts by the oil while permitting prompt breaking of the emulsion and liberation of water when the exhaust steam is condensed and recovered for return to the boiler.

Although reciprocating steam engines are one of the oldest forms of prime movers, the lubrication of their pistons and cylinders present many problems not present in the lubrication of other types of motive power such as steam turbines and internal combustion engines. Particularly, is this true of reciprocating engines operating on saturated or wet steam, where moisture tends to condense on the cylinder walls and wash off the oil film which is supplied for lubrication. Due to the temperatures and pressures encountered, along with the moisture, lubrication of these engines has, to date, been primarily a compromise between various factors. For example, it is generally recognized that high viscosity oils (i. e. a viscosity above 100 S. U. at 210° F.) are needed to furnish adequate lubrication at the temperatures involved, but, on the other hand, such high viscosity oils generally have high carbon residues and more readily decompose causing carbonaceous deposits on the piston rings and pistons. When the engines are operated in cold weather, such high viscosity oils are difficult to handle and do not meter properly in the oil-injection equipment. Likewise, when the engines are supplied with saturated steam it has been found necessary to add emulsifiers, such as lard-oil or certain soaps, in order to keep the moisture present emulsified with the oil as a water-in-oil emulsion; however, these emulsifiers are extremely troublesome when it is attempted to recover the exhaust steam for boiler water feed. In fact, for this reason, in most modern practice no attempt is

2

made to recover condensate from engines operating on saturated steam, as it is generally preferred to treat additional fresh boiler water than to put up with the problems involved in breaking the oil-water emulsions. Furthermore, high viscosity oils are relatively more expensive, more difficult to refine, and are less available than lower viscosity oils. In addition, the added cost of the emulsifying agent may be appreciable.

Due partly to the enormous viscosities acquired during storage at low temperatures by steam cylinder oils (of suitable viscosity at engine temperatures) derived from naphthene base and other low viscosity-index crudes, Pennsylvania and other high viscosity-index oils are generally used by the trade in spite of their high cost and relative scarcity.

In accordance with the present invention all the above disadvantages present in the conventional lubrication of reciprocating steam engines are either eliminated or greatly alleviated, while attaining a degree of lubrication equal to, and generally exceeding, present practice. To this end I have found that, when a light refined oil of about 55 to 65 S. U. viscosity at 210° F. and containing about 0.015% of an acid alkyl phosphate is commingled with the steam supplied to a steam engine, under the operating conditions occurring in the cylinder and valve chamber the oil will immediately emulsify with moisture present and, upon being deposited on the engine surfaces, will adequately wet and lubricate the working surfaces. The emulsion, however, contrary to those usually encountered in wet steam cylinder lubrication, is of a rather transient nature maintained primarily by the temperatures, pressures, and agitation occurring within the engine, and, though adequate to provide excellent wetting of the engine parts with the oil, the emulsion readily breaks upon being exhausted from the engine and being permitted to remain for a short time in a relatively quiescent zone. Accordingly, by condensing the steam and permitting the condensate to settle for a short period, the condensed water is available for further boiler feed. Likewise, the oil, upon separation from the condensate, may be re-used (at least for one or two cycles) with no more treatment than simple filtration or centrifuging to remove foreign matter.

In order to obtain the benefits of the invention, the base oil used should be a well refined oil of rather critical viscosity limits. I prefer to use an oil of about 55 to 65 S. U. viscosity at 210° F., although a range of 50 to 70 S. U. at 210° F. may be used. Lower viscosity oils are prone to

give inadequate lubrication, while higher viscosity oils do not readily demulsify and separate from the condensate. The base oil should be stable, of low carbon forming tendencies and, before the addition of the alkyl phosphate, should not have emulsifying tendencies. Accordingly the degree of refinement is important to the extent that reactive bodies and non-hydrocarbons (such as olefins, phenols, naphthenic acids, and the like) should be substantially absent. Many refining processes are known to the art which will remove unstable constituents, and any of these are suitable for the preparation of the base oil. Sulfuric acid refining and solvent refining are examples of suitable processes to produce a refined hydrocarbon oil within the requirements of the invention. Since one of the advantages of the invention is the elimination of carbon deposits in the engine, an oil of low carbon-residue is greatly to be preferred.

The percentage of acid alkyl phosphate in the oil is critical. Too small an amount will result in unsatisfactory emulsification with water within the engine, while too much will prevent proper separation of oil from the condensed exhaust steam. A weight percentage of 0.007 to 0.03 may be used satisfactorily, though 0.015% by weight is preferred. The acid alkyl phosphates suitable for use in the invention are the mono or di alkyl phosphates having from 8 to 18 carbon atoms in the alkyl group. They may be mixtures of such alkyl phosphates, and a convenient mixture, now on the market under the trade name of "Ortholeum 162," is understood to be approximately a 50:50 mixture of mono and di alkyl phosphates derived from C_8 to C_{12} alcohols from coconut fatty acids.

The amount of oil to be commingled with the steam and the method of its injection may vary considerably according to individual requirements. By far the best way to inject the oil is by means of the conventional atmoizer placed in the steam line just ahead of the valve chamber. The atomizer should be set to inject from about 1 to 5 pints per 24 hours for engines up to 12 inches in diameter, and proportionately larger amounts for larger engines. For continuous high speed operation (300 R. P. M.) the quantity required may be as little as one pint per 100,000 pounds of steam supplied to the engine. While for slow and intermittent operation somewhat more oil is required, the quantity need not be greater, in most instances than one pint per 2,000 pounds of steam.

The following example is illustrative of the practice of the invention and its benefits.

An 8'' bore steam pump of the slide valve type equipped with cast iron piston and cylinder and mild steel rings was equipped with new rings and piston and placed in operation on 150# gage saturated steam containing some condensed water. An oil having the following characteristics was injected into the steam line by a positive-injection type atomizer at the rate of one pint per 10,000 double strokes:

Type of crude	Mixed base
Refinement	Furfural extraction
Viscosity at 210° F. S. U.	61
Viscosity index	50
Pour point (° F.)	−10
Carbon residue (per cent)	0.04
Acidity (ASTM method D974–48T)	0.03
Color (ASTM method D155–45T)	2
Emulsion number (ASTM method D157–36)	below 600

To the above oil was added, before injection, 0.015% by weight of Ortholeum 162. The exhaust steam was passed through a cooling line sufficient to condense the steam and the condensate was run to a separation vessel. During a residence time in the vessel of about 30 minutes the oil separated from the condensate. After separation water was removed from the bottom of the vessel and returned to the boiler. This water was clean and contained but a trace of oil in suspension. The separated oil was removed at intervals, and inspected and found to be clean enough for re-use after filtration of suspended foreign matter. After three months' operation and, again, after nine months' operation the engine was disassembled and checked for condition and wear. Results are set forth in the following table, together with results expected from conventional operation using a Pennsylvania bright stock of 100 S. U. viscosity at 210° F. plus 10% acidless tallow oil for lubrication.

Time	Start	3 Months	9 Months	Conventional
Strokes (double)	0	3,000,000	9,000,000	9,000,000.
Oil used (gallons)		40	125	200.
Liner I. D. (inches)	8.022	8.024	8.024	
Change		.002	.002	0.01.
Condition of liner	Clean	Clean	Clean	Scored.
Piston O. D. (inches)	7.976	7.975	7.975	
Change		.001	.001	0.01.
Condition of piston	New	Clean	Clean	Dirty.
Ring #1 weight (gm.)	362.0	362.0	357.5	
Change		0.0	4.5	8.0.
Ring #2 weight (gm.)	364.0	363.8	360.2	
Change		0.2	3.8	8.0.
Condition of rings	New	Clean	Clean	Dirty.
Condition of ring lands	do	do	do	Gummed.
Packing of piston rod	do	Good	(1)	(2)
Recovery of condensate		Easy	Easy	Impractical.

[1] Replacement needed.
[2] Usual to replace packing about every three months.

The above table illustrates the many advantages to be gained by the practice of the invention over conventional practice in the lubrication of steam cylinders, resulting in better lubrication while providing a means whereby steam condensate may be recovered.

In the appended claims the term alkyl acid phosphate is intended to mean either a single alkyl acid phosphate or a mixture of two or more alkyl acid phosphates.

I claim:

1. In the lubrication of the cylinders of steam engines, the improvement which comprises supplying to the cylinder walls of a steam engine operating on saturated steam a refined hydrocarbon oil having a viscosity not over 70 S. U. at 210° F. and containing from about 0.007% to

about 0.03% by weight of alkyl acid phosphate having from 8 to 18 carbon atoms in the alkyl group.

2. In the lubrication of the cylinders of steam engines operating on saturated steam, the improvement which comprises commingling with the steam supplied to such cylinders a refined hydrocarbon oil having a viscosity not over 70 S. U. at 210° F. and containing from about 0.007% to about 0.03% by weight of alkyl acid phosphate having from 8 to 18 carbon atoms in the alkyl group.

3. The improvement specified in claim 2 in which the specified oil is injected in the form of a fine mist into the steam immediately before the steam enters the engine and is so furnished at a rate not exceeding one pint per 2,000 pounds of steam.

4. The improvement specified in claim 2 wherein the alkyl acid phosphate is a mixture of mono-alkyl phosphates and di-alkyl phosphates derived from C_8 to C_{12} alcohols obtained from coconut fatty acids.

5. The method of lubricating the cylinders of reciprocating steam engines operating on saturated steam, which comprises spraying into saturated steam supplied to a reciprocating steam engine a refined oil having a viscosity at 210° F. of 50 to 70 S. U., and regulating the character of the emulsion formed by said oil and moisture in the cylinders of said engine under operating conditions by providing as a component of said oil from 0.007% to 0.03% of an emulsifier consisting of alkyl acid phosphate having from 8 to 18 carbon atoms per alkyl group.

6. The method of lubricating the cylinders of reciprocating steam engines operating on saturated steam while recovering exhaust steam for boiler feed water, which comprises spraying into saturated steam supplied to a reciprocating steam engine a refined oil having a viscosity at 210° F. of 50 to 70 S. U., supplying to said steam as a component of said oil from 0.007% to 0.03% of alkyl acid phosphate having from 8 to 18 carbon atoms per alkyl group whereby said phosphate causes said oil to form a temporary emulsion with moisture in the cylinders of said engine under operating conditions, condensing the exhaust steam, permitting the resulting condensate and oil emulsion to settle, decanting the resulting water layer from the resulting oil layer and introducing said water into a boiler as feed water.

7. The process of claim 6 in which the specified oil is sprayed into the steam at a ratio not exceeding one pint of oil per 2,000 pounds of steam.

8. The process of claim 6 in which the alkyl acid phosphate is a mixture of mono-alkyl phosphates and dialkyl phosphates derived from alcohols obtained from coconut fatty acids.

9. As a new composition adapted for use as a lubricant for cylinders of steam engines, a refined hydrocarbon oil having a Saybolt viscosity between 50 and 70 at 210° F. having dissolved therein from about 0.007% to 0.03% by weight of an alkyl acid phosphate containing an alkyl group of from 8 to 18 carbon atoms.

SAMUEL CLYDE VAUGHN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
409,698	Murphy	Aug. 27, 1889
462,275	McGahan	Nov. 3, 1891
1,197,873	Tremain	Sept. 12, 1916
1,353,081	Stack	Sept. 14, 1920
1,778,447	Burkhardt	Oct. 14, 1930
2,084,531	Lazar	June 22, 1939
2,167,867	Benning	Aug. 1, 1939
2,215,956	Downing	Sept. 24, 1940
2,231,167	Lazar	Feb. 11, 1941
2,290,859	Burk	July 28, 1942