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WATER-SOLUBLE CUTTING COMPOUND AND METHOD OF MANUFACTURE

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This invention relates to improvements in metal cutting compounds or fluids adapted to cool metal cutting tools and facilitate their cutting action, and to improved process for making such compounds.

The invention relates more particularly to a water soluble cutting compound and method of manufacture from inexpensive base material.

Many types of cutting compounds are manufactured and used, but for the most part such compounds are either oils used directly or oils which are emulsified in water and do not give a clear solution. Furthermore, many of the presently used compounds are made from animal and vegetable oils which are relatively expensive, whereas, according to the present invention, the base material is a relatively inexpensive crude petroleum oil.

The primary object of the present invention is to provide an improved cutting compound or agent which is soluble in water and which gives a relatively clear solution.

Another object of the invention is to provide an improved process for manufacturing a water soluble cutting compound from crude petroleum oils.

A further object of the invention is to provide a relatively transparent cutting compound which will permit observation of the cutting tool and the metal being cut.

In general, the improved process of the present invention comprises the substantial conversion of a crude petroleum oil into an intermediate reaction product by reacting the crude oil at moderate temperature with an active inorganic halide and chlorine in the presence of a catalyst. The intermediate reaction product is thereupon subjected to a sulfonation operation to produce a tarry mass which is diluted with water, neutralized to Congo red indicator and concentrated to provide the base for the metal cutting compound. This base may then be diluted with the desired proportion of water and is ready for use in any desired cutting operation, the dilution depending to some extent upon the requirements of the particular cutting job.

While the invention is subject to considerable variation and modification in the manner of its particular application, particularly as regards the kind and proportions of the petroleum oil and reagents and the method of procedure, the following example will serve to illustrate the method of preparing the improved cutting compound.

Example

A batch of Duvall crude oil having an A. P. I. gravity of about 21 and comprising 275 cc., was heated to a temperature of from 300° to 350° F. and introduced into a vertical retort substantially filled with loose graphite chips. The retort was maintained in this temperature range, and a small stream of chlorine gas was introduced into the bottom of the retort and bubbled through the oil therein at a rate of about one gram per minute. After the flow of chlorine had been started through the retort, the upper end thereof being vented, 5 cc. of PCl_3 was slowly introduced into the bottom of the retort and flushed in with an additional 50cc. of the Duvall crude oil. These steps required eight or ten minutes, after which the introduction of the chlorine was continued for a period of thirty minutes, while the temperature in the retort was held within the range of 300° to 350° F.

The intermediate reaction product formed by the above procedure was withdrawn from the retort through a drawoff valve at the bottom and comprised approximately 323 cc. of liquid having a specific gravity of 0.93 (300 gms.). The retort was found to be clean and free of any sludge. The 300 gms. of intermediate product was cooled to room temperature and then treated with 45 grams of chlorosulfonic acid added slowly to avoid overheating and foaming, and the resulting mixture was permitted to react with mild stirring for a period of about two hours. The resulting material comprised an upper layer of black tarry viscous material, and a lower liquid oil layer which was separated and reserved for further treatment. The tar-like material comprising 138 gms. was dissolved in 290 cc. of water, by warming, and was then neutralized to Congo red with a 25% solution of sodium hydroxide, 17 gms. of NaOH being required.

The neutralized material comprising approximately 493 gms. was concentrated by evaporation to about 146 gms. The resulting concentrate separated into two layers, the upper of which was a brown viscous mass, while the lower layer comprised a highly fluorescent aqueous solution. The upper layer of 123 gms. and comprising the desired product, was dissolved in water to give a specific gravity of from 1.055 to 1.065, then settled (centrifuging may be used) to remove any water-insoluble residue. In this instance 350 gms. of water were required to give the solution a specific gravity of 1.060. This material is a concentrate and is not intended to be used di-

rectly, but should be diluted to at least approximately 20 to 1 with water. Dilutions as high as 50 to 1 have been successfully used as a cutting compound.

The concentrate is a water solution and gives a clear or transparent solution even with rather hard water. It has a water hardness tolerance in excess of 225 parts per million. At dilutions of 20 to 1, the cutting compound is inherently inhibited against the staining or corrosion, including rusting, of iron and steel and in fact on drying in contact with iron or steel will form a thin, elastic film which will protect iron and steel from corrosion by normal atmospheric influences. However, since the concentrate is an effective cutting aid at dilutions to 50 to 1 or more, it is preferred to reinforce its natural properties by first adding 5% sodium hydroxide solution until it is alkaline to red litmus followed by the addition of 1 to 2% by volume of a corrosion inhibitor such as triethanol amine. A slight tendency of the concentrate to foam on dilution is reduced by the addition of 0.10% by volume of an antifoaming agent such as octanol. The original concentrate has a pH of approximately 5.2. After treatment with sodium hydroxide, triethanol amine and octanol, the pH is in excess of 7.0.

The effectiveness of the metal cutting compound of the present invention was compared with that of a commercial product sold widely throughout most of the United States by diluting each concentrate with ordinary tap water to a dilution of 50 to 1. The commercial product produced a white emulsion-like composition which had the appearance of milk and was definitely opaque. The concentrate or base of the present invention produced a substantially transparent solution which however was somewhat brownish in color because of the hardness of the water. These 50 to 1 dilution products were tested under identical conditions with gradually increasing loads in a test machine. The compound made from the commercial product served satisfactorily up to a pressure of approximately 500 lbs., at which point it became inoperative and the metal surfaces in the test machine were welded. The cutting compound produced with the product made in accordance with the present invention gave smooth and satisfactory operation throughout the entire test wherein the load on the test machine was increased to 1000 lbs.

The Duvall crude oil (from Duvall County, Texas) of the type used in making the improved cutting base in accordance with the foregoing example contains substantially no low boiling constituents, has a specific gravity of 0.927 (A. P. I. gravity 21.1°) contained 0.55% of sulfur, has a pour test of 5° F. and a Saybolt universal viscosity at 100° F. of 238 Sec. A distillation of the Duvall crude showed no gasoline, naphtha or kerosene content, 33.9% gas oil having a specific gravity of 0.870, the remainder being high gravity constituents ranging from a specific gravity of about 0.90 to 0.96. In subjecting the Duvall crude to distillation at 753 mm. very little was taken overhead at 437° F. and only 14% up to a temperature of 482° F. 30.6% was distilled over up to 527° F.

In carrying out the improved method of the present invention, the original conversion operation may involve the treatment of other heavy petroleum oils, although crude petroleum oils of a naphthenic nature (as is Duvall) are preferred. The conversion reaction may likewise be carried out in the presence of other catalysts which are equivalent to graphite, such for example as activated carbon, activated charcoal, silica gel and other adsorbent catalysts such as activated clays and fuller's earth. The conversion reaction carried out in the retort may also be promoted by other active inorganic halides which are equivalent to the preferred PCl_3, such for example as $AlCl_3$; BCl_3; $FeCl_3$; $AlBr_3$; $SbCl_3$; $SnCl_3$; and $ZnCl_2$. Instead of using chlorine as the chlorinating agent, other equivalent chlorine-containing agents adapted to chlorinate some of the constituents in the oil during the conversion operation may be employed. The reaction product contained in the retort may likewise be subjected to sulfonation with other sulfonating agents such as SO_3, fuming sulfuric acid, or other equivalent materials. The neutralization step likewise may be carried out by the use of any water soluble alkali other than NaOH, such for example as KOH. The final diluted product should have a pH of from 6.7 to 7.5.

The chemical constitution of the improved cutting agent of the present invention has not been determined, and therefore it is to be understood that the invention is not to be limited by any theory or supposed type of reaction. However, the improved cutting compound is known to be of exceptional quality and effectiveness. This is probably due, at least in part, to the simultaneous treatment of the high gravity oil with the chlorinating agent and the active inorganic halide. In any case it is definitely known that the presence of PCl_3 prevents sludging of the oil in the step of effecting its chlorination. The preferred product comprises carbon compounds containing chemically combined phosphorus, chlorine and sulphonate groups. The invention contemplates products containing other electropositive atoms of active inorganic halides in place of phosphorus as indicated above.

Since it is apparent that different embodiments of the invention may be made within the spirit of the invention as described and illustrated herein, it is to be understood that the invention is not to be limited to the example or specific description except as so limited by the following claims.

Having thus described the invention in its preferred form, what is claimed as new is:

1. The method of making a compound for use in cutting metals, which comprises treating a heavy petroleum oil with chlorine in the presence of an active adsorbent catalyst and a reactive inorganic halide at a temperature of from 300° to 350° F. to convert a substantial proportion of the oil into an intermediate reaction product, treating the said product with chlorosulfonic acid for a substantial period of time and thereby producing a tar-like viscous mass as an upper layer, dissolving the tar-like mass in water and neutralizing the resulting solution with a water soluble alkali using Congo red as an indicator.

2. The method defined by claim 1 in which the heavy petroleum oil is a crude oil of the type of Duvall crude petroleum.

3. The method as defined by claim 1 in which the neutralized solution is concentrated to cause separation of undesirable constituents and thereafter dissolving the desirable portion in water.

4. The method as defined by claim 1 in which the heavy petroleum oil is treated with chlorine in the presence of graphite and phosphorus trichloride.

5. The method of preparing a cutting agent

adapted to facilitate the cutting of metals which comprises, treating a heavy petroleum oil with a chlorinating agent in the presence of an adsorbent catalyst and a reactive inorganic halide at a temperature in the neighborhood of 350° F., treating the resulting reaction product with a sulfonating agent under conditions adapted to prevent overheating to produce the desired reaction product as an upper layer, diluting the reaction product with water, and neutralizing the resulting diluted reaction product to Congo red with a water soluble alkali.

6. In the manufacture of water soluble cutting agents from heavy petroleum oils, the improvement which comprises reacting and converting the heavy petroleum oil with chlorine in the presence of a catalyst adapted to favor the chlorination of the oil and a reactive inorganic halidle, subjecting the resulting reaction product to treatment with a sulfonating agent under conditions adapted to prevent overheating to produce the desired product as an upper layer which is separated out, diluting the resulting reaction mixture with water, and neutralizing it with a water soluble alkali to provide a product having a pH value of approximately 7 plus.

7. A transparent water soluble metal cutting compound having a pH value of approximately 7 and a specific gravity in excess of one, said compound being prepared by reacting a heavy petroleum oil with chlorine in the presence of a chlorination catalyst and a reactive inorganic halide at a temperature of approximately 350° F., after which the resulting product is sulfonated and the sulfonation product separated from unreacted material and neutralized with a water soluble alkaline solution.

8. A mixture of water soluble carbon compounds adapted for use as a metal cutting material obtained by reacting a heavy petroleum oil with chlorine, with an active inorganic halide and with a sulfonating agent after which the resulting mixture of water-soluble compounds are separated out and neutralized, said mixture of water soluble carbon compounds being in aqueous solution and having a pH value of approximately 7 plus.

9. A water soluble cutting compound adapted for use in metal cutting operations at dilutions of 80 parts water to one part of compound, comprising a product having a specific gravity greater than that of water and a pH value in water solution of from 6.7 to 7.5, said product being produced by treating a high gravity naphthenic petroleum oil with a chlorinating agent, PCl_3 and a sulfonating agent, after which the compound is separated out, dissolved in water and neutralized.

10. A cutting oil compound as defined by claim 9 in which a concentrate containing approximately three parts of water to one part of the compound has a water hardness tolerance in excess of 200 parts per million.

11. A water soluble product adapted for use as a cutting agent when dissolved in a relatively large proportion of water, comprising a reaction product obtained by treating a high specific gravity petroleum oil with a chorinating agent in the presence of an adsorbent catalyst and a reactive inorganic halide, the resulting material then being treated with a sulfonating agent, the resulting reaction product separated out and finally dissolved in water and neutralized with an alkali.

12. The method of manufacturing a cutting agent adapted to facilitate the cutting of metals, which comprises treating a heavy naphthenic petroleum oil with a chlorinating agent and with PCl_3 to make a product containing combined phosphorus, treating the said product with a sulfonating agent to sulfonate said product, separating the resulting water-soluble sulfonated product and diluting it with water, and neutralizing the resulting water solution to Congo red with a water-soluble alkali.

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