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METHOD OF CLEANING METALS

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The present invention relates to a process for cleaning metal articles without the use of acid to condition the surface of the article for the reception of a protective coating such as zinc, tin, enamel and the like.

The invention is based on the discovery that ferrous metals and steel in particular can be rapidly and effectively cleaned by exposure in a heated condition to an atmosphere comprising the products of combustion of a hydrocarbon fuel which has been burned with chlorine and air in certain relative proportions.

The invention can best be explained in connection with the accompanying drawing forming part of this specification, and wherein Fig. 1 shows a simple arrangement of apparatus adapted to the practice of the process. Fig. 2 is a vertical cross section on line 2—2 of Fig. 1.

The metal to be cleaned is indicated as a strip 1 which unwinds from a suitably supported coil 2. The atmosphere by means of which the metal is to be cleaned flows through a heated chamber 3 through which the metal to be cleaned is caused to pass. This chamber is shown as a muffle which extends through a furnace 4 provided with burners 5 for maintaining the muffle at a predetermined temperature as hereinafter explained. Before entering the muffle 3 the strip is preferably passed through a preheating furnace 6 which is preferably open fired as indicated by the burners 7 to the end that oils and the like which may be present on the strip may be readily burned off. The processing to which the metal or strip 1 is subjected after having passed through the muffle 3 is of secondary importance insofar as the present invention is concerned. Thus it may be passed directly into a cooling zone or tunnel 8 wherein a non-oxidizing atmosphere is maintained and after having been cooled to below oxidizing temperature may be washed with water and then dried preparatory to being wound up on a reel 9. The wash water is shown as contained in a tank 10 into which the strip exit end of the tunnel 8 extends. 11 indicates a pair of pipes from which jets of air may be directed against the strip for drying the same. 12 indicates a vent pipe which leads from the tunnel 8 above the water level in the tank 10 to an exhaust pump as an injector 13, thus preventing steam from the wash water from backing up into the tunnel.

14 indicates a refractory combustion chamber wherein the hydrocarbon fuel is burned with chlorine and air to produce the metal cleaning gas of the present invention and 15 indicates a

conduit for conducting the products of combustion of such burning to the muffle 3, the preferred point of delivery being where the cooling zone or tunnel 8 may be said to begin as indicated at 16 whereby some of said products flow in the tunnel 8 to constitute a non-oxidizing atmosphere therein and the balance flows toward the front or strip-entering end of the muffle. 17 indicates a burner for delivering the hydrocarbon fuel, chlorine and air in a premixed condition to the combustion chamber 14.

Although the products of combustion from the combustion chamber 14 may be utilized without dilution they are so potent or corrosive that it is preferred to utilize them in diluted form. Nitrogen is an ideal diluent but, on the other hand, is relatively expensive in pure form. However, I have found that "flue gas," that is to say, products of combustion of any ordinary fuel burned with air alone, may be used as a diluent provided that excess water vapor has been removed. I prefer to produce this flue gas by burning a preformed mixture of ordinary fuel gas such as natural gas with its full complement of air for complete combustion in a combustion chamber 18 to which the mixture is delivered by a burner 19 and then to cool and wash the resulting combustion products by passing them through an ordinary gas scrubber 20 into which cold water is sprayed as by a spray head 21. The washed gases are then ready for use as a diluent.

The preferred place of adding the diluent to the cleaning gas is at a mixing chamber 22 at the discharge end of the combustion chamber 14 where said cleaning gas is produced. 23 indicates a pipe for conducting the diluent from the scrubber 20 to said mixing chamber. The volume of diluent added at the point 22 may, of course, be varied to suit operating conditions but ordinarily will be enough to lower the temperature of the combustion products from the combustion chamber 14 to such degree that on delivery at the point 16, the temperature will be sufficiently low to avoid heating of the strip as it enters the cooling zone or tunnel 8 from the muffle 3.

25 indicates a side outlet in the muffle for the exit of the spent cleaning gas therefrom, it being noted that this outlet is inside of the muffle furnace 4 near the front end thereof. The said outlet is therefore just as hot as the muffle thereby insuring that the outlet will not become plugged by condensation of vaporized solids present in the cleaning gas as a result of its cleaning action on the strip passing through the muffle.

Within the furnace 4 is an upright tube 26 whereinto which the outlet 25 discharges, this tube extending downwardly through the bottom of the furnace and into liquid in a tank 27 directly therebelow. To prevent the vaporized solids in the spent cleaning gas from condensing on the inside walls of the tube with consequent eventual plugging of the tube, water is flowed into the tube through a circumferential passage shown as holes 28 in connection with a source of supply of water as in a water jacket 29 around the tube where it passes through the bottom of the furnace. The water thus admitted to the tube flows down along the inside walls thereof and into the tank 10 as will be readily understood. 30 indicates a water supply pipe delivering to the water jacket 29. From the tube 26 the gas flows into an offtake 31 and thence preferably into a wash tower 32 for the removal of objectionable compounds before being vented to the open air. An injector 33 may be provided at the top of the tower to insure proper draft on the offtake 31.

The hydrocarbon fuel which is to be burned with chlorine and air in the combustion chamber 14 is preferably natural gas (methane). Methane, if burned with air alone, requires about ten volumes of air to one of methane for complete combustion. In accordance with the present invention the amount of air used is substantially less than this and may vary from about four to seven volumes of air to one of methane depending on the amount of chlorine used. Thus for two volumes of chlorine about four volumes of air would be used and for one volume of chlorine about seven volumes of air would be used. Within this range of relative proportions of air and chlorine, the general rule for varying the same may be stated as follows: Taking the ten volumes of air that are normally required for the complete combustion of one volume of methane as unity, then for each three-tenths deficiency in the normal volume of air approximately one volume of chlorine should be used. For example, if six volumes of air to one of methane are used then there should also be used about one and one-thirds volumes of chlorine. The most satisfactory relative proportions of the constituents of the combustible mixture for any given type of metal surface to be cleaned can be readily determined by observing the cleaning effect of the cleaning gas in the muffle 3. Ordinarily thorough cleaning should be effected in less than a minute or a few minutes at the most at the preferred temperature of operation.

The minimum temperature of the metal to be cleaned and the minimum temperature of the muffle 3 through which the metal is passed need not necessarily be the same. Thus the minimum temperature of the muffle will usually be above 1000° F. whereas the minimum temperature of the metal to be cleaned need not be much above 600° F. for a noticeable cleaning effect to be produced if the time of exposure to the cleaning gas is long enough. However, for speedy cleaning the temperature of the metal should be substantially higher than 600° F. In general, the higher the temperature of the metal, the more rapidly can it be cleaned. However, in practical operation it has been found that the best overall operating results are obtained when the temperature of the muffle 3 is maintained at from 1150° to 1250° F. Higher temperatures may be used but with very little, if any, gain in overall operating efficiency.

It will be understood that the surface of the

metal after cleaning will have an etched or grained appearance regardless of whether the original surface was bright as from cold reduction or scaled as from hot reduction.

Due to the rapidity with which cleaning can be effected (in a matter of seconds or a few minutes at the most) the process is particularly well adapted for use as an in-line operation as for example an operation preceding continuous galvanizing. Other advantages of the invention will be apparent to those skilled in the art to which the invention appertains.

The use of an atmosphere prepared as herein described for the cleaning of metals is believed to be basically new in the art.

This application is a continuation-in-part of my application Serial No. 316,107, filed January 29, 1941.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of treating a metal article for the purpose described which comprises exposing the article at a temperature above 600° F. to an atmosphere comprising the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with substantially less air than would normally be required to support complete combustion of the fuel if burned with air alone.

2. The method of treating a metal article for the purpose described which comprises exposing the article at a temperature above 600° F. to an atmosphere comprising the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with from four tenths to seven tenths of the volume of air that would normally be required to support complete combustion of said fuel if burned with air alone.

3. The method of treating a metal article for the purpose described which comprises exposing the article at a temperature above 600° F. to an atmosphere comprising the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with from four tenths to seven tenths of the volume of air that would normally be required to support complete combustion of said fuel if burned with air alone, the amount of chlorine used being inversely proportional to the amount of air used.

4. The method of treating a metal articles for the purpose described which comprises passing the article through a chamber maintained at a temperature above 1000° F., and maintaining in said chamber an atmosphere comprising the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with substantially less air than would normally be required to support complete combustion of said fuel if burned with air alone.

5. The method of treating a metal article for the purpose described which comprises passing the article through a chamber maintained at a temperature above 1000° F., and maintaining in said chamber an atmosphere comprising the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with from four tenths to seven tenths of the volume of air that would normally be required to support complete combustion of said fuel if burned with air alone, the amount of chlorine used being inversely proportional to the amount of air used.

6. The method of treating a metal article for the purpose described which comprises passing the article through a chamber maintained at a

temperature above 1000° F., and maintaining in said chamber an atmosphere comprising a substantially dry flue gas and the products of combustion of a hydrocarbon fuel burned with a substantial amount of chlorine and with substantially less air than would normally be required to support complete combustion of said fuel if burned with air alone.

7. The continuous method of treating a metal article for the purpose described which comprises burning a hydrocarbon fuel with a substantial

amount of chlorine and with substantially less air than would normally be required to support complete combustion of said fuel if burned with air alone, diluting the hot products of combustion of said burning with a substantially dry flue gas, maintaining a treating chamber at a temperature above 1000° F., delivering to said treating chamber the said products of combustion diluted as said, and passing the article through said treating chamber.

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