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HEAT-STABLE RUST INHIBITORS

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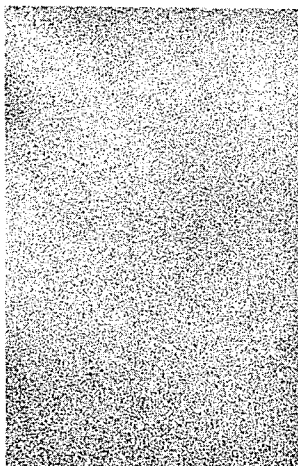


Fig. 1

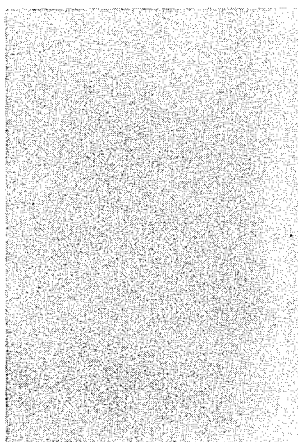


Fig. 2

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HEAT-STABLE RUST INHIBITORS

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5 Claims

ABSTRACT OF THE DISCLOSURE

In a process for inhibiting formation of rust on cold rolled ferrous strip, the strip, either during the rolling operation or subsequent to it, but prior to annealing, is treated, as by spraying, with an aqueous suspension of calcium hydroxide. The heat-resistant solid component of the suspension dries on the strip as a semi-adherent coating, and protects the strip from rusting during storage and shipping.

BACKGROUND OF THE INVENTION

This invention relates to a method of improving the rust resistance of ferrous strip, and more particularly to the use of a heat-stable rust inhibitor for cold rolled strip.

Cold rolled annealed steel strip has considerable susceptibility to rusting, due to deposition of chlorides from processing water. This susceptibility is especially pronounced when it is necessary to store and ship the strip in coiled form, or in lifts of cut lengths, in varying atmospheric conditions. Steel, as continuous lengths in coil form or as cut sheets packed in lifts, tends to develop speckled rust. Due to the large tonnage generally produced in a cold reducing mill, it is not always practical to maintain a non-corrosive atmosphere in all storage bays and shipping facilities. Also, because of the large tonnage involved, certain steps which might be taken to inhibit rusting are ruled out due to costly extra handling operations.

The most efficient method of applying an inhibitor material to the strip is by making such application as the strip comes off the cold reducing tandem mill. However, the well-known inhibitors are, for the most part, volatile materials which are removed or completely decomposed during the annealing step subsequent to cold rolling.

When inhibitors are applied to the strip after annealing, the strip must be uncoiled during application and then recoiled—an expensive operation. Certain mineral oils and wash oils have been used on strip after annealing with varied success. When oil is used as inhibitor, it must be completely removed before the strip is subjected to certain forming or finishing operations.

It is an object of this invention to inhibit rusting by application of a heat-stable inhibitor prior to coiling for annealing.

Another object is to develop a heat-stable inhibitor which is both inexpensive and readily applicable.

A further object is to provide a rust inhibiting method which does not require removal of an oil-base inhibitor after use.

SUMMARY OF THE INVENTION

I have found that each of the foregoing objects can be attained by coating the strip before annealing with a thin layer of calcium hydroxide.

The calcium hydroxide compound is applied to steel strip by spraying with, or immersing in, preferentially, a thin aqueous suspension of the compound. By applying the suspension to the strip as the strip emerges from the cold reducing rolls, the heat of the strip will dry

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the newly applied solids to a semi-adherent coating which will withstand annealing (with dehydration only) and normal handling. After annealing, the inhibitor will reabsorb water from the atmosphere to again form calcium hydroxide.

Because the inhibitor is applied in this method in such small quantity, the film produced is quite thin, from about 225 to 4500 Å., and there is practically no visual change of the strip surface from that of as-rolled, uncoated strip.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing, FIG. 1 represents an untreated panel and FIG. 2 represents a treated panel, each after subjection to a humidity test.

DETAILED DESCRIPTION

Practically all cold rolled strip is annealed to produce the proper soft structure to the strip. After annealing, the strip is usually given a temper roll, or skin pass, resulting in a hardened, bright surface. In the method of this invention, due to the fact that the inhibitor is not destroyed at the annealing temperature, it is applied before the annealing step, and preferably before the tandem mill coiler, in order to avoid additional costly uncoiling and coiling steps. Inhibitor may be added either before or after the last stand of the tandem mill.

A preferred method of performing this invention is given in the example immediately following.

In this example, an aqueous suspension, or slurry, of calcium hydroxide was used. The slurry was prepared by adding commercial grade calcium hydroxide to water in an amount equal to 10% by weight of $\text{Ca}(\text{OH})_2$. Thus, the calcium content of the slurry represented approximately 5.4% by weight of the solid phase. Commercial grade calcium hydroxide is adequate. However, it is preferred to maintain the carbon dioxide content below about 1.0%, and the chloride content below about 0.1%.

The slurry was introduced into a reservoir located near the last stand of the tandem mill of a strip cold reducing line. To provide a uniform dispersion, the slurry was agitated continuously. Slurry from the reservoir was sprayed uniformly across the entire width of both sides of a 43-inch wide moving strip, as the strip entered the last roll stand of the tandem mill at a speed of about 2000 feet per minute. As the strip leaving the tandem mill was quite warm, water from the slurry evaporated rapidly, leaving a thin, practically imperceptible film of calcium hydroxide on the strip surface. The calcium hydroxide deposit measured an average of 12 micrograms per square centimeter. After application of the inhibitor, the strip was coiled, box annealed at 1280° F. in an atmosphere of NH_3 gas (9% hydrogen) and given a skin-pass on a temper mill. The thus-treated coil was stored in a mill storage area for 190 days. The storage area was subject to humidity variation coincident with climatic changes. At the end of the storage period, the treated coil showed no rust. Untreated coils stored in the same area have been known to rust in as little as two days. In comparison, an untreated coil, stored at the same time and in the same area as the treated coil, showed excessive rusting at the end of the 190-day storage period.

The preferred range of slurry concentration is between about 1% and 20% by weight of calcium hydroxide. The slurry should be applied so as to deposit not less than about 5.0 micrograms per square centimeter of calcium hydroxide (dry basis) on the strip, although in most instances, it is preferable to apply a deposit of from about 10 to 100 micrograms per square centimeter. Greater quantities of inhibitor may be used, but they are unneces-

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sary and, due to the resultant excessive residue, may even be objectionable in some instances.

The treatment does not interfere with paint application and adherence under normal conditions. If the painted surface is exposed to high humidity conditions, the inhibitor may contribute to blistering of the paint. For these conditions the inhibitor should be removed before painting. For strip which is to be given a conversion coating such as that applied by immersion in phosphoric acid, the inhibitor should first be removed.

In order to further demonstrate the superior rust resistance of cold rolled steel surfaces treated by the method of this invention, as against untreated surfaces of similar material, treated and untreated specimens were subjected to an accelerated humidity test.

In the test, six 4-inch by 6-inch panels of 28-gage annealed sheet steel were sprayed on both sides with a ten weight percent slurry of calcium hydroxide in tap water. The wet surfaces were air dried. Analysis of a portion of the coating on one of the panels indicated that the film of calcium hydroxide equaled 86 micrograms per square centimeter. The coated panels, along with 6 uncoated 4-inch by 6-inch panels, were annealed in a closed chamber in a laboratory muffle furnace at 1280° F. in an atmosphere of 4% NH gas for about 8 hours, and then cooled to room temperature.

The cooled panels were aligned in racks, with individual panels out of contact with one another, and were placed in a humidity cabinet. The temperature of the cabinet was first raised to 85° F. to prevent condensation of moisture on the panels. The relative humidity was then raised to 85%. The 85° temperature and the 85% humidity were maintained for one week, after which the two groups of panels were withdrawn and examined.

Referring to FIG. 1 of the drawing, which represents a typical panel from the group of untreated panels, heavy rusting is readily observed throughout the entire surface. By contrast, FIG. 2, representing a typical panel from the group of treated panels, is substantially free of any rusting after the one week of severe exposure.

When the inhibitor is added to the strip before the annealing step, an additional benefit is obtained in that the film of inhibitor reduces the possibility of welding, or sticking, between laps of the coils during annealing, especially when substantially more than minimum amounts of lime are used. Welding between laps at certain hot spots in the coil is an ever-recurring problem in annealing of coils of steel strip, and it has been found that the inhibitor of this invention reduces the welding problem.

When the coated strip is annealed, the calcium hydroxide coating, which loses its water of constitution at the

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elevated temperature of the annealing furnace, is converted to calcium oxide, and when the strip is removed from the annealing furnace and subsequently exposed to a rust-forming atmosphere, the moisture in said atmosphere converts calcium oxide back to calcium hydroxide. Whether the calcium compound comprising the strip coating inhibitor at any given time, following annealing, is in the form of the oxide or hydroxide, the coating retains its inhibitive characteristics.

I claim:

1. The method of inhibiting formation of rust on cold rolled ferrous strip which comprises treating said strip before annealing with an aqueous suspension of 1%–20% by weight of calcium hydroxide, then annealing the strip at a temperature of about 1280° F. and forming on the strip a dry film of a compound taken from the group consisting of calcium hydroxide and calcium oxide.

2. The method according to claim 1 wherein the strip is sprayed with said suspension before annealing.

3. The method of inhibiting formation of rust on cold rolled ferrous strip which comprises forming a thin rust-inhibiting film of a thickness of from 225 to 4500 Å. on said strip before annealing by treating the strip with an aqueous suspension of from 1%–20% by weight of calcium hydroxide, then annealing the strip at a temperature of about 1280° F. and forming on the strip a dry film of a compound taken from the group consisting of calcium hydroxide and calcium oxide.

4. The method of claim 1 wherein both sides of said strip are treated with sufficient calcium hydroxide to produce on both sides of said strip a coated surface of at least 0.75 microgram per square centimeter of calcium hydroxide.

5. The method according to claim 3 wherein the strip is treated just prior to or immediately following the last stand of a cold reducing mill.

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