PROCESS FOR TREATING A COATING OF ALUMINUM DEPOSITED
ON A METAL SUPPORT, MORE PARTICULARLY, SHEET METAL
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PROCESS FOR TREATING A COATING OF ALUMINUM DEPOSITED ON A METAL SUPPORT, MORE PARTICULARLY, SHEET METAL...

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ABSTRACT OF THE DISCLOSURE

A process for treating an aluminum coating deposited on sheet-metal such as a steel plate, sheet or strip, comprising applying the aluminum coating by evaporation under vacuum, with a thickness less than 20 microns, onto sheet-metal which advances continuously, subjecting systematically the aluminum coating to superficial hot oxidation by passing the coated sheet-metal directly to atmosphere while its temperature is still 100°C, so as to form a film of aluminum oxide, subjecting the thus formed film of aluminum oxide to the action of a hot fluid based on water while the sheet-metal is still advancing continuously in order to transform the aluminum oxide to hydrated aluminum oxide.

BACKGROUND OF THE INVENTION

The present invention relates to a process for treating a coating of aluminum deposited on a metal support, more particularly sheet metal.

Industrially, coatings are usually applied onto metal products, not only for the purpose of giving to the latter a more beautiful appearance but also and mainly for protecting these products against corrosion.

Among the various metals which may be used for making these coatings, aluminum offers great advantages because of some of its interesting qualities: in addition to a low price, it has a very good resistance to atmospheric corrosion and a good deformability. The latter property is of great importance in effecting forming operations which occur in the manufacture of some articles. Thin steel plates provided with an aluminum coating of little thickness may be subjected to forming operations as easily and as well as thin steel plates which are uncoated.

In addition, it is known that an aluminum coating on a support of steel such as a steel plate, sheet, or strip may be applied by various methods, and particularly by the so-called method by evaporation under vacuum. In applying said method, the product to be coated is passed through an enclosure in which is created a high vacuum of about 10⁻⁴ torr in which metal vapours are emitted from a melting-pot containing the metal which has to make up the coating and which is heated up to a high temperature, generally above the melting point of said metal. The emitted metal vapours condense on the product to be coated and form thereon a well-adhering coating whose thickness may depend, on conditions, vary from several tenths to several tens of microns.

However, sheet-metal coated with an aluminum coating shows a very serious drawback. The coating becomes covered with a pulverulent film of aluminum oxide which is formed immediately by oxidation of the aluminum, as soon as the coated sheet-metal going still in warm or hot condition out of the coating apparatus, comes into contact with air.

The pulverulent film thus formed is very porous and highly water absorbent, so that stains such as finger stains made during handling of the sheets, are indelibly marked thereon.

Because the appearance of the coating is completely altered and the commercial value of the sheet metal is thus lowered, several means have been provided to prevent the formation of the oxide film, by suppressing the surface oxidation of the coating. It has for example, been proposed either to add other metals in the bath of evaporating matter, either to heat to a high temperature of about 450°C the sheet-metal which is to be coated with aluminum, or to effect deposition under a very high vacuum up to 10⁻⁴ torr. These methods are not entirely satisfactory because of difficulties in applying them and their unfavourable influence on the cost price.

SUMMARY OF THE INVENTION

The problem to be solved by the present invention is to provide a simple and low cost process for obtaining a stable aluminum coating which, while preserving its resistance to atmospheric corrosion, is perfectly ductile so as to undergo forming operations without damage.

A solution to this problem is obtained by a process for treating a metal product and, more particularly sheet-metal such as a steel plate or sheet or strip, based on the finding that contrary to the known teachings, there is a possibility of using natural oxidation of the aluminum coating of sheet-metal in the warm or hot state going out from a coating apparatus, to obtain a perfectly stable coating by transforming aluminum oxide Al₂O₃ into hydrated aluminum oxide (Al₂O₃)(OH)ₓ which is stable and non porous.

According to the invention, there is applied onto the product an aluminum coating of a thickness less than 20 microns, the coating is subjected to superficial oxidation so as to form a film of aluminum oxide, and the aluminum oxide film is subjected to the action of a fluid based on water so as to have its natural porosity removed.

In accordance with a particularly preferred embodiment, a coating of aluminum is applied onto sheet-metal by the process of evaporation under vacuum, the coating is subjected to the oxidizing action of atmospheric air by causing the coated sheet-metal to go out from the vacuum apparatus at a temperature above 100°C, the coated and hot sheet-metal is immediately thereafter subjected to the action of hot water which is at a temperature above 60°C, the hot water being allowed to act for a variable duration comprised between 1 minute and 1 hour depending on its temperature. Practically, the sheet-metal provided with the coating oxidized by air passes in a hot water bath immediately after its exit from the coating apparatus.

In another embodiment, the aluminum coating obtained by evaporation under vacuum is subjected to oxidation by ambient air and then to the direct action of steam projected by any known means such as nozzles carried by supporting means extending along the path of travel of the product being treated.

In this embodiment, the coated sheet-metal passes between two such supporting means which project steam at pressures comprised between 1 and 10 kg/cm².

The practical application of the process according to the invention is specially simple.

DESCRIPTION OF THE DRAWING

The accompanying drawings shows a diagrammatic view of an apparatus for applying the process of the invention.

A steel strip 1 of about 0.8 mm thickness passes continuously in an apparatus 2 where it receives an aluminum coating on each of its two faces by a process of evaporation under vacuum which needs not be described since it is well known. The steel strip 1 enters the apparatus 2 by passing through a lock-chamber 3a and goes out of the apparatus through a similar lock-chamber 3b after
having received an aluminium coating and enters the atmosphere while it is still at a high temperature of about 150° C. Generally, the temperature of the steel strip coming out of the coating apparatus may be comprised between 100° C. and 250° C. During this passage from the apparatus into air, the heated aluminium coating becomes quickly oxidized and superficially covered with a film of aluminium oxide Al$_2$O$_3$ having a few microns thickness. Said film is porous and water absorbent.

After its passage into atmospheric air, the coated steel strip, still warm, passes immediately between supporting means 4 and 5 equipped with nozzles 6 and 7 which project onto said strip steam at a pressure comprised between 1 and 10 kg./cm.$^2$; said steam is fed by conduits 8 and 9 connected to a source of steam not shown. In this way, the steam impinging the strip causes systematically immediate transformation of aluminium oxide Al$_2$O$_3$ into Al$_2$O$_3$(OH)$_x$ which has a much greater specific volume than Al$_2$O$_3$. The result thereof is that the superficial layer of the aluminium coating becomes compact and continuous that is without any porosity, which contributes to protecting the steel plate in a perfect way against corrosion because the coating successively oxidized and treated with steam does no longer undergo subsequent oxidation.

The just-described process also is particularly advantageous from economic point of view because the steel strip comes continuously out of the coating apparatus, at sufficiently high temperature to be oxidized systematically by simple passage through air. However, the coating treated in this way is perfectly ductile which allows the coated steel strip to undergo forming operation without fear of making the aluminium coating to burst. This capability has been noticed by subjecting a sample of coated and treated steel strip to bending tests.

Another example of similar application is that in which a continuous steel strip of 0.8 mm. thickness receives by evaporation under vacuum an aluminium coating of about 3 microns on both faces. The aluminium becomes immediately oxidized as soon as the strip comes out of the coating apparatus and, in the air, is covered with a film of alumina Al$_2$O$_3$ having a thickness of about 0.1 micron which is changed to hydrated aluminium oxide by immersing then the coated strip which advances continuously directly into an opened tank containing water at a temperature close to 100° C.

Immediately on its exit from the tank the strip is seen to have get a dull, milk-like, white tint which is well uniform and the finger stains are no longer marked upon it. Moreover, samples taken from said strip have been subjected to various tests of corrosion and bending and it appeared that the coating of the strip has a very good resistance to atmospheric corrosion and a good deformability without any fissures having appeared.

What I claim is:

1. A process for treating an aluminium coating deposited on sheet steel, comprising applying to sheet steel of indeterminate length an aluminium coating by evaporation under vacuum, with a thickness less than 20 microns, while advancing the steel steel continuously, subjecting the aluminium coating to superficial hot oxidation by passing the coated sheet steel directly through the atmosphere as the sheet steel emerges from the coating apparatus at a temperature which is still comprised between 100° C. and 250° C. so as to form a film of aluminium oxide, and continuously transforming said aluminium oxide into hydrated aluminium oxide by continuously passing the sheet steel from the atmosphere into a bath of hot aqueous fluid for between 1 minute and 1 hour.

2. A process according to claim 1, in which the hot fluid used comprises steam.

3. A process according to claim 1, in which the sheet metal provided with the oxidized aluminium coating is directly immerged into a hot water bath.

4. A process according to claim 3, in which the sheet metal provided with the oxidized aluminium coating is passed directly in front of a steam projecting device which projects steam at a pressure comprised between 1 and 10 kg./cm.$^2$.

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