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METHOD OF PRODUCING THIN, BRIGHT UNSPANGLED GALVANIZED COATINGS ON FERROUS METAL STRIPS

BACKGROUND OF THE INVENTION

This invention relates to the production of light gage galvanized strip and more particularly to the production of very flat thinly coated light gage strip.

Very light gage hot dip coated ferrous strip and sheet invariably has poor flatness or "shape" due to waviness and buckles in the strip. Such sheet is often very difficult to fabricate into certain products such as Panel Stock where a very flat sheet is necessary. It has been discovered that the waviness and buckles in the strip result from variations in the thickness of the coating applied. A normal hot dip coating may have as much as a one tenth ounce coating variation from place to place on the surface within a few inches. When such a coating is applied to a thin strip this coating variation may be sufficient to cause significant overall gage variations of the coated strip which variations result in buckles and waviness of the strip as it is handled. Heretofore so-called light commercial coatings have been available. These coatings have ranged down to as little as 0.7 ounces per square foot of strip surface but this coating has not been thin enough to significantly improve the flatness characteristics or so-called "shape" of the strip.

SUMMARY OF THE INVENTION

The present inventors have discovered that a thin flat hot dip coated strip can be made by closely controlling the conditions under which the strip is coated and furthermore that strip coated in the manner of the invention has a very superior bright unspangled thin galvanized coating of less than 0.5 ounces of coating per square foot of strip material, and, if desired, less than 0.4 ounces, or approximately half the thickness of those coatings previously attainable.

Briefly the inventors have discovered that a strip having the desired flatness and coating surface characteristics can be obtained by the correct combination of the following:

1. The gage of the strip.
2. The degree of roughness of the strip surface.
3. The speed of the strip through the bath.
4. The temperature of the strip.
5. The temperature of the bath.
6. The aluminum content of the bath.
7. The wiping of the strip by steam dies.
 - a. the width of steam orifice.
 - b. the amount of steam used.
 - c. the spacing of the steam dies from the strip surface.
 - d. the spacing of the steam dies from the surface of the molten bath.

A coating of less than 0.5 ounces per square foot of strip surface must be obtained by the correct combination of the above in order to provide a strip having the desired flatness and coating surface characteristics.

Briefly summarized the galvanized coating is applied to a 0.015 to 0.033 inch gage strip having a profilometer reading between approximately 20 and 80 and preferably between 30 and 50 microinches by passing a cold strip at a temperature approximately 300 to 450° F. at a rate of about 200 to 400 and preferably between 300 to 330 feet per minute into a cool molten zinc pot held at a temperature of approximately 825° F. to 850° F. and having an aluminum content of approximately 0.05 to 0.15 percent and preferably 0.08 percent to 0.10 percent and then wiping by a powerful steam blast from wiper dies closely spaced to both the strip and the molten bath.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a schematic representation of a coating line suitable for the practice of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The first step in the novel process is the proper roughening of the strip surface. Preferably the roughening takes place in a rolling operation. Basically a very smooth strip surface is desired. However, the surface cannot be too smooth. It has been discovered that a certain minimum roughness must be present to obtain the desired bright unspangled coating surface. We have discovered that the correct roughness of the strip is about 20 to 80 and preferably between a 30 to 50 microinch finish. This may usually be obtained by specifying that the strip be rolled on the last cold rolling pass through worn out rolls.

The strip may after proper roughening be passed through standard surface preparation operations such as cleaning and pickling operations. Such cleaning and pickling should not be severe enough to substantially alter the profilometer readings of the surface roughness.

The strip may next be fluxed with a suitable flux and then heated to a temperature between 300 and 450° F. before being passed directly into a molten zinc pot at an approximate rate of from 200 to 400 feet per minute and preferably between 300 to 330 feet per minute. The aluminum content of the molten zinc bath should be between 0.05 to 0.15 and preferably between 0.08 and 0.10 percent aluminum by weight. The temperature of the molten bath should be maintained between 825° F. and 850° F. and preferably between 830° F. and 835° F.

As the strip leaves the molten zinc bath it is wiped by steam wiping dies of any suitable type. A high steam pressure is maintained in these dies so that a very strong blast of steam issues from the elongated steam orifices of the dies adjacent the face of the strip and contacts the strip with a high force to wipe a large amount of still molten zinc from the surface of the strip. The face of the die should preferably be maintained within about one-fourth to three-eighths inches of the face of the strip and the height of the wiping die orifice away from the bath surface should be about 6 to 12 and preferably 8 to 10 inches. Superheated steam at a temperature of 900° to 1000° F. is preferably used. With a wiping die having a steam orifice an average of 0.012 to 0.015 inches wide a steam pressure of at least 130 pounds at each superheater control valve has been found very suitable. Average figures are given because some dies may have steam slots tapered towards the center and/or concave steam faces.

In the single FIGURE there is shown schematically a coating line suitable for practice of the present invention. Strip 11, which has previously been roughened to have a 20 to 80 microinch finish and preferably a 30 to 50 microinch finish by any suitable roughening means such as by passing through worn out rolls on a finishing mill, is uncoiled from coil 13 and passed through a pickling tank 15 and then through a rinse chamber 17 where any adhering pickle liquor is rinsed from the strip surface. The strip 11 next enters a flux tank 19 where a flux of any suitable type is applied to the strip. The strip 11 then passes into a drying chamber 21 where the flux is dried by heat before the strip passes downwardly into a suitable zinc bath 23 contained in a pot 25, where it passes around sinker rolls 27 and 29 and then upwardly from the bath between two coplanar gas wiping dies 31 and 33 and up over a deflector roll 35 which directs the strip to a coiling operation, not shown.

A suitable wiping gas such as steam enters the gas wiping dies 31 and 33 through inlet pipes 37 and exits through narrow parallel openings 39 in the face of the dies 31 and 33 directed at the two sides of the strip 11 to wipe the zinc coating down to a very thin layer of zinc. Suitable control means such as control valves 41 and 43 are shown inserted respectively in the inlet pipes feeding the wiping dies 31 and 33.

It will be understood that the drawing is illustrative only and any other suitable apparatus could also be used.

If desired a cooling means of any suitable type may be used after the strip passes between the steam dies to cool the zinc coating. Ordinarily, however, the thin strip and thin coating

because they have very little mass cool very quickly. It is important that the coating of zinc shall solidify as quickly as possible so that there is insufficient time for a significant alloy layer to form at the iron-zinc interface. The alloy layer between the sheet and the coating should be very thin.

The resulting zinc coated strip will be found to have a very bright pleasing unspangled matte surface which is excellent for painting with proper pretreatment and which when unpainted maintains its brightness for an unusually long period. The strip, furthermore, will be found to have a very minimum of "shape" or in other words will have excellent flatness characteristics which are most desirable for the forming of many articles from strip.

It is also possible to apply the thin coating to somewhat heavier strip than the optimum, not normally subject to buckles and waviness, so long as a proper heat balance is maintained between the molten bath and the strip.

It is very important that a proper roughness of the strip be attained prior to its entrance into the molten zinc bath. If the strip surface is too rough too heavy a layer of zinc will be picked up from the bath and it will be impossible to wipe the excess zinc away with the steam wipers. The ferrous surface of a rough strip will, furthermore, tend to alloy with the molten zinc coating so that when the strip is wiped by the steam wipers only an iron-zinc alloy surface remains. On the other hand if the surface of the base strip does not have a slightly rough surface preferably in the form of a matte surface the coating of zinc will not have a bright matte surface but a spangled surface. When the surface of the base strip has a 20 to 80 and preferably a 30 to 50 microinch finish, however, and the strip is coated with a zinc coating of less than 0.5 ounces per square foot or in other words less than 0.25 ounces of zinc per square foot of strip on one surface, the underlying matte surface is able to initiate the formation of a matte surface on the overlying zinc coating surface as well. This matte surface on the zinc surface is, as indicated supra, unusually bright and durable for a matte surface.

It is also important that the strip be coated at a minimum temperature so that the usual dull matte surface of an iron-zinc alloy layer is not formed. A high aluminum content is desirable in the molten bath as this decreases the alloying of the zinc with the ferrous base and also decreases the fluidity of the bath so that the steam wipers can more easily remove the excess molten zinc from the surface of the strip. A high speed of strip passage through the bath also aids in preventing alloying of the strip with the coating. A minimum gage strip must be used to avoid alloying also due to the excessive heat body provided by a heavy strip. On the other hand if the strip is too cool as it passes through the bath too heavy a zinc layer will be built up which cannot be successfully wiped from the surface. It is also important that the steam wipers be positioned to wipe the coating from the surface as soon as possible after the strip leaves the molten bath before it begins to solidify upon the surface. Solidification cannot be delayed to facilitate wiping by providing more heat else the zinc may alloy excessively with the ferrous surface of the strip. A heavy blast of steam is provided and the steam wiping dies are positioned very close to the strip so that a maximum amount of zinc is wiped from the strip surface.

It is clear from the above discussion that the particular conditions of coating can be varied somewhat from the optimum for any given condition and still provide excellent flat thin zinc coated nonspangled sheet and strip if other conditions are also varied to compensate but that the conditions cannot be varied too greatly else the desired coating will not be attained.

For instance if the aluminum content of the bath is in the high range the speed of the strip may be lower and the pot temperature may be higher, while if the aluminum content is in the low range the speed of the strip must be higher and the pot temperature lower. Likewise if the surface is rougher than the optimum the temperature of the pot should be in the lower range and the aluminum should be in the higher range in order

to prevent excessive buildup of an iron-zinc alloy layer. Conversely if the surface of the strip is extraordinarily smooth the temperature and aluminum content should be suitably adjusted in the opposite direction. The ultimate aim in each case is to provide conditions which favor the attainment of both a very thin alloy layer and the maximum removal of unalloyed molten zinc from the surface of the strip without wiping all the unalloyed zinc from the surface so that the underlying matte surface of the strip can initiate the formation of a matte surface on the overlying zinc coating surface.

As a specific example of our invention we took a 0.021 gage cold rolled strip which had been rolled on its last pass through worn out rolls and was found to have a 40 microinch surface finish. This strip was cleaned electrolytically and subjected to a very mild pickle. It was then fluxed with a standard chloride type flux and the flux dried. The strip was then slightly heated and passed while held at a temperature of 300° F. at a speed of 330 feet per minute into a molten zinc bath held at a temperature within the range of 830 to 835° F. and having an aluminum content of 0.10 percent by weight. As the strip passed from the bath it was wiped with a steam blast from a wiper die having a wiping slot an average of 0.015 inches wide and using steam at a pressure of 132 pounds per square inch. The face of this die was positioned three-eighths inches from the face of the strip and the steam wiping slot was positioned 9 inches from the surface of the bath. This location of the die wiped as much molten zinc as possible from the surface of the strip but avoided spitting or blowback of zinc from the strip surface and the bath. The resulting strip was found to have very superior "shape" characteristics and a very bright pleasing nonspangled matte surface.

We claim:

1. A method of producing thin-galvanized coatings having a pleasing bright unspangled surface upon a thin-gaged strip comprising:

- a. providing ferrous strip material between 0.015 to 0.033 inches gage,
- b. providing a surface finish on said strip between 20 to 80 microinches,
- c. heating said strip to between 300 and 450° F.,
- d. providing a molten zinc bath at a temperature of 825° F. to 850° F. and having an aluminum content between 0.05 to 0.15 percent by weight,
- e. passing said strip into and through said zinc bath at 200 to 400 feet per minute,
- f. passing said strip between gas wiping dies to remove all excess molten zinc and provide a zinc coated strip having not more than 0.25 ounces of zinc per square foot on one side, and
- g. cooling said strip to solidify the zinc coating and provide a flat thinly galvanized strip having a bright unspangled surface finish.

2. A method of producing thin galvanized coatings having a pleasing bright unspangled surface upon a thin-gaged strip comprising:

- a. providing ferrous strip material between 0.015 and 0.033 inches gage,
- b. providing a surface finish on said strip between 30 and 50 microinches,
- c. heating said strip to between 300 to 450° F.,
- d. providing a molten zinc bath at a temperature of 825° to 850° F. and having an aluminum content between 0.08 and 0.10 percent by weight,
- e. passing said strip into and through said molten zinc bath at a rate of 300 to 330 feet per minute,
- f. passing said strip between spaced gas wiping dies to remove all excess molten zinc and provide a zinc coated strip having not more than 0.25 ounces of zinc per square foot on one side, and
- g. cooling said strip to solidify the zinc coating and provide a flat thinly galvanized strip having a bright unspangled surface finish.

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