CATHOLYTE RINSE OF ELECTROCOAT


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4 Claims

ABSTRACT OF THE DISCLOSURE

An improved method for electrophoretic painting upon an electrically conductive substrate from an aqueous dispersion of such paint is provided wherein catholyte liquid is separated from the coating bath and discharged upon an article which has been coated in and removed from such bath with such article positioned in a manner such that the liquid so discharged returns to the coating bath.

BACKGROUND OF THE INVENTION

The electrophoretic deposition of paint from an aqueous dispersion thereof upon an electrically conductive workpiece is now well known in the art. See, for example, U.S. Patents 3,230,162; 3,335,103; 3,378,477; and 3,403,088.

Conventionally, the coated object is withdrawn from the coating bath and taken with it a quantity of adhered or otherwise entrapped paint which is not a part of the electrophoretic paint film thereon. This material is conventionally removed by rinsing and/or by compressed air streams. This material together with the rinse water conventionally drains into the plant waste system or is otherwise disposed of. The amount of paint lost by "drip-out" differs widely with the resin system employed in the coating tank and represents a substantial loss in coating efficiency as measured by the paint coverage obtained per unit volume of paint solids introduced into the coating bath.

If extraneous rinse water is returned to the bath in order to return the paint solids therein, the water content of the bath is unduly increased. Such a method cannot be maintained unless there is devised some method for effecting water removal from the bath which is quantitatively essentially equal to the inflow of extraneous rinse water. The difficulties attendant to operating an electrophoretic bath with a constantly changing water supply are obvious to one skilled in the art.

THE INVENTION

It has been discovered that coating bath liquid which has been freed or substantially freed of paint solids is particularly suitable for use as rinse liquid for an electrophoretic process. If this material is then returned to the bath with undeposited paint removed from a coated article through rinsing, it maintains the water balance of the bath and can be controlled so as not to introduce extraneous contaminants, always a potential danger if a new supply of water is being continuously added to the bath.

In the method of this invention liquid is separated from the bath which is free or substantially free of paint solids. This liquid is continuously or intermittently continuously pumped to a rinsing station constructed and arranged so that the rinse liquid and paint particles rinsed from the coated workpiece flow back into the coating bath and are redispersed.

The removal of liquid catholyte is effected by placing in the bath a catholyte separation unit which comprises a water permeable wall and includes a cathode in electrical connection with the primary cathode of the coating cell. This auxiliary cathode assumes the polarity of the primary and may or may or not be a part of the water permeable wall.

The vast majority of operations wherein paint is electrophoretically deposited from an aqueous bath are systems wherein the paint has affinity for the anode and is anodically deposited, i.e., the object to be coated serves as the relatively positive electrode of the electrophoretic disposition cell. Such systems conventionally employ a polyacrylamide resin paint binder and are dispersed within the bath with a water-soluble base. The preferred bases for this purpose are water-soluble amines. It is known in the art that other bases are operable for this purpose. These include ammonium, potassium hydroxide, lithium hydroxide, sodium hydroxide, etc.

Suitable binder resins for anodic deposition are synthetic polyacrylamide acid resins, i.e., organic resins having free or ionizable carboxyl groups in their molecular structure which are derived from a constituent monomer. Acidic film-forming resins include, but not by way of limitation, any of the polyacrylamide acid resins used in the electrophoretic painting of paint from an aqueous bath. They include coupled oils such as sunflower, safflower, perilla, hempseed, walnut seed, dehydrated castor oil, rapeseed, tomato seed, menhaden, corn, tung, soya, oiticica, or the like, the olefine double bonds in the oil being conjugated or nonconjugated or a mixture, the coupling agent being an acrylic olefinic acid or anhydride, preferably maleic anhydride, but also crotonic acid, citraconic acid, or anhydride, fumaric acid, or an acrylic olefinic aldehyde or a mixture of an acrylic olefinic ester such as acrolein, vinyl acetate, methyl maleate, etc., or even a polybasic acid such as phthalic or succinic, particularly coupled glyceride oils that are further reacted with about 2 to about 25% of a polymerizable vinyl monomer; maleinized unsaturated fatty acids; maleinized rosin acids, alkyd resins, e.g., the esterification products of a polyol with polybasic acid, particularly glyceride drying oil-extended alkyl resins; alcoholic hydrocarbon drying oil polymers such as those made from maleinized copolymers of butadiene and diisobutylene; diphenolic acid and like polymer resins; and acrylic vinyl polymers and copolymers having carboxylic acid groups such as butyl acrylate-methyl methacrylate-methacrylic acid copolymers, acrylic acid and lower alkyl (C₂ to C₄) substituted acrylate-acid-containing polymers, i.e., those having carboxyl groups contributed by alpha beta unsaturated carboxylic acids or residues of these acids, etc. These and other suitable resins are described in detail in many patents of which the following are illustrative: U.S. Patents 3,230,162; 3,297,557 and 3,569,983. Such resins are electrophoretically deposited with an impressed potential in the range of about 50 to about 500 volts or higher. The concentration of binder resin in the bath is advisedly in the range of about 5 to about 15 weight percent of the bath.

If a cathodically depositable paint is employed and the workpiece to be coated forms the cathode, relatively negative electrode of the electrophoretic disposition cell, the auxiliary electrode is in electrical connection with and assumes the polarity of the anode. Cathodically depositable resins include those having ionizable amine groups in their molecular structure. They can be dispersed in aqueous dispersion with the aid of a water-soluble acid, e.g., acetic acid.

This invention will be more easily understood by referring to the accompanying drawings wherein:

FIG. 1 is a semidiagrammatic sectional side view of apparatus used in carrying out one embodiment of this invention;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;
Fig. 3 is a sectional view taken along line 3-3 of Fig. 1;

Fig. 4 is a semidiagrammatic sectional side view of apparatus used in carrying out a second embodiment of this invention and taken along line 4-4 of Fig. 3.

Fig. 5 is a view taken along line 5-5 of Fig. 4; and Fig. 6 is a view taken along line 6-6 of Fig. 5 and is a partial end view of the apparatus shown in Fig. 4 and looking in the direction of workpiece travel to and through the coating bath.

Referring now to Figs. 1, 2 and 3, a steel coating tank 11 containing the coating bath 13, i.e., an aqueous dispersion of paint comprising pigment, a polymeric acrylic acid resin and a water soluble base, and serves as a negative electrode (cathode) in the coating process. Tank 11 is electrically connected to D.C. power supply unit 17 via conductor 15. An article 19 to be coated, e.g., an automotive body, is shown suspended from a conveyor 35 by hanger 21. Conveyor 35 is a conventional, electrically powered, chain driven conveyor constructed and arranged for the transportation of articles to be coated through bath 13. Hanger 21 includes insulator 23 which electrically insulates article 19 from the grounded conveyor. Contact plate or brush 25 is attached to and in electrical connection with hanger 21. Article 19 is shown immersed in bath 13 and in electrical connection with bus bar 37 via contact plate 25 and in turn is in electrical connection with D.C. power supply unit 17 via conductor 39. Article 19, therefore serves as the positive electrode of an electrodeposition cell while the article is passing through bath 13.

It will be understood that bus bar 37 may be segmented and that certain of the various segments thereof may have no connection with power unit 17 or another power supply unit not shown as to permit impression of a higher voltage than that impressed on other segments, or may be electrically connected with a power supply unit so as to admit of polarity reversal with respect to other segments of the bus bar.

Power supply unit 17 is constructed and arranged to convert (rectify) an alternating current power source to direct electric current or the equivalent thereof and to provide between the electrodes and through the coating bath a direct current flow of electrical energy that is commensurate with the size of the electrodeposition operation contemplated. Design of the power supply unit should take into consideration the surface area of the workpieces that will be in residence within the coating bath at any given time, the workpiece surface area entering the bath per unit time, the deposition properties of the coating formulation, the conductivity of the coating bath, the thickness of the coating to be formed, etc.

At the left or exit side of tank 11 there is shown an article 27 that has been electrodecoated in bath 13 and is now undergoing rinsing to wash adhered paint particles which are carried out of the bath with the coated article. Article 27 is suspended from conveyor 35 by a hanger 29 which is equipped with an insulator 31 and a contact plate or brush 33.

Positioned along one upper side of tank 11 is a catholyte separation unit 40. Catholyte separation unit 40 comprises a porous metal box, e.g., expanded metal or wire mesh, and a separation membrane 43 which admits of the passage of water and water soluble materials such as amine, KOH, LiOH, NaOH, etc., therethrough while preventing the passage of substantial amounts of paint solids. Thus, separator membrane 43 may be cloth, e.g., sailcloth, water permeable plastic membranes, and other water permeable synthetic or natural fiber means. In another embodiment, the separation membrane is the porous or water permeable box itself and is structured so that the opening is sufficiently small to provide a degree of separation specified for the separate separation membranes. In still another embodiment, the walls of separation unit are formed of a porous ceramic and a conductor positioned inside such unit is in electrical connection with the primary cathode. The separation membrane 43 may be structured to provide an essentially complete barrier to the paint particles of bath 13 or it may admit of their limited passage to a degree such that the concentration of such particles in catholyte separation unit 40 is below about 50, preferably below 10 and more preferably below 5, percent of the corresponding concentration in coating bath 13. Otherwise expressed there exists through the barrier of differential flow with respect to water and solubilizer or resin dispersal assistant on the one hand and paint solids on the other.

Positioned within catholyte separation unit are pumping means 45 having intake means 47. Pumping means 45 is operatively connected to conduit 49 through which liquid from within catholyte separation unit 40 is passed by pumping means 45 to conduits 51 and 53 and through the same to shower heads 55 and 57 from whence the same is discharged upon article 27. In this embodiment, article 27 is thus rinsed while immediately over the coating bath and hence the drainage from such rinsing falls directly into coating bath 13. Conduit 49 is provided with valve 49-1 which can divert the flow from pump 45 through outlet conduit 49-2 for purging.

Porous metal box 41 is supported in bath 13 and in electrical connection with the coating tank 11. Thus, it becomes a part of the cathode of the cell and attracts cations through separation membrane 43, primarily those of the water soluble base employed to disperse and/or solubilize the acidic paint binder resin. Thus, within catholyte separation unit 40, there exists an aqueous dispersion that paint solids poor and base rich relative to bath 13. This fluid is therefore particularly suitable as a rinse fluid for removing adhered paint particles from the coated workpiece.

Figs. 4, 5 and 6 relate to a second embodiment of this invention. In this embodiment, there is shown a steel coating tank 111 which contains coating bath 113 and serves as the negative electrode in the coating process. Tank 111 is electrically connected to D.C. power supply unit 117 via conductor 115. An article to be coated 119 is shown suspended from a conveyor 135 by hanger 123. Conveyor 135 is a conventional, electrically powered, chain driven conveyor constructed and arranged for the transportation of articles to be coated through bath 13. Hanger 121 includes insulator 123 which electrically insulates article 119 from the grounded conveyor. Contact plate or brush 125 is attached to and in electrical connection with hanger 121. Article 119 is shown immersed in bath 113 and in electrical connection with bus bar 137 via contact plate 125 and in turn is in electrical connection with D.C. power supply unit 117 via conductor 139. Article 119, therefore, serves as the positive electrode of an electrodeposition cell while the article is passing through bath 113.

Extending from coating tank 111 and in the direction of workpiece travel from coating tank 111 is a drainboard assembly 112 constructed and arranged so that rinse liquid falling thereon drains back into coating bath 113 in coating tank 111. Above drainboard assembly 112 there is shown another workpiece article 127 that has been electrocoated in bath 113 and is now undergoing rinsing to wash off adhered paint particles which are removed from bath 113 with the coated article. Article 127 is suspended from conveyor 135 by a hanger 129 which is equipped with an insulator 131 and a contact plate or brush 133.

Positioned along the upper edge of coating tank 111 and positioned at the end of the tank where the articles to be coated enter the bath is a U-shaped catholyte separation unit 140. Catholyte separation unit 140 comprises a metal box 141 having a porous bottom 141-1 which may be of expanded metal or wire mesh, a separation membrane 143 which admits of the passage of water and water soluble materials such as amine, amnomia, KOH, LiOH, etc., therethrough. The separator membrane 143 may be cloth, e.g., sailcloth, a water per-
meable plastic membrane, or other filter means of synthetic or natural materials.

The separation membrane 143 may be structured to provide an essentially complete barrier to the paint particles of bath 113 or it may admit of their limited passage to a degree such that the concentration of paint in catholyte separation unit 140 ranges up to 50, preferably below 5 and more preferably below 1, percent of the corresponding concentration of the same in coating bath 113.

Catholyte separation unit 140 has outlet means on opposite sides of tank 111 in the form of conduits 160—1 and 160—2 through which liquid flows from the upper interior of catholyte separation unit 140 by gravity flow into collection units 161—1 and 161—2 which optionally are provided with filters 162. Collection units 161—1 and 161—2 are provided with drain conduits 163—1 and 163—2 which are operatively connected to pumps 145—1 and 145—2. Pumps 145—1 and 145—2 are operatively connected to conduits 149—1 and 149—2 through which liquid from catholyte separation unit 140 is passed by pumps 145—1 and 145—2 to shower heads 155 and 157 from whence the same is discharged upon article 127. In this embodiment, article 127 is thus rinsed while our drainboard assembly 112 and the rinse liquid drains back into coating bath 113.

Metal box 141 of catholyte separation unit 140 is in electrical connection with the tank 111. Thus, it becomes a part of the cathode of the cell and attracts cations through separation membrane 143, primarily those of the water soluble base employed to solubilize and/or disperse the acidic paint binder resin. Thus, within catholyte separation unit 140, there exists an aqueous dispersion that is paint solids poor and base rich relative to bath 113.

Catholyte separation units 40 and 140 are advantageously positioned near the point where uncoated workpieces enter the coating bath since the greatest surge of current occurs before an electrically resistant film builds upon the workpiece.

In this application, the term "paint" is meant to include pigment and/or finely ground filler, the binder without pigment and/or filler or having very little of the same, which can be tinted if desired. Thus, the binder which is ultimately converted to a durable film, can be all or virtually all that is used to form the film, or it can be vehicle for pigment and/or particulate filler material.

It will be understood by those skilled in the art that modifications can be made within the design of the apparatus shown and described herein without departing from the scope of the invention as hereinafter claimed.

I claim:

1. In a process for electrodepositing paint wherein an aqueous dispersion comprising a synthetic polycarboxylic acid resin and water soluble base form a coating bath which is retained within a bath container and is in contact with a relatively negative cathode, a relatively positive anode is immersed in said coating bath and a film of said paint is electrodeposited thereon, said anode is removed from said coating bath after electrodeposition of said film of paint and the resultant coated anode is sprayed with liquid to wash therefrom unattached paint particles thereon, the improvement which comprises separating from said bath within said bath container a liquid bath fraction which comprises water and water soluble base and a concentration of paint particles between 1 and 50% of the corresponding concentration in said bath by positioning within said bath a catholyte separation unit comprising an auxiliary cathode and a water permeable membrane through which a flow of paint particles is impeded thereby providing a differential flow through said membrane of paint particles on the one hand and water and water soluble base on the other and removing said liquid bath fraction from within said catholyte separation unit, discharging said liquid bath fraction upon said coated anode while said coated anode is outside said coating bath and returning said liquid bath fraction to said bath.

2. The method of claim 1 wherein said liquid bath fraction has a concentration of paint particles between 5 and 10% of the corresponding concentration within said coating bath.

3. The method of claim 1 wherein said liquid bath fraction is discharged upon said coated electrode while said coated electrode is directly above said coating bath and drains directly from said coated electrode by gravity flow into said coating bath.

4. The method of claim 1 wherein said liquid bath fraction is discharged upon said coated electrode after said coated electrode has been moved from a position over said coating bath and drains directly from said coated electrode by gravity flow onto drain means constructed and arranged to cause said liquid bath fraction to drain therefrom by gravity flow into said coating bath.

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