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IMPROVEMENTS IN AND RELATING TO UNIFORM CURRENT DISTRIBUTION IN ELECTROLYTIC CELLS FOR ELECTROFINISHING PROCESSES

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THIS IS AN INVENTION BY BALKUNJE ANANTHA SHENOI, SCIENTIST AND RAMACHANDRA SUBRAMANIAN, SCIENTIST, BOTH ARE EMPLOYED IN THE CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, KARAIKUDI-623003, TAMIL NADU, INDIA, AND ARE INDIAN NATIONALS

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed:—

This invention relates to improvements in and relating to uniform current distribution in electrolytic cells for electrofinishing processes in the fields of anodising techniques particularly in lithoplates for printing plates manufacture.

The advantages of anodising aluminium plates in a number of acid electrolytes particularly sulphuric acid, chromic acid, boric acid and borates for hardening the surface of aluminium lithoplates are well known. The aluminium sheets are cleaned in alkaline solutions and are chemically or electrochemically treated to obtain optimum grain-size and roughness and are subsequently anodised in any one of the above mentioned electrolytes by making it anodic during d.c. electrolysis or as one of the electrodes during a.c. electrolysis so as to give a hardened and a corrosion-resistant surface. In order to obtain a very good quality printing from such anodised aluminium plates, it is found desirable to have uniform thickness of the anodised coating usually in the order 8 to 10 microns all over the surface with grain size, pore structure and hardness also uniform. The uniformity of thickness is especially important when preparing the stencils for printing on such anodised plates either by surface etch or deep-etch processes.

Further, the uniform distribution of the thickness of the anodised oxide film on aluminium becomes a problem when printing plates of various dimensions—sizes 10″ × 16″ to 54″ × 48″ have to be processed in the same processing tank even though the thickness of the anodised film deposit on plain surfaces with parallel electrodes are more uniform than complicated shapes. For example, the inter-electrode distance for obtaining very uniform thickness on parallel electrode arrangement should be greater than or equal to at least 1.5 times the width of the plain sheet provided the electrodes occupy the entire cross-section of the tank in which it is treated. This becomes even more serious when one considers processing of plates of different sizes in the same tank.

To obviate these disadvantages, the present invention makes use of the shielding technique to control the path of current lines between the electrodes by providing with a properly perforated or gauze-like insulating shield in front of and just near the cathode close to it at a predetermined distance. The principle that slot in front of the cathode controls the path of current lines from the anode is well known and that the pattern of current distribution varies with the slot width and position in front of the cathode is also well established. The same principle has been made use of in this present invention by proper choice of the hole aperture, number of holes and their positioning in the perforated/gauze-like insulating shield placed in between and just near the cathode such that the current lines concentrating on the edge and on the top just below the solution level are diverted and more uniformly distributed over the entire area of the plain anode or electrode as the case may be. At the same time, because of a large number of apertures in the said perforated/gauze-like insulated shield, there is not much resistance to the path of current and the cell voltage is not increased.

The possible shorting of the tin long aluminium sheets as electrodes at times due to flexing is also avoided because of the insulating shield between the electrodes.

It has been found that by such an arrangement of the said perforated or 'gauze-like' insulating shield, a very uniform thickness of the oxide film could be obtained even from such electrolysis which possess generally poor throwing power.

A second advantage of the present invention is that a shorter inter-electrode distance will be possible with the perforated/gauze-like insulating shield in between the electrodes and closer to the cathode irrespective of the size of the plates to be processed.

It is also possible now to anodise different sizes of plates in the same tank without need to alter the inter-electrode distance if the said insulated perforated shield is placed in position.

To these ends, the invention broadly consists in interposing a perforated insulating plane shield between the anode and cathode or between the electrodes when a.c. is used) in the electrolytic cell and making the work as anode in the anodising electrolytes. The positioning of the insulating perforated shield in the electrolytic cell is such that the path of current lines to the work is made more or less parallel resulting in uniform current density over the entire area of the anode sheet.

Thus, when the plain aluminium sheet is made the anode and anodised in the anodising electrolytes like sulphuric acid, chromic acid or any suitable anodising electrolyte, an insulating perforated shield is positioned in front of the insoluble cathode sheet of appropriate dimensions at 1 to 2.5 inches in front of it. So that it shields practically the entire cathode area except the portions in opposition to the said perforations. Because of this said arrangement, the current flux flowing from the cathode to anode is made more or less parallel and the current distribution on the anode is made more uniform than without the said shield and thus excessive thickness build-up of oxide coating at the edges and corner of the anode is minimised.

During a.c. anodising two such insulated perforated shields are placed in front of each electrode at distance 1 to 2.5″ from each. This again makes the current distribution more uniform and hence the thickness of oxide film on the entire plate is uniform.

Tables 1 and 2 give in quantitative terms the advantage of the new principle in improving the thickness distribution over the existing methods. This new arrangement has made it possible to reduce the inter-electrode distance from 10″ to 6″ in one particular set of conditions simultaneously improving the thickness more uniform.

The present invention consists of the use of a perforated shield for better distribution of current flux on a working electrode in an electrolytic cell which comprises an electrolytic tank, two electrodes (a cathode and an anode in case of d.c. electrolysis)-kept suspended in anodising electrolyte, the electrodes being connected to two terminals of a suitable current supply—characterised in that an insulated perforated shield of such size is suspended at a suitable distance of 1 to 2.5 inches in front. The diameter of these perforations and number of such perforations in the insulating shield are determined by the size of the plates being anodised and normally the diameter range being 1/8″ to 1/4″ and the distance between the perforations being 0.5″ to 1″ from centre to centre. The material of the insulating shield can be polyvinyl chloride, perspex or acrylic resins or of such materials which are not attacked by the electrolytes.

By incorporating such an arrangement the thickness of oxide film formed is uniform over the entire area of the anodised plate and the grain size and shape on the aluminium plate is more uniform without much variation from edges to centre of the plate during graining electrolytically.

The invention is carried out as described below for preparation of anodised micro-grained aluminium lithographic plates. The aluminium sheets of proper size are alkaline cleaned, rinsed, and introduced into the electrolytic graining tank (Fig. 1) of the accompanying drawings. In Fig. 1 (4) is the graining tank made of wood or mild steel lined inside with PVC containing the graining electrolyte (5). (2) are the said aluminium sheets suspended from the electrode rods (1) placed across the tank at suitable distance from each other and connected to the source of current supply through the seatings (1). The insulated perforated shields (3) are suspended in front of each aluminium sheet parallel to its surface and in front of it at a distance 1 to 2.5″ from it. Then the required current is passed through the electrodes for a predetermined time to get uniformly grained surface.

Then the sheets with the perforated shield attachment is removed, rinsed thoroughly in water and anodised either using a.c. or d.c. source. When the anodising is done using a.c., the arrangement in the anodising tank will be as in Fig. (1).

For d.c. anodising, the cell arrangement as shown in Fig. 2 is used. (8) is the tank lined with PVC, containing the electrolyte (9). 7 is the aluminium sheet connected to positive terminal of current supply through the busbar rod. (10) is a lead sheet cathode connected to negative terminal of current supply and (11) is the insulating perforated shield suspended parallel to it and in front of it at a distance of 1 to 2.5″. Anodising is then carried out by sending in d.c. current of preset density and time to get the desired thickness. Then the anodised micrograined aluminium sheet is rinsed thoroughly with water, dried and used for the preparation of printing plates.

The following typical examples are given to illustrate the invention:

Example 1

The aluminium sheet of size 24″ × 20″ after alkali cleaning and rinsing is suspended parallel to another aluminium sheet of same size is electrolytically treated by passing an alternating current between the sheets at 20V in an electrolytic tank with the capacity of 200 liters containing the graining electrolyte. Two perforated perspex shields of size 25″ × 21″ with a number of 3/16″ perforations at distances of 0.75″ from centre to centre is suspended just 1.5″ in front of each electrode and the alternating voltage of 20 to 22 volts is applied between the electrodes for 15 minutes after which time, the entire electrode assembly is lifted, rinsed and introduced in the anodising tank of same dimensions and anodised with an alternating current, the electrode being sulphuric acid, 15% v/v at 20°C with a current density of 1.5 amp per sq. dm. Mild air agitation is given through perforated PVC agitation pipes.

It has been found that the thickness of the film formed is more uniform and the shape and size of the grains produced being uniform from edge to edge whereas in absence of the insulating perforated shields, the grains at the corner edges are more rough and deeper. Figure 1 gives one such cell arrangement. Thirty sections of the aluminium anodised plate were cut out as shown in the table from top to bottom and right to left and numbered as indicated. These segments were weighed before and after stripping the anodic film in boiling phosphoricchromic acid. The difference in weight in milligram per square decimeter are indicated against each segment in the plate in the table in their respective positions. Table 1 gives the weight distribution of oxide film in mg. per sq. dm. over an anodised plate with and without the perforated shield in front of the aluminium sheets.

Example 2

One of the aluminium sheets processed as above up to electrograining stages is made the anode in a chromic acid anodising bath. The perforated PVC sheet of size 24″ × 20″ with 3/16″ dia. perforations at 0.75″ centre to centre distance is suspended 2″ before a lead cathode sheet and in between the anode and cathode and a d.c. voltage of 30 volts is applied between the anode and cathode. Again, the thickness of the oxide film is found to be more uniform over the entire area of the anodised aluminium. Fig. 2 gives the cell arrangement and Table 2 gives the weight distribution of oxide film in mg/sq. dm. over the anodised plates with and without the perforated shield in front of the cathode.

The following are among the main advantages of the invention:

1. In a tank of given size with sheet electrodes of given dimensions, the present invention of using a perforated insulated shield between the electrodes nearer to the cathode in case of d.c. anodising makes the distribution of the deposited film very uniform.

2. It is now possible to process sheets of different sizes in the same tank to get uniform thickness of oxide films by using a perforated insulating shield with proper distance from the cathode/anode, (distribution and size of perforations in the insulating shield predetermined), without the necessity of altering inter-electrode distances.

3. It is also possible to increase the current density threefold for hard anodising without causing burning of the edges as the current distribution is now more uniform.

TABLE 1

A.C. anodising in 15% v/v sulphuric acid 20°C 16 asf with air agitation 15 minutes

Weight of oxide film in mg. per sq. dm. at positions shown

Without the perforated shield						With perforated shield						Top
1	2	3	4	5	6	1	2	3	4	5	6	
195	190	190	190	210	215	190	190	195	195	190	195	A
200	200	190	195	220	220	195	195	195	200	200	195	B
210	200	200	205	215	220	200	195	195	200	195	200	C
240	220	225	225	235	235	210	200	205	205	200	210	D
230	225	220	230	235	240	220	210	205	205	200	215	E
												Bottom

TABLE 2

D. C. anodising in 10 % chromic acid 40°C 30V with air agitation 15 minutes
Weight of oxide film in mg. per sq. dm. at positions shown

Without perforated shield						With perforated shield						Top
1	2	3	4	5	6	1	2	3	4	5	6	
155	150	150	150	155	160	160	160	155	155	160	160	A
160	160	165	165	165	170	165	165	160	160	165	165	B
170	165	165	165	170	175	170	170	165	165	165	160	C
180	175	175	170	175	180	170	165	160	165	165	165	D
180	175	170	175	180	180	160	165	170	170	165	160	E
												Bottom

We claim:

1. An arrangement form uniform distribution of current flux on a working electrode/working electrodes in an electrolytic cell which comprises an electrolytic tank two electrodes (a cathode and an anode in case of d.c. electrolysis/both as working electrodes in case of a.c. electrolysis)—kept suspended in anodising and/or graining electrolyte, the electrodes being connected to two terminals of a suitable current supply —characterised in that an insulated perforated shield of such size is suspended at a suitable distance of 1 to 2.5 inches in front.

2. An arrangement with the insulated perforated shield as under claim 1 with perforations on the said shield the diameter of the perforations being 1/8″ to 1/4″ in size and positioned at distances 0.5″ to 1″ (centre to centre) from each.

3. An arrangement with the insulated perforated shield as claimed in claims 1 and 2 wherein the material of construction of said shield is polyvinyl chloride, perspex, acrylic resin, polypropylene, polyethylene, fibre reinforced glass or glass.

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