Aug. 1, 1972

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RECOVERY OF ELECTRO-CHEMICAL PLATING SOLUTIONS

Filed July 6, 1970
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Filed July 6, 1970, Ser. No. 52,155

Int. Cl. C23h 5/06, 5/48

U.S. Cl. 204—51

5 Claims

ABSTRACT OF THE DISCLOSURE

A process for economically recovering electroplating solutions, which are usually discarded, from an electroplating production line. The process provides for one or more static rinses where the plated material is washed free of the plating solution. The rinse solution is then filtered and treated in a cation exchanger where impurities are removed from the rinse and the purified solution returned to the plating tank for immediate use or to a holding tank for future use.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to an economical process for recovering and purifying electroplating solutions and more specifically to a recovery system which eliminates the need for the use of expensive evaporating and condensing equipment. The process can be operated economically to recover even small volumes of chemicals, which heretofore had to be chemically destroyed to satisfy anti-pollution laws in effect for rivers and the like.

Description of the prior art

Up until the present invention, recovery systems for retrieving plating chemicals from rinse solutions were very expensive and required the use of evaporating and condensing equipment. This equipment, which requires a large initial cost outlay to cover the purchase and installation of the equipment, is also expensive to operate and maintain. Thus because conventional recovery systems are so expensive, it is not economical to use such systems to recover relatively small volumes of plating chemicals produced each year in small plants. However, because of the increasing problem of pollution of rivers and streams, and the enactment of laws by the municipalities covering water pollution, the plating chemicals can no longer be discarded into sewer systems. Therefore, the industry has been using expensive chemical-destroying systems to eliminate the plating chemicals. Thus, those skilled in the art have been seeking, without success, a recovery system which is economical to install and to operate. Such a system would be required to recover plating chemicals, particularly where the chemicals are discarded in small volumes, at low cost without the necessity of a large capital investment.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a process for recovering plating chemicals from rinse solutions without using evaporating or condensing equipment and thus, materially reduce the cost of installing and operating the process.

It has now been discovered that by using at least one static rinse for rinsing the plated material, and then passing the rinse solution through a standard cation exchanger to remove all cationic ions, which represent most of the impurities in a chromium plating solution, the rinse water containing the purified plating solution and diluted plating solution can be returned to the plating tank without any further process steps. The invention enables small units to be economically used to purify small volumes of solution not previously recoverable because of the cost of the recovery equipment.

The cation exchange unit used in the process of the present invention can be any of the several types available. For example, an electrodialysis cell containing cation exchange material in the form of a membrane or gel can be used as well as cation exchange beds. The ion exchange material usually comprises a stable insoluble organic polymer having active acidic functional groups chemically bonded thereto and dissolvable into free mobile cations to impart a negative charge to the polymer. The active acidic functional groups can be SO₃H—COOH and the like which is attached to a polymer such as ureaformaldehyde resins, melamine formaldehyde resins, polyalkylene polyamineformaldehyde resin and the like. While there is nothing critical as to the choice of the cation exchange unit used, the unit must be capable of removing from the rinse solution cations such as sodium, copper, calcium, zinc, iron, nickel and trivalent chromium. It is these materials which are the impurities present in the rinse solution which will directly prevent the rinse solution containing the plating chemicals from being recycled to the plating tank.

The present process as explained above will work well with all types of commercial plating solutions. However, it has been found that the present process has particular utility in the chromium electroplating industry where only relatively small volumes of plating chemicals are discarded in some plants each year. A typical chromium plating solution consists of chromic acid, a catalyst such as sodium fluosilicate and a mist suppressant such as Zero Mist, manufactured by Udylite Corporation. All of these chemicals can be recovered with the method of the present invention and thus not only eliminates the cost for waste treatment but also saves the cost of the recovered chemicals which now can be used again in the plating operation.

Another advantage of the present process is that in using static rinses as opposed to the flow rinses of conventional systems the process can be operated with from about 60% to about 80% reduction in water use.

The process can also be used to purify plating solutions in a plating tank when the contamination level has exceeded tolerable levels and cause defective plating as will be more fully explained below.

BRIEF DESCRIPTION OF THE DRAWING

The advantage of the present invention can be more fully understood by reference to the accompanying drawing which illustrates a preferred embodiment of the invention.

Referring to the drawing, numeral 10 designates a plating tank in which the electro-plating operation is carried out in accordance with methods well known in the art.

Connected to the plating tank 10 by way of valve 12 is a heated holding tank 14, containing electroplating solution which is fed to the plating tank as needed. A pump can be used to move the plating solution from the holding tank 14 to the plating tank 10 or gravity flow can be used to move the solution by mounting the holding tank above the level of the plating tank.

The holding tank is preferably heated by means of a steam pipe (not shown) for purposes which will be explained below.

Three static rinse tanks 16, 18 and 20 are shown in the drawing as a matter of convenience and more or fewer tanks can be used. The tanks 16 and 18 are connected together by a valve 24. The valves are used to allow liquid flow from tank 20 to tank 18 to tank 16 and not in the reverse direction.
Static rinse tank 20 also has an inlet for receiving de-mineralized tap water through a valve 26 which is connected to a standard demineralizer unit 28 which, in turn, is connected to a source of tap water (not shown). The static rinse tank 16 is connected to the holding tank 14 through a cation exchanger 32, a filter 34 if required, a pump 36 and a valve 38.

The holding tank 14, which is heated, will evaporate water from the solution and thus concentrate the plating chemicals flowing into the holding tank 14 from the rinse tank 16. The holding tank will usually be heated before it reaches capacity so as not to overflow. Because of the evaporation taking place within the holding tank 14, the tank should be vented or hooded to permit fresh air to flow over the tank to carry away the water vapor.

In operating the process, the static tanks 16, 18 and 20 which are mounted on the same level are first filled with de-mineralized tap water by opening valve 26, to allow de-mineralized water to flow into tank 20 and through valves and 24 into tanks 16 and 18. Thus, the three tanks 16, 18 and 20 will fill simultaneously. After the tanks are filled, valves 26, 22 and 24 are closed.

The pieces or parts (not shown) that are to be plated are placed into the plating tank 10 where the plating operation is carried out. After the parts are plated, they are rinsed in the first static rinse tank 16. The parts will be cleaned of all of the plating solution it carried from the plating tank 10 in this one rinse. However, to insure that no plating solutions remain on the parts, the parts are then placed in tank 18 and then into tank 20. At this point most of the solution is rinsed from the parts. However, to assure that the parts are perfectly clean it is subjected to a second rinse (not shown). After the rinse, the rinses can be discarded as they will usually meet anti-pollution laws. A number of methods known to the art can be used to dispose of the rinsing rinses if the amount of chemicals present exceed legal limitations. For example, an active neutralizing chemical can be used to properly treat the traces of chemicals remaining.

After the production operations have proceeded for a sufficient length of time so as to build up a concentration of plating solution in the rinse tank 16, the recovery operations can begin. More specifically, valve 38 is opened and pump 36 started so as to pump the entire contents of static rinse tank 16 through the filter 34, and the cation exchanger 32 into the holding tank 14. The filter 34 and the cation exchanger 32 remove all solid particles and cations from the rinse solution respectively and allow only the pure diluted solution to enter the holding tank 14. After the static rinse tank 16 is emptied, the pump 36 is stopped and valve 38 closed. Valves 26, 22 and 24 are then opened and the static rinse tanks 16, 18 and 20 are filled with de-mineralized water as explained above.

An equally acceptable alternate procedure is to purify the rinse solution while the plating line is being used. This can be done by opening valves 22, 24, 26 and 38, and allowing the tanks 16, 18 and 20 to refill with de-mineralized water at the same rate that the rinse solution tank 16 is being pumped through the filter 34 and cation exchanger 32 into holding tank 14.

The process of the present invention can also be used to remove impurities which build up in a plating solution in the plating tank 10. At a predetermined time e.g., when the plating solution contains excessive impurities, such as once a week, the contents of static rinse tank 16 is pumped into holding tank 14 through the filter 34 and the cation exchanger 32. Solution is transferred by any suitable means, such as a bucket, siphon, or small pump, from the plating tank 10 to partially fill the static rinse tank 16. As shown in the drawing, the liquid level in tank 10 may be above the level in tanks 16, 18 and 20 so that tank 10 can be at least partially emptied by flowing out, through a valved line 17. Enough de-mineralized water is then added to the tank 16 and mixed to dilute the plating solution sufficiently so that when it is pumped through the cation exchanger it will not damage the cation resin. The solution is then pumped into holding tank 14 by way of filter 34 and cation exchanger 32. The now purified solution is returned to the plating tank 10 when needed.

The following example will illustrate further the present invention without, however, limiting the same thereto.

Using the equipment layout shown in the drawing, a 2600 gallon capacity plating tank is filled with a chromium plating solution consisting of 40 ounces per gallon (o.p.g.) of chromic acid (CrO₃) 0.9 o.p.g. of the catalyst sodium fluorosilicate (Na₂SiF₆) and 0.50 o.p.g. of the mist suppressant, Zero Mist, manufactured by Udyllte Corporation.

Three static rinse tanks 16, 18 and 20 each having a capacity of 250 gallons are filled with de-mineralized tap water in accordance with the method described above. After 12.5 hours of electroplating and rinsing production parts it has been found that the chromic acid concentration is 4 o.p.g. in static rinse tank 16 and very low in static rinse tanks 18 and 20 respectively. The dilution in static rinse tank 16 is 10 times, since the plating solution originally contained 40 o.p.g. of chromic acid. This corresponds to a plating solution carry-in of about 2 gallons per hour.

After the plating operations are stopped, valve 38 is opened and the rinse solution in static rinse tank 16 is pumped through the filter 34 and cation exchanger 32 to the holding tank 14. The material leaving the cation exchanger 32 is free of any insoluble particles and cathodic ions such as sodium, copper, calcium, zinc, iron, nickel and trivalent chromium. The purified diluted solution mix is then stored in the steam-heated holding tank 14 which had a capacity of 1000 gallons. After tank 16 is emptied, valves 22, 24 and 26 are opened and de-mineralized water is added to tank 20 until tanks 16, 18 and 20 are filled in accordance with the procedure described above.

The bottom of the holding tank 14 is located above the level of the top of the chromium plating tank 10 so that the solution will flow by gravity to the plating tank. The next morning 150 gallons of solution in the holding tank are allowed to flow into the plating tank 10 to replace water lost to evaporation and enrich the solution. The plating operation is then started and the process repeated.

When the level of the solution in the holding tank 14 rises until the tank is almost filled, the tank is then heated by steam passing through coils. This prevents overflow by evaporating part of the solution. In addition, the concentration of the solution increases making it more suitable for use in the plating tank.

It will be understood that it is intended to cover all changes and modifications of the preferred embodiments of the invention, herein chosen for the purpose of illustration, which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. A method of operating an electro-plating system which includes a plating tank and a series of rinse tanks arranged to successively receive the plated work for effecting progressive rinsing operations thereon; said method comprising the steps of (a) interconnecting the tanks with a number of liquid feed lines arranged in counterflow relation to the direction of solution movement taking place during the plating and rinsing operations; (b) batch-filling the system with water from a purified source by delivering purified water into the last clear rinse tank, thence through the interconnecting feed lines to the first most-contaminated rinse tank and plating tank; (c) periodically removing cathodic ions from the first rinse tank by, as by positioning a cation exchanger in the feed line going from the first rinse tank to the plating tank;
(d) carrying out the plating and rinsing operations with each of the tank feed lines closed and each rinse tank in a static-filled condition so that each rinse tank has a contamination build-up dictated solely by the nature of the work presented to the respective tank; and

(e) recovering plating solution in the rinse water and simultaneously replacing liquid lost from the plating tank by periodically repeating step (b).

2. The method of claim 1 wherein filling step (b) comprises the sub-step of passing liquid from the cation exchanger into a holding tank prior to delivery to the plating tank.

3. The method of claim 2 wherein the holding tank is selected to have a capacity appreciably greater than the contemplated solution losses from the plating tank during each operating interval, measured between successive replacements of the lost plating solution.

4. The method of claim 2 wherein the holding tank is located above the plating tank for gravity discharge thereto, and liquid is passed from the first rinse tank through the cation exchanger into the holding tank via a pump.

5. The method of claim 1 wherein the plating tank is cleansed of cathodic impurity accumulations by transferring solution therefrom into the first rinse tank, diluting the transferred solution with demineralized water from the aforementioned source, and passing the diluted solution through the cation exchanger.

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