ELECTROCHEMICAL MACHINING ELECTROLYTE FOR ZINC


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7 Claims

ABSTRACT OF THE DISCLOSURE

An electrochemical machining electrolyte for use primarily with zinc-based die castings which are to be machined at current densities of less than about 1,000 amps/in.². The electrolyte is an aqueous solution of glacial acetic acid, potassium dichromate, and at least one salt selected from the group consisting of sodium chlorate, potassium chlorate, sodium perchlorate and potassium perchlorate.

This invention relates generally to electrochemical machining electrolytes and more specifically to alkali metal dichromates, and particularly to zinc-based die casting alloys. This invention is an improvement to the electrolyte disclosed and claimed in copending U.S. patent applications Ser. No. 664,770 entitled "Electrochemical Machining Electrolyte," filed on Aug. 31, 1967, in the name of Mitchell La Boda and assigned to the assignee of the copending invention. It is intended that the aforesaid patent application be incorporated herein by reference. The aforesaid copending application relates to alkali metal dichromates and perchlorate-based electrochemical machining electrolytes. These electrolytes, heretofore referred to simply as "chlorate electrolytes," have revolutionized the electrochemical machining industry by providing a unique combination of properties which permit the rapid and accurate machining of metals with little or no overcutting or splash-cutting, while at the same time producing machined surfaces having finishes as low as 2–5 microinches. These electrolytes are effective on zinc and its alloys as well as a host of other metals. However, in order to obtain the extremely fine finishes on zinc alloys using only the chloride electrolytes it is generally necessary to use them under conditions where the current density was at least about 1,000 amps/in.². At current densities less than about 1,000 amps/in.², the finishes produced on the die castings and subsequent buffing steps were required to obtain more lustrous finishes. It is desirable to avoid such high current densities if possible because the metal removal rate is so high that control becomes more difficult. Likewise, at high current densities, special bus bar requirements must be met which may further complicate and increase the costs of a production process. Accordingly, it would be desirable to be able to obtain these fine finishes at more practical current densities which are below 1,000 amps/in.² and preferably down to about 100–200 amps/in.². It is likewise desirable to improve machining control possible with chloride electrolytes which are to be used to electrochemically machine zinc and its alloys.

Accordingly, it is an object of this invention to provide an improved chloride electrolyte especially tailored for use with zinc and its alloys, and especially the zinc-based die casting alloys, which electrolyte improves machining control and produces highly reflective, specular finishes at current densities substantially less than about 1,000 amps/in.².

This and other objects and benefits of the incident invention will become more apparent from the detailed disclosure which follows.

Briefly stated, this invention relates to the addition of acetic acid and dichromate ions to chloride electrolytes to be used for the electrochemical machining of zinc-based alloys. In its preferred form, the dichromate ions are provided by the dissolution of alkali metal dichromates and particularly potassium dichromate. The potassium salt is preferred because it is readily available and avoids any precipitation problems arising out of the common-ion effect. The effect of these additives is to produce highly reflective, specular finishes while reducing wild-cutting at current densities of less than about 1,000 amps/in.². This electrolyte contains at least about 50 g/L to saturation of the chlorate salt.

The acetic acid is added to improve machining control by reducing wild-cutting in the low current density areas of the zinc workpiece and accordingly is being designated as a machining controller. About 25–100 milliliters of glacial acetic acid per liter of electrolyte is sufficient for this purpose. Below about 25 ml/L, no appreciable improvement in machining control and wild-cutting reduction is noticed. Above about 100 ml/L, control is excellent but the metal removal or cutting rate is reduced considerably.

The dichromate ion appears to be the constituent which has the greatest influence on the specular finish and accordingly is being designated a surface improver. About 10–50 g/L of potassium dichromate is sufficient for this purpose. This corresponds to about 7–37 g/L of dichromate ion. Below 7 g/L, no appreciable improvement in the surface finish is noted. Above about 37 g/L, the specular finish is lost and the surface appears quite rough. It is believed that at the higher concentrations of dichromate there is some grain boundary attack which produces the roughened surface.

The additives of this invention are to be used with the chloride electrolytes disclosed and claimed in the aforesaid U.S. patent application Ser. No. 664,770. The chloride electrochemical machining electrolytes of that application were effective at concentrations of about 50 g/L to the saturation of the salt in the solution. However, the most practical operating concentration range is about 350–500 g/L. The same is true for this invention. Likewise, though other current densities may be used, it is most desirable and practical to operate these electrolytes at current densities of about 100–200 amps/in.², as these current densities provide adequate metal removal rates and do not introduce any particular manufacturing problems such as special equipment, bus bars, etc. This invention permits operation at this level without sacrificing fine finish advantages of the higher operating current densities (i.e., above 1,000 amps/in.²). The addition of acetic acid and dichromate ions to the chloride electrolyte will produce mirror-like finishes (i.e., 1 to 2 microinches) on zinc-based die castings which have been machined at current densities below 1,000 amps/in.² and especially in the range of about 50–200 amps/in.².

While acetic acid can be added in concentrations from about 25–100 ml/L, and dichromate ions added in concentrations of about 7–37 g/L, it is preferred to add about 50–100 ml/L of acetic acid and about 11–26 g/L of dichromate (e.g., 15 g/L—35 g/L K₂Cr₂O₇). The following are two specific examples of electrolytes formulated in accordance with this invention. These electrolytes are particularly useful for the electrochemical ma-
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chining of zinc-based die casting alloys SAE 903 and SAE 925. The composition of these respective alloys is as follows:

SAE 903

Copper—0.25 max.
Aluminum—3.5—4.3
Magnesium—0.03—0.08
Lead—0.007 max.
Cadmium—0.005 max.
Tin—0.005 max.
Iron—0.100 max.
Zinc—remainder

SAE 925

Copper—0.75—1.25
Aluminum—3.5—4.3
Magnesium—0.03—0.08
Lead—0.007 max.
Cadmium—0.005 max.
Tin—0.005 max.
Iron—0.100 max.
Zinc—remainder

EXAMPLE I

Sodium chlorate—350 g./l.
Potassium dichromate—25 g./l.
Acetic acid—100 mL/l.
Water—balance

EXAMPLE II

Potassium chlorate—70 g./l.
Sodium dichromate—25 g./l.
Acetic acid—100 mL/l.
Water—balance

While our invention has been described solely in terms of certain specific embodiments thereof, we do not intend to be limited thereto but rather only to the extent defined by the claims which follow.

We claim:

1. An electrolyte for the electrochemical machining of zinc and alloys thereof at current densities of less than about 1,000 amperes/in.² wherein said electrolyte contains a machining controller, a finish improver, and at least one salt selected from the group consisting of sodium chlorate, potassium chlorate, sodium perchlorate and potassium perchlorate, the improvement comprising said machining controller being acetic acid and said finish improver being dichromate ions.

2. The electrolyte as defined in claim 1 wherein the concentration of said acetic acid is between about 25 to about 100 milliliters per liter of electrolyte and the concentration of said dichromate ions is about 7 to about 37 grams per liter of electrolyte.

3. The electrolyte as defined in claim 2 wherein said dichromate ions are derived from the dissolution of the dichromate salts of the alkali metals.

4. The electrolyte as defined in claim 3 wherein said alkali metal is potassium.

5. The electrolyte as defined in claim 4 wherein said zinc alloy is selected from the group consisting of die casting alloys, the concentration of said acetic acid is about 50 to about 100 milliliters per liter of electrolyte and the concentration of said potassium dichromate is about 15 to about 35 grams per liter.

6. In the process for electrochemically machining zinc and its alloys at current densities of less than about 1,000 amperes per square inch using aqueous electrolytes consisting essentially of at least one salt selected from the group consisting of sodium chlorate, potassium chlorate, sodium perchlorate and potassium perchlorate, the improvement comprising adding to each liter of said electrolyte about 25 to about 100 milliliters of acetic acid to effect closer machining control and about 7 to about 37 grams of dichromate ions to effect improved surface finishes.

7. The process as claimed in claim 6 wherein said zinc alloys are selected from the group consisting of zinc-based die casting alloys, said current density is between about 100—about 200 amperes per square inch, the concentration of said acetic acid is about 50 to about 100 milliliters per liter of electrolyte and the concentration of said dichromate ions is about 11 to about 26 grams per liter of electrolyte.

References Cited

UNITED STATES PATENTS

2,805,197 9/1957 Thibault et al. 204—143

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