

[54] **REDUCTION OF ELECTROLYTIC CELL VOLTAGE BY ANODE VIBRATION**

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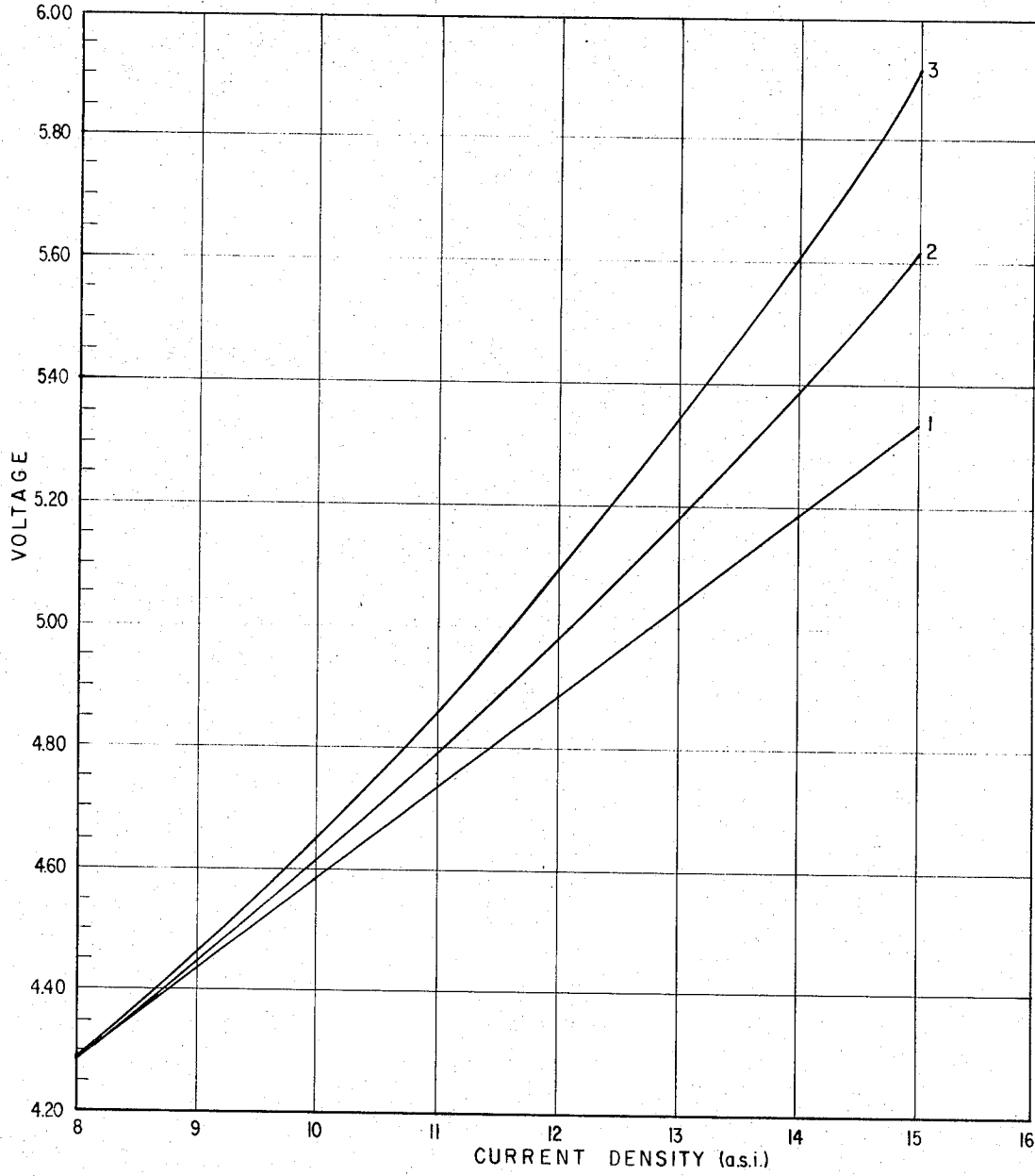
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[57] **ABSTRACT**

The operating voltage of an electrolytic cell in which gaseous evolution occurs at the anode is reduced by applying high speed mechanical vibration to the anode.

**2 Claims, 1 Drawing Figure**



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## REDUCTION OF ELECTROLYTIC CELL VOLTAGE BY ANODE VIBRATION

### BACKGROUND OF THE INVENTION

A variety of electrochemical reactions is known wherein electrical current is passed through an aqueous electrolyte between an anode and an opposed cathode, the current being such as to result in the generation of a gas or gasses at the anodic surface. Electrowinning of metals from aqueous solution, the electrolysis of water and the production of chlorine, caustic and the chemical compounds thereof are but a few examples of such reactions. As the applied anode current density in these processes is increased, the rate of production and the amount of gaseous evolution increase, as does the operating cell voltage. At least initially, this increase in voltage is, for all practical purposes, in direct relation to the increase in current density. However, it has been noted at the higher current densities desirable in order to increase the production rate of a given electrolytic cell that the voltage begins to increase at a rate greater than theoretical, resulting in an increase in power consumption per unit of product.

Attempts have been made to counteract this undesirable rate of increase in voltage. For example, following the suggestion of certain prior art, the electrolyte has been subjected to ultrasonic vibrations with, unfortunately, no detectable effect.

### STATEMENT OF THE INVENTION

Therefore it is an object of the present invention to provide a method for reducing the operating voltage of an electrochemical cell, which method is especially effective when the cell is operated at relatively high current densities.

This and further objects of the present invention will become apparent to those skilled in the art from the specification and claims which follow.

In a method for conducting an electrolytic reaction wherein, upon passing an electric current through an aqueous electrolyte between an anode and an opposed cathode, gaseous evolution occurs at the anode, the improvement has now been found which consists essentially of reducing the operating voltage by directly subjecting the anode to high speed mechanical vibrations.

### DESCRIPTION OF THE DRAWING

The FIGURE is a graph illustrating the improved performance of the present invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

As described above, the invention is applicable to those electrochemical reactions wherein an electric current is passed through an aqueous electrolyte at a voltage sufficient to achieve the desired reaction and result in the evolution of a gas or gasses at the anodic surface. Generally the gas evolved either is desired product (e.g., chlorine) or is required for a subsequent chemical reaction resulting in the desired product (e.g., chlorine reacting to chlorate). However, the invention functions equally as well where the gas evolved is an unavoidable by-product, the desired reaction occurring predominantly at the cathodic surface (e.g., oxygen at the anode in electrowinning).

The advantage of the instant invention is most marked at relatively high current densities wherein the

rate of production is such that considerable quantities of gas are evolved and rapid decomposition of the electrolyte occurs at the anodic surface. These conditions of high current density have become increasingly common-place in recent years with the advent of dimensionally stable anodes that are not subject to the usual decomposition and attrition of, for example, graphite at increased current densities.

The action to which the anode is subjected is stated as being "high speed mechanical vibration". As suggested by this phrase, together with the word "directly," it is intended that the anode itself, especially the working face thereof, be caused to vibrate, preferably at a rate in excess of 6,000, especially in excess of 9,000 vibrations per minute and up to speeds which may be considered ultrasonic (e.g., 20,000 vibrations/second). The vibrations are applied directly to the anode and/or its supporting and connecting framework up to and including the current lead in (busbar). Vibrations applied to other of the cell components, such as the cell supports or sidewalls, or to the electrolyte have been found to have substantially no effect.

The means for inducing the mechanical vibration is of little or no consequence to the invention, although obviously important from a practical standpoint. It has been found that in order to be effective the vibrations must be continually applied, that is, upon cessation of the vibrations the operating voltage immediately increases to its prior, excessive, value. For this reason the vibrating means should be chosen for its durability and simplicity of operation and maintenance. Typical of such are those vibrators in which compressed air is used to impart unbalanced rotation to balls or rollers which in turn induce vibrations in members in contact therewith.

Illustrative of the present invention is its effect upon the electrolysis of an aqueous alkali metal halide solution in a cell employing a dimensionally stable anode and a flowing mercury cathode. The cell used is a horizontal-type mercury cell employing an anode suspended above a steel cathode base plate, the assembly being enclosed to contain the electrolyte and products of electrolysis. The dimensionally stable anode is constructed primarily of titanium, is supported by an anode frame and is connected to a copper busbar. An anode riser leads from the busbar connection to the interior of the cell, the active working face of the anode consisting of a plurality of elongated rod-like elements positioned in a plane parallel to the flowing mercury surface and connected by welding through secondary conductors to the anode riser. The surface of these titanium rods is coated with an electrically-conductive electrocatalytically active material, in this case a titanium dioxide-ruthenium oxide deposit. The anode-cathode gap is established at 0.136 inch. A 305 grams/liter sodium chloride solution is employed as the electrolyte at an average cell temperature of 76°C.

The Figure shows the relationship between applied anode current density and the operating cell voltage at the above-described conditions. The first line (1) charts the theoretical straight line relationship between voltage and current density for the given conditions. Line 3 is a plot of the anode current density versus the actual cell voltage obtained, measured from anode face to mercury. Line 2 is again a plot of the measured voltage at the various current densities, all conditions being

the same as those of Line 3 with the exception that mechanical vibration is employed.

Vibration is effected by placing a commercially-available compressed air-driven vibrator (Vibrolator Model BDR-16, Martin Engineering Co.) directly on the anode busbar. The vibrator operates within the range of 9,000-11,000 vibrations per minute. The location of the vibrator on the copper busbar is a matter of convenience, attachment to the anode per se and the anode frame having been found to give equivalent results.

The substantial reduction in voltage obtained by the application of vibrational force is readily seen from the attached figure, reductions of up to 300 millivolts having been observed.

While the invention has been described with reference to certain preferred embodiments thereof, it is not to be so limited since changes and alterations may be made therein while remaining within the scope of the appended claims.

I claim:

1. An improvement in the method of electrolyzing alkali metal halide solutions by passing a current between an anode and an opposed cathode, said current being sufficient to cause gaseous evolution at the anode, which improvement consists essentially of causing said anode to vibrate rapidly and continuously by the direct application of mechanical force to the anode structure.

2. In a method of electrolyzing an aqueous alkali metal halide by passing current through said aqueous halide between an anode and an opposed cathode at an anode current density of greater than 8 amperes per square inch, the improvement which consists essentially of reducing the operating voltage by causing said anode to vibrate continuously at a rate of from 6,000 vibrations per minute up to ultrasonic by the direct application of mechanical force to the anode structure.

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