Title: ANODE ROD TRACKING SYSTEM FOR ELECTROLYSIS PLANTS

Abstract: Method for operating an electrolysis plant, said plant comprising an anode assembling station (comprising a rod mark reading station with means for reading the machine-readable rod mark and an anode mark reading station with means for reading the machine-readable anode mark), a potroom, a butt return station (comprising a rod mark reading station and an anode rod divert section into which rods can be diverted if the machine-readable rod mark cannot be read), a butt treatment station in which said anode assembly is separated into the anode rod and the used anode butt, a production management system, an anode marking station (with means for marking the anode with a machine-readable, individual anode mark) and a rod marking station (with means for marking the anode rod with a machine-readable, individual rod mark and an alphanumeric individual rod mark), and at least one handheld rod mark reading station.
ANODE ROD TRACKING SYSTEM FOR ELECTROLYSIS PLANTS

Background of the invention

This invention relates to electrolysis plants in which anodes, in particular carbon anodes, are consumed in a bath of molten inorganic material that undergoes electrolysis in a reduction cell between said anode and a cathode. In particular the invention relates to aluminum electrolysis plants (smelting plants) using the Hall-Heroult process to obtain metallic aluminum by electrolysis of alumina dissolved in a molten bath of cryolite. Electrical current is applied to the reduction cells between an anode and a cathode, and an electrolytic process take place in the electrolytic bath which produces an end product, such as aluminum.

These plants handle a large number of carbon anodes which can be fitted to metallic anode rods which are then connected to an electrical busbar (the anode beam). The fitting of the anode rod to the anode to form an anode assembly is usually carried out in a dedicated workshop (the rodding shop). These anode assemblies are then transported over relatively large distances within the plant. After consumption of the carbon anode in the electrolytic process, the anode assembly is withdrawn from the cell and replaced. The used anode assembly is returned into the rodding shop where the carbon anode butt is separated from the anode rod; the latter is then cleaned and reused in a new anode assembly.

In such an electrolysis plant it is desirable to keep trace of the different electrode parts. This allows in particular to monitor which anodes fail, and to improve the quality control of the processes involved in the manufacturing of such anodes. Usually each anode and each anode rod carry an individual marking. The marking of the anode rod should survive many cycles of use. As all the handling of the anodes, anode rods and anode assemblies is automatized, difficulties arise when the anode rod marking is no longer readable.

Prior art

It is known from US 2009/0136122 (ALCOA) to collect characteristic data for a plurality of anode assemblies used in aluminum electrolysis cells, to collect electrolysis cell data for a plurality of such electrolysis cells, to correlate electrolysis cell data and anode characteristic data to manage smelting activities. Anode assembly data are derived from images; they include geometrical characteristics, anode thickness, defects of various
forms. Each anode assembly can be identified by a unique data matrix, RFID or transponder. This information can be correlated with metal production data.

It is further known from US 2008/0067257 (Norsk Elektro Optikk AS) an electrode information system for electrodes for use in aluminum smelters, comprising an encoding and marking device for said electrodes and a reading and decoding device that allows to provide each electrode with a unique code.

Machine-readable marks or codes are known as such in many embodiments, as well as marking devices and reading devices; this is described in the patent application US 2008/0067257 cited above.

Potlines in aluminium smelters are a generally hostile environment characterized by high temperatures and high magnetic fields. Moreover, anodes being in contact with the melt at around 1000°C, the anode rod will become very hot. The marking of anode rods must withstand that heat and magnetic fields, and must be reliable over several cycles of use. In particular there can be some concern about the use of RFID technology in such an environment. The use of RFID tags for anode rod tracking has been described in the publication "ARTS - Anode Rod Tracking System - A New Tool For Optimization of Anode Performance" by Ivan Grle et al., published in Light Metals 2014, p. 1259-1262.

The present inventors have found that prior art processes of operating an electrolysis plant do not provide sufficient flexibility for the case where machine-readable anode rod marks cannot be read by a camera. This leads to the loss of useful data during the anode tracking process, and these data will be missing when trying to correlate electrolysis cell data and anode characteristic data to manage smelting activities.

Subject-matter of the invention

According to the invention, the problem is solved by using both a machine-readable and a human-readable anode rod mark, by providing appropriate means and process steps by which the human-readable anode rod mark can be entered manually into the production management system, and by diverting used anode rod assemblies into an anode rod divert section in which operators can manually input anode rod marks that are no longer machine-readable.

The subject-matter for the invention is a method for operating an electrolysis plant, said electrolysis plant comprising
(a) an anode assembling station in which an anode is fixed to an anode rod to form an anode assembly,
(b) a potroom comprising a plurality of pots in which said anode rod assembly is used in an electrolysis process,
(c) a butt return station,
(d) a butt treatment station in which said anode assembly is separated into the anode rod and the used anode butt,
(e) a production management system including a plurality of data input stations, memory units and displays,

and said electrolysis plant further comprising an anode marking station and a rod marking station, and at least one handheld rod mark reading station,

and in which electrolysis plant

(a1) said anode assembling station comprises a rod mark reading station and an anode mark reading station, said rod mark reading station and said anode mark reading station being possibly combined in one single station,
(a2) said rod marking station comprises means for marking the anode rod with a machine-readable, individual rod mark and an alphanumeric individual rod mark,
(a3) said rod mark reading station comprising means for reading said machine-readable rod mark,
(a4) said anode marking station comprising means for marking the anode with a machine-readable, individual anode mark,
(a5) said anode mark reading station comprising means for reading said machine-readable, individual anode mark,

(c1) said butt return station comprises a rod mark reading station, and further comprises a anode rod divert section into which rods can be diverted, wherein said rod mark reading station can be a part of said anode rod divert section,

and said at least one handheld rod mark reading station having means to input alphanumeric information,

said method for operating an electrolysis plant comprising the steps of:

(i) Assembling an anode and an anode rod in the anode assembly station to form an anode assembly, said anode carrying an individual anode mark A_n, and said anode rod carrying an individual machine-readable anode rod mark R_n,
(ii) Reading said individual anode mark $A_n$ at said anode mark reading station and said individual machine-readable anode rod mark $R_n$ at said rod mark reading station, and possibly associating said read anode mark $A_n$ and said read anode rod mark $R_n$ to an entity $E_n(A_n, R_n)$.

(iii) Storing said marks $A_n$ and $R_n$ and possibly said entity $E_n$ in said production management system,

(iv) Transporting said anode assembly from said anode assembly station to said potroom,

(v) Loading said anode assembly in an identified pot at an identified position,

(vi) Entering pot identifier information $C_n$ and position identifier information $P_n$ on said handheld rod mark reading station, and reading said machine-readable anode rod mark using with said handheld rod mark reading station, these three operations being carried out in any order, before or after the loading of said anode assembly in said pot, and whereby, if said machine-readable rod mark cannot be read by said handheld rod mark reading station, an operator reads said alphanumerical individual rod mark $R_n$ and enters it into said handheld rod mark reading station using said means to input alphanumeric information,

(vii) Storing said pot identifier information $C_n$, said position identifier information $P_n$ and said machine-readable anode rod mark $R_n$ or said alphanumerical rod mark $R_n$ in said production management system,

(viii) Operating said anode in said pot for a certain time,

(ix) Unloading said anode assembly from the pot and transporting said anode assembly to said butt return station,

(x) Reading said machine-readable anode rod mark $R_n$ using said rod mark reading station,

(x)(a) If said machine-readable rod mark cannot be read by said rod mark reading station, said alphanumeric rod mark $R_n$ is read by an operator and entered into said production management system, preferably by using said means to input alphanumeric information of said handheld rod marking reading station;

(x)(b) If said machine-readable rod mark $R_n$ can be read by said rod mark reading station, this reading is entered in said production management system and the rod is transported to said anode assembly station for further use.

wherein said steps (x)(a) and (x)(b) can be carried out before or after the rod assembly having passed said butt treatment station.
At step (x) the anode assembly can be diverted into said anode rod divert section, where steps (x)(a) and/or steps (x)(b) are carried out.

After step (x)(a) said anode rod mark can be cleaned or replaced, and said rod is then transported to said anode assembly station for further use.

Said anode mark reading station advantageously comprises an anode positioning mechanism capable of positioning the anode at a defined position for reading the anode mark. In an advantageous embodiment of the process, said machine-readable, individual anode mark is an alphanumeric mark (possibly including one or more special, non alphanumeric characters) that is also human-readable. This allows a manual input of said alphanumeric mark if it cannot be read by said anode mark reading station.

In the return butt station anode assemblies or anode rods can be diverted into the anode rod diverter station either for reading the anode rod mark (in which case the anode rod mark reading station is a part of said anode rod divert section), or after the anode rod mark reading station has failed to machine-read the anode rod mark. In this latter case diverting of the anode rods into the anode rod diverter station allows to separate these anode rods from the flux of anode rods that are immediately reusable in the process, knowing that the diverted anode rods have to undergo special treatment, including reading the rod mark by a human operator, cleaning the rod mark and possibly affixing a new rod mark. The inventors have recognized that this "special treatment" needs some time and cannot be carried out within a (continuous or discontinuous) flux of anode rods carried by a linear conveyor. While it is practical that the anode rod remains fixed to a conveying means, the anode rod diverter station represents a either a bifurcation of the conveyor, dividing the anode rod into two fluxes, or a loop of the conveyor.

In the "bifurcation" embodiment, the flux is divided into a first flux, called "ordinary flux", of anode rods bearing a rod mark that is (still) machine readable, and a second flux, called "diverted flux", of anode rods the mark of which is no longer machine readable. Anode rods of the ordinary flux can move on for immediate reuse. Anode rods of the diverted flux undergo special servicing (such as cleaning and/or replacement of the rod mark).

In the "loop embodiment" the flux is diverted into one or more loops that slow down their advancement, allowing to carry out servicing operations either on line or after having taken out anode rods that need to be serviced. Both embodiments can be combined.

In an embodiment of the inventive process:
- for each anode the anode mass $M_n$ is determined prior to forming the anode assembly, and said anode mass information $M_n$ is stored in said production management system; and/or

- for each anode assembly the mass $S_n$ is determined prior to its loading in the pot, and said mass information $S_n$ is stored in said production management system; and/or

- for each anode assembly the mass $T_n$ is determined after its unloading from the pot, and said mass information $T_n$ is stored in said production management system; and/or

- at least one image $I_n$ of the consumed anode and/or of the anode rod is taken after unloading the anode assembly from the pot, and said image information $I_n$ is stored in said production management system; and/or

- at least one image $J_n$ of the anode and/or of the anode rod is taken prior to its loading in the pot, and said image information $J_n$ stored in said production management system; and/or

- all the mass information and/or image information gathered on each anode is associated with said marks ($A_n$ and $M_n$) and possibly with said entity $E_n$.

In further embodiments that can be combined with any of the preceding ones, said pot identifier information $C_n$ and said position identifier information $P_n$ are stored in said production management system in association with said marks $A_n$ and $M_n$ and possibly with said entity $E_n$.

In further embodiments that can be combined with any of the preceding ones, said machine-readable anode rod mark $R_n$ is stored in said production management system in association with said marks $A_n$ and $M_n$ and possibly with said entity $E_n$.

In further embodiments that can be combined with any of the preceding ones, at the beginning of step (x(a)) said anode assembly is diverted into said rod mark station where said alphanumeric rod mark $R_n$ is read by said operator.

Advantageously, at the end of step (x) and after butt treatment said anode rod is transported to said anode assembly station for further use in the process for forming an anode assembly.

The method according to the invention for operating an electrolysis plant can be used for the production of aluminium.
Figures

The nine figures illustrate various aspects and embodiments of the invention.

Figure 1 shows a general outline of the flow diagram of the anode rod tracking process in the rodding shop and in the potline. Figures 2, 4, 5, 6 and 7 to give a more detailed view of embodiments of the various steps of figure 1. Figure 2 shows an embodiment of step 10, figure 4 shows an embodiment of step 20, figure 5 shows an embodiment of step 30, figure 6 shows an embodiment of step 40, and figure 7 shows an embodiment of step 50.

Figure 3 shows an anode mark read at step 110: properly aligned (figure 3b) or misaligned (figure 3a). Figure 8 shows an anode rod mark.

Figure 9 shows the information chain related to anodes of the electrolysis plant (solid lines) and the specific information added to the data base in this area (broken lines) in relation with the anode mark or the rod mark.

Description of the invention

The invention is based on the principle that each single anode and each single anode rod bear its individual identification code. As the anode is consumed during its use in the electrolysis pot, its identification code is no longer legible once it has been entered into the pot. When the anode is withdrawn from the pot (usually after an period of time of the order of one month) and discarded, certain pieces of information related to the anode will be valuable for monitoring the operation of the potline, in particular the weight and profile of what remains from the consumed anode (called anode butt), and the anode stub profile. Once introduced into the pot, the anode can no longer be identified by its anode mark, and that is why the anode rod is marked, too. Before immersing the anode into the pot a data set comprising the anode code and the anode rod code is stored, allowing to identify the anode by tracking the anode rod. The identification of the pot and of the location of the anode inside the pot (so-called stall number) allows a unique view on both pot behavior and anode behavior: possible dissymmetry of the pot and possible operational trends of the pot can be monitored as well as possible trends in intrinsic anode properties that may be related to specific events or trends in anode manufacturing (such as: voluntary changes in raw materials or anode baking process parameters; trends related to raw materials or green anode manufacturing; trends in anode baking process parameters); the monitoring of occurrence of catastrophic failure of anodes due to cracks or other causes adds to this information. In summary, the monitoring of consumable anodes in an
electrolysis plant yields a wealth of useful data, and anode rod tracking is the only way to keep track of the anodes.

Figure 1 shows a general outline of the flow diagram of the anode rod tracking process in the rodding shop and in the potline. This diagram focuses on the flow of anode rods and on the identification of anodes, anode rods and anode assemblies.

At step 10 the baked anode that has been marked with its anode mark enters the anode rodding shop. In the anode rodding shop the anode mark is read in the anode mark reading station, and the anode is weighed. Step 10 does not involve an anode rod, and for this reason a broken line is used for the arrow leading to the next step.

An embodiment of step 10 is explained is shown in more detail in Figure 2: the anode enters a conveyor (step 100), the anode mark is read (step 110) in the anode mark reading station and registered, and the anode is weighed (step 120). Steps 110 and 120 can be inverted. The data acquired (more particularly the data set formed by the anode mark and anode weight) is be stored in a computer system (step 130) for further processing and reporting.

The anode mark reading station comprises a camera and an illumination system. The anode mark is an alphanumeric mark (possibly comprising one or more special, non alphanumeric characters, such as: "<", ">", "=", ";", "") stamped directly into the anode; as the anode is consumable, no extrinsic material will be used for marking. Reading this marking with an optical device needs a controlled illumination of the anode mark, and proper alignment of the anode with respect to the reading device of the anode reading station is important. Figure 3 shows a typical anode mark: for an anode that is properly aligned (figure 3b) and that is misaligned (figure 3a).

In an advantageous embodiment of step 10 a camera captures an image of the anode; the reference to this image then is included in the set of data that is recorded into the data management system at step 130.

Reading of the anode mark can also be done prior to entering the anode into the rodding shop.

As shown in more detail in Figure 4, at step 20 the anode enters the anode assembling station (also called rodding station). Here the anode rod with its anode rod mark (that has previously been added to the anode rod in a rod marking station) is fixed to the anode (usually by inserting the extremities of the anode rod into holes machined into the upper surface of the anode that have been partially filled with liquid cast iron acting, upon
solidification, as a bonding agent), forming an anode rod assembly; this technology is known as such and not modified by the inventive process.

In the rodded anode station the rod mark is read in a rod mark reading station (step 210), and the anode rod assembly is weighed (step 230). The anode mark can also be read in an anode mark reading station (step 220). At step 240 the data acquired, and more particularly the set formed by the anode rod mark, the anode assembly weight and the anode mark (whether acquired at step 20 or taken from the data set acquired at step 110) are stored in a computer system.

In the embodiment of step 20 shown on figure 4 the anode mark and the rod mark are read simultaneously (steps 210 and 220), but they can also be read separately, in any order. Likewise, weighing of the anode assembly (step 230) can be carried before or after reading the anode mark and/or anode rod mark.

In an advantageous embodiment of step 20 a camera captures an image of the anode rod assembly; the reference to this image then is included in the set of data that is recorded into the data management system at step 240. In a variant of this embodiment two cameras are used, one capturing an image of the anode rod, the other capturing an image of the anode.

If the anode mark cannot be read at step 220 (this occasionally happens if the anode mark has been damaged or covered by metal cast) the anode will be identified with a dummy identifier (such as "xxxx") and excluded from further data analysis.

In one embodiment of the process according to the invention steps 10 and 20 can be merged.

At step 30 the anode assembly enters the potroom and is mounted on a pot (step 300) in a given position referred to as the stall number. This is done by a potroom operator (who is usually physically present at the potroom level), and is carried out using a specifically equipped crane operated by a crane operator.

As shown on figure 5, at step 310 the line reference, pot reference and stall reference are entered into a data management system: this can be done by an operator (advantageously by a potroom operator) using a handheld device. At step 320 the anode rod mark is read at a rod mark reading station. Said rod mark reading station can be a handheld device used by an operator (advantageously by a potroom operator); this handheld device may include an optical scanner configured to read the rod mark. In
practice, capturing of rod identification data is carried out by pointing the handheld scanner towards the mounted anode rod and pressing a scan button. This step is advantageously carried out by a potroom operator after mounting (setting) the anode by the crane.

Advantageously this is the same handheld device as that used in step 310. If the anode rod mark is legible (step 332), the rod mark identification is recorded into the data management system (step 350), and a set of data is formed that comprises the pot reference, the stall reference and the anode rod mark reference. If the rod mark is not legible by the rod mark reading station (step 331), the operator enters the rod mark manually (step 340) on the keypad of his handheld terminal.

The data transfer to the data management system at step 350 can be done individually for each anode assembly or for a set of anode assemblies. In one embodiment it can be carried out at the end of the shift or at the end of the operator's working sequence. It is preferred that the data transfer be carried out by the operator at a remote position rather than by wireless real time data transfer, because wireless data transmission in electromagnetically noisy environments like a potroom may be unreliable.

At step 40 the anode assembly enters the return butt station (step 400 on Figure 6 which shows a specific embodiment). The rod mark is read at a rod mark reading station (step 410). If at step 410 the anode rod mark is legible, the rod mark identification is recorded into the data management system (step 430). If the rod mark is not legible (this can happen if the rod mark has fallen off or has been seriously damaged, or more likely due to the accumulation of dirt or dust which is in general the main cause of unreadable anode rod marks at step 331, as well as at steps 210 and 410) the rod will be identified with a dummy identifier (such as "xxxxx") and excluded from further data analysis. Then the anode rod is extracted from the consumed anode (called "anode butt") (step 440).

At step 420 the weight of the anode assembly is determined and recorded at step 430 into a data management system. From this anode assembly weight (which comprises the anode rod weight and the weight of the anode butt) the anode butt weight is computed; as the anode butt is likely to disintegrate upon its extraction (step 440) it is not practical to determine its weight directly by weighing its remains after extraction from the rod assembly.

In an advantageous embodiment of step 40 a camera captures an image of the consumed anode; the reference to this image then is included in the set of data that is recorded into the data management system. Likewise, the anode rod image can be captures at that stage and recorded into the data management system.
At step 50 the used anode rod, substantially free from consumed anode (anode butt) and thimble (the metal, usually cast iron, used for joining the anode rod to the anode), is sent to the Auto Rod Diverter Station (step 500 on Figure 7). This is an essential step of the process according to the present invention; it ensures that all damaged and unreadable anode rod marks are replaced.

At the Auto Rod Diverter Station the anode rod mark is read at a rod mark reading station (step 510). If at step 520 the rod mark is readable (step 522), the anode rod will eventually be returned at step 530 to the rodded anode station 20 for a new cycle of use in an anode assembly. If at step 520 the rod mark is not readable (step 521), the anode rod is diverted at step 540 to the rod marking station.

At the rod marking station (step 70) the rod is serviced, that is to say the rod mark is first checked whether it needs to be replaced: in many cases the rod mark does not require replacement and cleaning will be sufficient for it to be readable again, whereas in other cases a new rod mark will have to be applied to the anode rod. Checking, cleaning and/or replacement of the anode rod mark are comprised here in the term "servicing". The serviced anode rod is then transferred to the rodded anode station 20 for a new cycle of use.

In an advantageous embodiment of step 50 a camera captures an image of the anode rod; the reference to this image then is included in the set of data that is recorded into the data management system.

In an advantageous embodiment the anode rod mark comprises a two-dimensional bar code. In another advantageous embodiment the anode rod mark comprises both a two-dimensional bar code and an alphanumeric code. These two codes can be included on a tag or plate that is affixed to the anode rod using mechanical means. Such a tag is shown on Figure 8. Advantageously said tag or plate is made of aluminium. Although no detachment of such plates has ever been observed by the applicant, it is possible for total safety to engrave the alphanumeric code on the rod, which avoids that both codes are lost in the unlikely event that the tag or plate is lost or has fallen off (for instance due to mechanical damage); this requires however specific engraving equipment.

This alphanumeric code representing the rod mark can be read and entered into a terminal by an operator when the machine-readable code is no longer legible (due to dust accumulation or mechanical damage) or has disappeared. Said terminal is advantageously a handheld device with a customized application.
A plurality of anode rod mark reading stations are used throughout the anode rod tracking process. They all comprise an anode rod mark reading device. Anode rod mark reading devices can be handheld or fixed. Fixed anode rod mark reading stations comprise a camera and a suitable illumination device, such as a colored LED array.

Optionally a secondary camera (so-called Light Enhancement System) can be mounted upstream to the main camera in order to determine the intensity of light reflected by the anode's surface. To maintain the uniform output from the main camera irrespective of the reflectivity of the anode surface, the main camera uses this light intensity value derived from the output of secondary camera for its settings.

In an advantageous embodiment a fixed anode rod mark reading station further comprises a nozzle directing an air jet pulse at the anode rod mark for blowing away accumulated dust.

During the reading process the anode rod (and the anode, where applicable) should be stationary (i.e. it should not move, and in particular it should not swing) and properly positioned and aligned with respect to the anode rod mark reading device; various mechanical devices can be used for the purpose of limiting movement and controlling the position and orientation of the anode assembly or anode rod, and each anode rod mark reading station should comprise an appropriate anode positioning mechanism or an anode rod positioning mechanism.

During certain steps of figure 1 the anode rod and/or anode rod assembly is carried by a conveyor, and will usually be freely hanging; swinging movements during the anode rod mark reading process should be avoided.

The data sets transferred to the data management system at the various steps of the process (for instance at steps 130, 240, 350, and/or 430) may comprise the date and time (the time may comprise the hours, minutes and possibly also the seconds) as well as photographs or reference to photographs. As described above, these photographs can be taken at various steps using cameras. Appropriate illumination devices as well as shading devices need to be provided in order to ensure a constant and reproducible illumination of the rod marking section (and the anode mark section, if applicable); furthermore means for cleaning the camera objective, the anode rod mark must be provided at appropriate steps in the process. As an example, the camera objective can be cleaned with an air jet nozzle blast, or dust accumulation can be avoided by a low air pressure curtain, possibly controlled by a computer system (also called control system).
Taking into account that the process according to the invention allows to identify which anode has been used in which stall, this process ensures the traceability of anodes. Moreover, as mentioned above, the anode rod tracking system according to the invention allows to gather a wealth of data that is specific to a given anode. In an advantageous embodiment of the invention, the data management system is capable of generating at least the following reports:

- Butt analyzer report,
- Stub Analyzer report
- Butt and Sub Profile Report
- Carbon consumption report,
- Butt parameter report,
- Rod history report,
- Anode butt damages report,
- Rod damage/rejections report.
- Production Planning Report

This is further explained in relation with figure 9. This figure shows the information chain related to anodes of the electrolysis plant (solid lines) and the specific information added to the data base in each area (broken lines) in relation with the anode mark or the rod mark (knowing that the anode mark is no longer readable once the anode has been plunged into the molten salt bath of the electrolysis cell). As can be seen from figure 9 in relations with figures 2,4,5, and 6, the information chain is consolidated on a single database application recorded in a data management system, based on a unique identification code of anode and rod.

The method according to the invention can be implemented with various variants, one of which being described here in more detail.

At the rod marking station the anode rod mark can be added to the anode rod on two sides of the anode rod. Said two sides can be adjacent (preferred) or opposite, and can be at the same height (preferred) or at a different height. This double marking makes it very unlikely that the anode rod mark is lost or not legible on both sides at the same time. To implement this variant, the machine that stamps the anode rod or affixes the tag or plate to the anode rod rotates by 90° or 180° in order to add the second anode rod mark; a 90° rotation is preferred because it is simpler and faster than a 180° rotation. Said machine either rotates itself or its fixture can support rotation. Since both anode rod marks are identical, it is sufficient that only one of them is read at the rod mark reading stations; if the first rod mark is missing or not readable, the second rod mark will be read (typically
by using a second camera or by the operator using his handheld reading device). The fact that one of the two rod marks is missing or not readable is detected at the Auto Rod Diverter Station, and the rod is then diverted into the rod marking station in order to add the missing rod mark.
CLAIMS

1. Method for operating an electrolysis plant, said electrolysis plant comprising
   (a) an anode assembling station in which an anode is fixed to an anode rod to form an anode assembly,
   (b) a potroom comprising a plurality of pots in which said anode rod assembly is used in an electrolysis process,
   (c) a butt return station,
   (d) a butt treatment station in which said anode assembly is separated into the anode rod and the used anode butt,
   (e) a production management system including a plurality of data input stations, memory units and displays,

and said electrolysis plant further comprising an anode marking station and a rod marking station, and at least one handheld rod mark reading station,

and in which electrolysis plant

   (a1) said anode assembling station comprises a rod mark reading station and an anode mark reading station,
   (a2) said rod marking station comprises means for marking the anode rod with a machine-readable, individual rod mark and an alphanumeric individual rod mark,
   (a3) said rod mark reading station comprising means for reading said machine-readable rod mark,
   (a4) said anode marking station comprising means for marking the anode with a machine-readable, individual anode mark,
   (a5) said anode mark reading station comprising means for reading said machine-readable, individual anode mark,
   (c1) said butt return station comprises a rod mark reading station, and further comprises a anode rod divert section into which rods can be diverted, wherein said rod mark reading station can be a part of said anode rod divert section,

and said at least one handheld rod mark reading station having means to input alphanumeric information,

said method for operating an electrolysis plant comprising the steps of:
(i) Assembling an anode and an anode rod in the anode assembly station to form an anode assembly, said anode carrying an individual anode mark \( A_n \), and said anode rod carrying an individual machine-readable anode rod mark \( R_n \).

(ii) Reading said individual anode mark \( A_n \) at said anode mark reading station and said individual machine-readable anode rod mark \( R_n \) at said rod mark reading station;

(iii) Storing said marks \( A_n \) and \( R_n \) in said production management system,

(iv) Transporting said anode assembly from said anode assembly station to said potroom,

(v) Loading said anode assembly in an identified pot at an identified position,

(vi) Entering pot identifier information \( C_n \) and position identifier information \( P_n \) on said handheld rod mark reading station, and reading said machine-readable anode rod mark using with said handheld rod mark reading station, these three operations being carried out in any order, before or after the loading of said anode assembly in said pot, and whereby, if said machine-readable rod mark cannot be read by said handheld rod mark reading station, an operator reads said alphanumerical individual rod mark \( R_n \) and enters it into said handheld rod mark reading station using said means to input alphanumerical information,

(vii) Storing said pot identifier information \( C_n \), said position identifier information \( P_n \) and said machine-readable anode rod mark \( R_n \) or said alphanumerical rod mark \( R_n \) in said production management system,

(viii) Operating said anode in said pot for a certain time,

(ix) Unloading said anode assembly from the pot and transporting said anode assembly to said butt return station,

(x) Reading said machine-readable anode rod mark \( R_n \) using said rod mark reading station,

(x)(a) If said machine-readable rod mark cannot be read by said rod mark reading station, said alphanumerical rod mark \( R_n \) is read by an operator and entered into said production management system, preferably by using said means to input alphanumerical information of said handheld rod marking reading station;

(x)(b) If said machine-readable rod mark \( R_n \) can be read by said rod mark reading station, this reading is entered in said production management system and the rod is transported to said anode assembly station for further use.
wherein said steps (x)(a) and (x)(b) can be carried out before or after the rod assembly having passed said butt treatment station.

2. Method according to claim 1, wherein at step (x) the anode assembly or anode rod is diverted into said anode rod divert section, where steps (x)(a) and/or steps (x)(b) are carried out.

3. Method according to any of claims 1 or 2, wherein after step (x)(a) said anode rod mark is cleaned or replaced and wherein said rod is then transported to said anode assembly station for further use.

4. Method according to any of claims 1 to 3, wherein said machine-readable, individual anode mark is an alphanumeric mark (possibly comprising one or more non alphanumeric characters) that is also human-readable.

5. Method according to any of claims 1 to 4, wherein the anode mark reading station comprises an anode positioning mechanism capable of positioning the anode at a defined position for reading the anode mark.

6. Method according to any of claims 1 to 5, wherein for each anode the anode mass \( M_n \) is determined prior to forming the anode assembly, and wherein said anode mass information \( M_n \) is stored in said production management system.

7. Method according to any of claims 1 to 6, wherein for each anode assembly the mass \( S_n \) is determined prior to its loading in the pot, and wherein said mass information \( S_n \) is stored in said production management system.

8. Method according to claim 7, wherein for each anode assembly the mass \( T_n \) is determined after its unloading from the pot, and wherein said mass information \( T_n \) is stored in said production management system.

9. Method according to any of claims 1 to 8, wherein at least one image \( I_n \) of the anode assembly is taken after unloading the anode assembly from the pot, and wherein image information \( I_n \) is stored in said production management system.

10. Method according to any of claims 1 to 9, wherein at least one image \( J_n \) of the anode and/or anode rod is taken prior to its loading in the pot, and wherein said image information \( J_n \) stored in said production management system.

11. Method according to any of claims 6 to 10, wherein all the mass information and/or image information gathered on each anode is associated with said marks \( A_n \) and \( M_n \).
12. Method according to any of claims 1 to 11, wherein said pot identifier information $C_x$ and said position identifier information $P_x$ are stored in said production management system in association with said marks $A_n$ and $M_n$.

13. Method according to any of claims 1 to 12, wherein said machine-readable anode rod mark $R_n$ is stored in said production management system in association with said marks $A_n$, and $M_n$.

14. Method according to any of claims 1 to 13, wherein at the beginning of step (x(a)) said anode assembly is diverted into said rod mark station where said alphanumeric rod mark $R_n$ is read by said operator.

15. Method according to any of claims 1 to 14, wherein at the end of step (x) and after butt treatment said anode rod is transported to said anode assembly station for further use in the process for forming an anode assembly.

16. Method according to any of claim 1 to 15, wherein said rod mark reading station and said anode mark reading station are combined in one single station.

17. Method according to any of claims 1 to 16 for the production of aluminium.
Figure 1

Anode Entry point

Rodded Anode station

Potlines

Return Butt station

Auto Rod Diverter

Rod mark readable?

Rod Marking Station

Figure 3a

Figure 3b
Anode enters conveyor 100

Read anode mark 110

Acquire anode weight 120

Record data into data management system 130

Rodded anode station 20

Anode enters rodding station 200

Read anode rod mark 210

Read anode mark 220

Acquire anode assembly weight 230

Record data into data management system 240

Potline 30
3/5

Anode assembly is mounted on pot 300

Operator enters references concerning pot line, pot and stall 310

Read anode rod mark at a rod mark reading station 320

Rod mark readable? 330

Yes 332

Record data into data management system 350

331 no

Operator enters rod mark manually 340

Enter auto rod diverter station 500

Read anode rod mark at a rod mark reading station 510

Rod mark readable? 520

Yes 522

Return to rodded anode station 530

521 no

Rod marking station 540

Figure 7
400: Enter return butt station
410: Read anode rod mark at a rod mark reading station
420: Acquire anode butt weight
430: Record data into data management system
440: Extract anode rod from anode butt

Figure 6

Figure 8
Anode tracking

Dock -> Anode raw materials
Green mill
Process parameters
Green anode weight
Baking kiln
Anode mark
Process parameters
Baked anode weight
Rodding
Anode assembly weight
Rod mark, anode mark
Butt weight
Anode rejection
Rod/stub damages
Potlines
Line + cell + stall
Process parameters
Anode problems
Anode rejection

Figure 9
A. CLASSIFICATION OF SUBJECT MATTER
IPC: C25C 3/06 (2006.01); C25C 3/12 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED:
Minimum documentation searched (classification system followed by classification symbols)
C25C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WIPO, EPODOC, PAJ, TXTG, Espacenet, Internet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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[x] Further documents are listed in the continuation of Box C. | [x] See patent family annex.

*T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention.

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family.

Date of the actual completion of the international search: 12 January 2016 (12.01.2016)

Date of mailing of the international search report: 14 January 2016 (14.01.2016)

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