MULTIPOLAR MAGNESIUM CELL

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ABSTRACT

Molten metal is continuously produced by electrolysis of a molten electrolyte which is denser than the metal in an electrolytic multipolar cell characterized by a high and stable current efficiency. Molten metal droplets are separated from the circulating electrolyte along a set of horizontal channels of gravity settlers disposed between the electrolysis chamber and the metal collecting chamber. Thereafter the metal rises to and floats on the surface of the electrolyte in the metal collection chamber, is conveyed to a metal collecting reservoir immersed in the electrolyte and periodically removed to maintain the cell in continuous operation. The coalescence of the metal droplets is enhanced by sealing the cell to prevent ingress of air into the chlorine room and into the front compartment. The sealing is obtained by lowering the joint between the covers and the cell walls to levels close to the electrolyte level and by using large impervious ceramic tiles in the lowered joint, in the barrier wall between the chlorine room and the front compartment and as a cladding of the walls of the cover of the electrolysis chamber and by cladding the exposed graphite surfaces with a gas barrier foil. The barrier wall and other consumable components are removable without emptying the cell, for an increased campaign life. Surplus heat is controllably and safely extracted from the electrolyte in a recoverable way by a set of evaporative heat extraction devices immersed in the electrolyte across the circulating stream.
MULTIPOLAR MAGNESIUM CELL

FIELD OF THE INVENTION

[0001] The invention is an improved process and apparatus for the continuous production of molten metal in an electrolytic cell by electrolysis of a molten salt electrolyte which is denser than the metal. More specifically, it relates to multipolar cells which are in commercial use for the production of magnesium. In a notably important sense, the invention is concerned with process and apparatus for the production of magnesium at high productivity and power efficiency with improved campaign life.

BACKGROUND OF THE INVENTION

[0002] The invention relates to electrolytic cells for the production of a metal by electrolysis of a molten electrolyte which is denser than the metal, and has a particularly useful but not exclusive application in the production of magnesium by electrolysis of molten electrolyte containing magnesium chloride. These cells have a chlorine room where the chlorine gas is collected and a front compartment in which the molten metal collects and is stored between periodic tapping operations. This inventor has been involved in the development of magnesium cells for a long time and his contributions to their technological progress are documented in many U.S. patents, for example U.S. Pat. No. 5,396,994, issued August 1998; U.S. Pat. No. 4,960,501, issued October 1990 and U.S. Pat. No. 5,855,775 issued January 1999, including Provisional U.S. Patent Application 61/372,854 filed Aug. 11, 2010, which are included herein as reference. Over the years, major advances have resulted in increased productivity and decreased power consumption, especially with the development of multipolar cells of the type described in the last two cited patents.

[0003] The use of multipolar cells has resulted in increased cell production due to the simple fact that each of the inter-electrode spaces contributes to the metal production, which is proportional to the DC current being supplied to the cell multiplied by the number of inter-electrode spaces. The number of inter-electrode spaces is however limited by the increased current bypass due to the increased electrolyte flow requirements. Also, the number of inter-electrode spaces and the DC current that could be used are limited by the surplus heat generated within the cell. The use of conventional heat exchangers to extract the heat takes up valuable space in the metal collection chamber inside the cell.

[0004] The construction of existing cells is such that ingress of ambient air is difficult to avoid completely. The consequence oxidation of the metal and hydrolysis of the electrolyte results not only in reduced metal coalescence but also in wear of the graphite electrodes and damage to the refractory lining, with consequent short cell life. The existing cells are not designed to remove and replace consumable components easily, except for some components in the metal collection chamber that can be replaced by removing and replacing the cover to which they are attached. The maintenance expenses are high because of the limited campaign life of some non-removable components of the cell.

[0005] In these cells, current efficiency has been negatively affected by the need to maintain a high electrolyte circulation in order to limit the back-reaction between the metal and the chlorine in the inter-electrode spaces. Only by maintaining strict process control, efficiencies up to 80% could be reached and maintained with difficulty, as compared to 90% obtainable with monopolar cells. It is now realized that a significant loss of current efficiency, attributable to the inefficient collection of metal droplets in the metal collection chamber, could be significantly reduced in cost-effective ways.

PRIOR ART

[0006] A good description of the prior art is contained in U.S. Pat. No. 5,855,775 where it is stated that “coalescence could be a significant factor to improve the current efficiency of multipolar cells, as it is believed that droplets, which are smaller than a critical size and are re-circulated in the electrolysis compartment, are consumed by back reactions in the inter-electrode spaces. The critical size of the metal droplets depends on the degree of turbulence and on the path of the circulating electrolyte. Therefore, the geometry of the metal compartment where the metal separates by upwards settling is very important to obtain high current efficiency.” See also Sivilotti O. G., Operating Performance of the Alean Multipolar Magnesium Cell, Light Metals, 117th AIME Annual Meeting, Phoenix, 1988 and Olivo G. Sivilotti, Development of the Multipolar Magnesium Cell: a Case History of International Cooperation in a Competitive World, Magnesium Technology, TMS Annual Meeting, San Diego, 2011.

[0007] While satisfactory operation has been obtained with multipolar cells of the prior art, the present invention is designed to obtain significant improvements in such cells and in their method of operation. The main objective is a better current efficiency and improved yield and metal recovery. Longer operating life and lower maintenance expense are also obtained by constructing the cell with consumable components that are removable and replaceable while the cell is maintained in operation, and by providing better seals both in the chlorine room and in the front compartment. Higher productivity and improved energy efficiency are obtained by providing the cell with a novel heat extraction system.

SUMMARY OF THE INVENTION

[0008] It is an object of the invention is to provide an electrolytic cell of long campaign life with removable and replaceable consumable components and of tight and cost-effective construction for the production of metals lighter than the electrolyte.

[0009] Another object of the present invention to provide a process to produce at high current efficiency magnesium and other molten metal products lighter than the electrolyte by efficiently separating the metal from the electrolyte stream.

[0010] A further object of the invention is to improve a multipolar cell by providing it with a heat extraction and electrolyte temperature control system that is based on safe, energy efficient and externally controllable evaporator/condenser heat transfer technology.

[0011] Thus the invention provides a process for the production of a molten metal by electrolysis in an electrolytic cell having an electrolysis chamber and a metal collection chamber. The process comprises electroyzing in the electrolysis chamber an electrolyte containing a fused salt to produce molten metal, the electrolyte having a greater density than the metal; causing the metal and the electrolyte to circulate continuously from the electrolysis chamber to the metal collection chamber and continuously separating the metal from the electrolyte by gravity settlers to increase the metal collection efficiency within the cell.
Additionally, the invention provides a multipolar electrolytic cell comprising an electrolysis chamber; a metal collection chamber and means to safely and controllably extract surplus heat from the electrolyte by an array of evaporative heat extraction devices immersed in the electrolyte across the circulating stream in the metal collection chamber and to transfer the heat to a condensing device located outside the cell where the heat can be recovered.

Furthermore, the invention provides a sealed cell to prevent oxidation of the metal and hydrolysis of the electrolyte and a method to remove and replace consumable components without the need to empty the cell, in order to effect significant improvements in maintenance costs, as it will become apparent by studying the drawings and reading the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of the invention will become apparent upon reading the following detailed description and upon referring to the drawings in which:

FIG. 1 is a partial cross section "AA" through a plane of electrolyte circulation of a cell according to the invention, equipped with gravity settlers in the electrolysis chamber to separate the light metal from the electrolyte stream, a metal collecting reservoir to facilitate tapping at infrequent intervals, and an array of evaporative heat extraction devices immersed in the electrolyte across the circulating stream in the metal collection chamber to transfer the surplus heat to a condenser located outside the cell, and means to seal the cell to stop any ingress of ambient air into the chlorine room and into the front compartment during normal operation, including removable consumable component means.

FIG. 2 is a horizontal section "BB", at an elevation above the surface of the electrolyte, showing a cell according to the invention, equipped with gravity settlers on the back of the cathodes, a metal pump and a metal collecting reservoir and an array of evaporative heat extraction devices immersed in the electrolyte across the circulating stream in the metal collection chamber and a removable barrier wall to seal the chlorine room from the ingress of ambient air while the cell is in operation.

FIG. 3 shows a partial cross section of a conventional cell through the same plane of electrolyte circulation as in FIG. 1. The cell is equipped with gravity settlers, a metal collecting reservoir and an array of evaporative heat extraction devices immersed in the electrolyte across the circulating stream, all located in the metal collection chamber and all removable and replaceable while the cell is in operation, according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

As is evident in the prior art, and in any event to those skilled in the art, the invention is in the context of electrolyzing a fused salt to produce a molten metal lighter than the salt in multipolar electrolytic cells, which are divided into electrolysis and metal collection chambers separated by a partition or curtain wall and have at least one electrode assembly including a cathode defining within it a cavity, an anode disposed within the cavity and at least one intermediate bipolar electrode disposed between the anode and the cathode within said cavity. When the cell is in operation, a natural circulation is set up, brought about by the liberation of gas in the inter-electrode spaces. As the gas rises, it functions as a gas-lift pump to set up the electrolyte circulation within the cell. The inter-electrode spaces operate in parallel as far as the circulation of electrolyte is concerned, and operate in series as far as the electric current is concerned. Various means have been used to direct the circulating stream along the upper part of the cell from the electrolysis chamber to the metal collection chamber and hence downward to the lower part of the metal collection chamber and back to the lower part of the electrolysis chamber under the electrode assemblies. For example, in the cell of U.S. Pat. No. 4,960,501, a baffle means 36 is provided on the back of the cathodes to deflect the stream towards the upper part of the metal collection chamber, where a floating metal pad is formed and is tapped on an intermittent basis. At appropriate times in the cycle, the cell is fed to enrich the electrolyte.

Two general criteria are required to obtain current efficiencies that are close to those obtainable in monopolar electrolytic cells that collect the metal at the cathode and keep it separate from the electrolysis gas (as, for example, in U.S. Pat. No. 3,396,094). First, the metal droplets that are released in the inter-electrode spaces and are entrained in the circulating electrolyte must spend the shortest possible time in the inter-electrode spaces; and, second, the droplets must separate from the electrolyte into a metal pad regardless of their small size. To meet the first criterion the electrolyte is made to circulate as fast as possible in the inter-electrode spaces and to meet the second criterion, notwithstanding the large electrolyte flow, means must be provided to obtain rapid coalescence and separation of small metal droplets before they are returned with the electrolyte to the bottom of the electrode assemblies.

When ambient air is allowed to enter the cell, it creates oxidation conditions and the salt reacts readily with the moisture in the air. The hydrolyzed electrolyte affects not only the reaction on the anodic surfaces by attacking and consuming the graphite but also the reaction on the cathodic surfaces by co-depositing metal oxide species that cont the metal being produced. When electrolyzing magnesium chloride to produce magnesium, for example, it is known from the old literature that the cathodes may become coated with solid magnesium oxide layers and some of the metal produced is coated with an oxide film that prevents coalescence of the droplets. Therefore, production of "fish egg" metal is sometimes detected under the floating metal pad or even in the sludge that accumulates on the bottom of the cell. These conditions are characterized by very poor current efficiency.

Reference to FIGS. 1 and 2, the apparatus illustrated is an electrolytic cell 10 having a conventional structural steel casing 12 lined with insulating and refractory walls 14 suitable to contain a molten salt electrolyte 16. Cell 10 is divided into an electrolysis chamber 18 and a metal collection chamber 20, which are enclosed by back wall 22, front wall 24 and side walls 26 and 28.

Electrode assemblies 30 are shown in electrolysis chamber 18, including cathodes 32 defining within them cavities in which anodes 34 are disposed in facing relationship. One or more bipolar electrodes 36 are disposed, also in facing relationship, between cathode 32 and anode 34 to form multiple inter-electrode spaces 38 operating in series as far as the electric current is concerned and in parallel as far as the electrolyte circulation is concerned. The electrolyte circulation is driven by the gas rising in the inter-electrode spaces 38 and is directed from the electrolysis chamber 18 to the metal collection chamber 20.
The electrolyte from the electrolysis chamber 18, before reaching metal collection chamber 20, flows through gravity settlers 42 that replace baffle means described in U.S. Pat. No. 4,960,501 as item 36. Gravity settlers 42 comprise sets of thin plates 46 stacked vertically and disposed in horizontal or sub-horizontal planes to divide the flow of electrolyte into horizontal or sub-horizontal flow channels 48, one upon the other. Channels 48 form uniform-velocity streams, operating in parallel, and the retention time of the electrolyte between entry and exit of each channel is proportional to the height of the channel. The average retention time of the electrolyte in gravity settler 42 is between one to ten times the retention time of the electrolyte in the inter-electrode spaces 38. Plates 46 can be disposed in horizontal planes but are preferentially inclined upwards towards the exit of gravity settler 42. The metal collects and coalesces under plates 46 into a molten metal layer when wetting conditions are adequate, or flows with the electrolyte as a monolayer of metal droplets ready to coalesce. Inclined plates make the draining of the electrolyte from the gravity settler easier, when cathode 32, to which the plates are attached, is removed from a cell full of electrolyte for maintenance.

The stack of plates 46, across the plane of electrolyte circulation, are preferentially shaped as inverted wide-angled chevrons of included angles between 0.8r and 0.95r, so that the collected metal flows towards riser 50 located at the vertices of the inverted chevrons at the exit of gravity settler 42. Risers 50 are located below inverted trough 52 that conveys the collected metal transversely to a discharge opening 54 at one of the two sides of the metal collection chamber 20 where a metal pump 56 is located. The metal rises from the discharge opening 54 of the inverted trough 52 to the surface of the electrolyte, forming a metal pad 58.

Pump 56 conveys the metal to a metal collecting reservoir 60, from which it is intermittently removed with conventional means through tapping standpipe 62. Pump 56 can be as described in FIG. 5 of U.S. Pat. No. 5,855,757, or can be another pump suitable for molten metal and molten salt operation. The intake of pump 56 is located at the metal pad/electrolyte level 70 while the discharge is directed towards the open bottom of metal collecting reservoir 60. The surface electrolyte circulates sideways from corner 64 towards metal pad 58, directed by baffles 66 and 68, and flows downwards, freed of metal, in free space 44 to re-enter the electrolysis chamber 18 through port 45 and reaches the bottom of electrode assemblies 30 to restart the cycle. Standpipe 72 is used to feed cell 10 intermittently, as needed, to maintain continuous operation. An open-bottom submerged tank 74 is partially filled with inert gas to maintain the electrolyte level 70 constant during operation, independently from the feeding and tapping cycles.

An array of evaporative heat extraction devices 76 immersed in the electrolyte across the circulating stream in metal collection chamber 20 are provided to transfer surplus heat from the electrolyte to a condenser outside the cell via manifold 78 located above cover 80 of metal collection chamber 20. Manifold 78 is connected to a steam duct, not shown, to a heat recovery system somewhere else in the plant. Boiler-quality water is supplied from an outside condenser/water storage tank and pumping system, not shown, common to the whole plant. Evaporative heat extraction devices 76 are fed in parallel in the array via a pressure regulating valve responsive to a thermostat that senses and controls the temperature of the electrolyte. Individual level control valves 82 respond to floats 84 located close to the bottom of evaporators 85. The throttling action of valves 82 is required for safety reasons to avoid flooding conditions in evaporators 85, which may occur due to progressive deterioration of the heat transfer efficiency of an evaporator at the end of its campaign life. For this reason, the opening of control valve 82 varies with time and is externally monitored. An alarm alerts the operator of the impending need to replace an aging evaporator and, if the operator does not respond, valve 82 shuts off the flow of water to evaporator 85 to provide automatic protection against unsafe operating conditions.

Re-circulated water enters evaporator 85 through feed ring 86 and is sprayed tangentially downwards around the full circumference at an angle that imparts a swirling action to the flow. This swirling action of the downward liquid flow is maintained by providing evaporator 85 with a continuous spiral gutter 88 that surrounds the inner wall and extends all the way down to the bottom of evaporator 85. The outside diameter of gutter 88 is smaller than the inside diameter of evaporator 85 and a screen 90 is fitted around spiral gutter 88 to maintain a liquid curtain continuously flowing down in the gap and to separate the liquid from the rising vapor flow. The latter is affected by the spiral gutter and acquires a swirling action that separates by centrifugal force the water droplets that are entrained in the rising vapor.

Steel-cased refractory cover 80, above metal collection chamber 20 is extended downwards along front wall 24 and side walls 26 and 28 to horizontal front joint 92, located just above the maximum operating level 70 of the electrolyte, inside outer rim 94 of steel casing 12. Similarly, steel-cased refractory cover 96, above electrolysis chamber 18 is extended downwards along back wall 22 and side walls 26 and 28 to horizontal back joint 98, located just below the minimum operating level 70 of the electrolyte inside outer rim 94 of steel casing 12. The difference in elevation between front joint 92 and back joint 98 is less than 10 cm.

A horizontal layer of large, impervious, insulating and corrosion-resistant ceramic tiles 100 is installed flat along joints 92 and 98 on top of walls 22, 24, 26 and 28 and acts as a seal, spanning over the inner faces of refractory walls 14 and the outer rim 94 of steel casing 12. Tiles 100 support the refractory-lined and steel-cased covers 80 and 96 and separates and electrically insulates them from steel casing 12.

Steel-cased covers 80 and 96 are also provided with high temperature seals in all the joints between the steel cases and the equipment installed through them, to prevent ingress of ambient air into the cell. Only the small surfaces of metal and of electrolyte within the standpipes 62 and 72 are exposed to ambient air when lids 102 and 104 are opened during feeding and tapping operations.

Cell 10 is provided with a gas-tight primary barrier wall 106 across the width of cell 10. Barrier wall 106 is supported at both ends on tiles 100 and by a steel beam 108 that runs above and outside (out of electrical contact with) steel cases 110 and 112 of covers 80 and 96. Steel beam 108 frames a double layer of tiles 114 and 116, which are disposed in the vertical plane that separates cover 96 of the electrolysis chamber 18 from cover 80 of the metal collecting chamber 20. During operation, tiles 114 and 116, reaching below the minimum operating level 70 of the electrolyte, form a stable sealing structure between chlorine room 118 and front compartment 120. Primary barrier wall 106 is removable and
replaceable while cell 10 is maintained in full operation by shifting cover 80 frontwards and lifting the barrier wall assembly out of the cell.

[0032] Barrier wall 106 is made of a double layer of large, impervious, insulating and corrosion-resistant ceramic tiles, disposed with staggered vertical joints. The tiles are tightly bonded together by high temperature cement applied to their back-to-back faces.

[0033] Removable primary barrier wall 106 runs along a similarly constructed secondary barrier wall 122, which is similarly reaching down to the level of back joint 98 but is attached to the steel case of cover 96 of electrolysis chamber 18. Secondary barrier wall 122 is sealed to the steel case of cover 96 to form a gas-tight structure with said case. Secondary barrier wall 122 is an integral part of cover 96 and is removed only when said cover is removed by previously switching off the DC current, disconnecting the anodes and lowering the electrolyte level 70 below back joint 98 (but without the need to empty the cell). Secondary barrier wall 122 provides double protection for the ingress of ambient air into the chlorine room 118, which for safety reasons is maintained under a slight suction during normal operation of the cell.

[0034] Cover 96, removable for maintenance as outlined above, is lined with conventional castable concrete and additionally is internally clad along walls 22, 26 and 28 with a protective curtain made of large ceramic tiles 124, which are insulating and corrosion-resistant to both chlorine and electrolyte. The tiles reach down below the minimum operating level 70 of the electrolyte to back joint 98, to seal the chlorine room and to protect the tops of the walls of electrolysis chamber 18 from electrochemical erosion and mechanical erosion during the operation of the cell.

[0035] Large size ceramic tiles that are almost completely impervious to gas and liquid and are electrical insulators, could be used advantageously for these applications to extend significantly the campaign life of the cell.

[0036] The exposed surfaces of anodes 34 of cell 10 are provided with a gas barrier 126 in the form of high temperature foil, including household aluminum foil, to prevent the ingress of ambient air into the cell through the porous graphite.

[0037] It can be seen that the cell of this invention, according to this preferred embodiment, is built by using modular and durable components, that can be installed and removed without shutting down the cell, such components being, among others, the cover 80 of the metal collection chamber 80 with the equipment assembled to it and the primary barrier wall 106. The anodes 34, the cover 96 of the electrolysis chamber and the electrode assemblies 30, can be installed and removed by shutting down the cell, but without the need to empty the cell. The campaign life of the cell body and of the consumable components inside the cell can be individually extended to their individual useful limit.

[0038] FIG. 3 shows schematically a second preferred embodiment of the invention. According to this embodiment, gravity settlers 128 are located in the metal collection chamber 20. The design criteria of gravity settler 128 are the same as those illustrated for gravity settler 42, being an arrangement of vertical stacks of thin plates, the plates of each stack being disposed in horizontal or sub-horizontal planes to divide the space above the metal collecting reservoir 60 and submerged tank 74 into horizontal or sub-horizontal channels through which the electrolyte flows in parallel at uniform velocity. The flow of the electrolyte reaches gravity settler 128 from the electrolysis chamber 18 through exit port 40 and continues downwards in free space 44 and back to the bottom of electrolysis chamber 18 through entry port 130. This alternative embodiment has the advantage that gravity settler 128, being attached to cover 80 together with evaporative heat transfer devices 76, submerged tank 74, metal collecting reservoir 60 and metal pump 56 could be lifted out and replaced without shutting down cell 10, if it become necessary for maintenance reasons. Also, this alternative is suitable as a retrofit modification to existing cells to enhance their productivity and their current efficiency, without significantly increasing their operating and maintenance costs.

[0039] To enhance the separating efficiency of gravity settlers 42 or 128, sometimes it is convenient to increase the density of the electrolyte without altering significantly the electrolytic process. For example, when producing magnesium, the use of barium chloride as an additive to the conventional electrolyte composition can be considered as a further enhancement to the metal collection efficiency of cell 10.

[0040] The sealing arrangements described above such as the removable primary barrier wall, the horizontal joints near the electrolyte level with their tile layer and the tile cladding of the chlorine compartment are applicable to other electrolytic cells for the electrolysis of a molten salt electrolyte which is denser than the metal, to extend their campaign life.

[0041] It is apparent that there has been provided in accordance with the invention a process and apparatus that fully satisfies the objects, aims and advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as they fall within the spirit and broad scope of the invention.

1. A process for the production of molten magnesium metal by electrolysis in a cell with an electrolysis chamber and a metal collection chamber, said process comprising electrolyzing in said electrolysis chamber an electrolyte containing a fused salt of said metal to produce said metal, said electrolyte having a greater density than said metal, and at least one electrode assembly that comprises a cathode defining within it a cavity, an anode disposed within the cavity and at least one intermediate bipolar electrode disposed between the anode and the cathode within said cavity, said electrolytic cell being characterized by a primary barrier wall that can be separately removed and replaced while the cell is in full operation.

2. A process for the production of molten magnesium metal by electrolysis in a cell with an electrolysis chamber and a metal collection chamber, said process comprising electrolyzing in said electrolysis chamber an electrolyte containing a fused salt of said metal to produce said metal, said electrolyte having a greater density than said metal, and at least one electrode assembly that comprises a cathode defining within it a cavity, an anode disposed within the cavity and at least one intermediate bipolar electrode disposed between the anode and the cathode within said cavity, said process being characterized by the use of gravity settlers as a means to increase metal collection.

3. An electrolytic process as claimed in claim 2, wherein said gravity settler consists of a set of thin plates stacked vertically, said plates being disposed in horizontal or sub-
horizontal planes to divide the flow of the electrolyte into horizontal or sub-horizontal channels disposed one upon the other to form uniform-velocity streams that operate in parallel, and being so designed that the retention times of the electrolyte between entry and exit of each channel are proportional to the height of the channel.

4. An electrolytic process as claimed in claim 3, wherein the average retention time of the electrolyte in the gravity settler is between one and ten times the average retention time of the electrolyte in the inter-electrode spaces and the ratio between the height and the length of each channel is between 1/10 and 1/40.

5. An electrolytic process as claimed in claim 3, wherein said set of plates are shaped, across the plane of electrolyte circulation, as a set of wide-angled chevrons, for the efficient collection of metal droplets under the lower faces of said plates along said channels.

6. An electrolytic process as claimed in claim 2, wherein said gravity settlers are located on the back of said cathodes in said electrolysis chamber.

7. An electrolytic process as claimed in claim 2, wherein said gravity settlers are located in said metal collection chamber continuous with the exit ports of said electrolysis chamber.

8. An electrolytic process as claimed in claim 2, wherein said metal that separates in said gravity settler is allowed to rise to the surface of the electrolyte and to float as a pad in a corner of said metal collection chamber wherefrom it is conveyed to an open-bottom metal collecting reservoir immersed in the electrolyte.

9. An electrolytic process as claimed in claim 1, characterized by increased cell efficiency obtained by sealing said cell to prevent any ingress of ambient air during normal cell operation into the chlorine room and into the front compartment.

10. An electrolytic process as claimed in claim 9, wherein said sealing of said cell includes locating the joints between the cell covers and the cell casing to an elevation, in the front compartment, above the maximum operating level of said electrolyte and, in the chlorine room, below the minimum operating level of said electrolyte, and the provision of a horizontal layer of large, impervious and corrosion-resistant ceramic tiles that lay flat on top of the cell walls to support the refractory-lined and steel-cased covers and to electrically insulate them from said steel casing, while sealing the outer rims of said steel casing and the bottom outer edges of said steel-cased covers.

11. An electrolytic process as claimed in claim 10, wherein a primary barrier wall assembly, removable and replaceable while said cell is in operation, electrically insulates said covers from each other and reaches down below the minimum operating level of the electrolyte to form a stable sealing structure between the chlorine room and the front compartment.

12. An electrolytic process as claimed in claim 11, wherein said removable barrier wall extends upwards above the covers and outwards towards said outer rim of said steel casing as a double layer of large, impervious, insulating and corrosion-resistant ceramic tiles disposed with staggered vertical joints and tightly bonded together by high temperature cement applied to their back-to-back faces.

13. An electrolytic process as claimed in claim 1, wherein said primary barrier wall is backed up by a secondary barrier wall made of ceramic tiles attached and sealed to the cover of said electrolysis chamber, said cover being also clad by ceramic tiles around and inside the refractory walls of the chlorine room to provide added corrosion resistance and protection to the ingress of ambient air into the chlorine room.

14. An electrolytic process as claimed in claim 9, wherein the steel-cased covers are provided with high temperature seals in all joints between the steel cases of said covers and the equipment permanently installed on them, to prevent ingress of ambient air into said cell, including the provision of high temperature foil, including household aluminum foil to clad the exposed surfaces of the anodes.

15. An electrolytic process as claimed in claim 2, wherein power efficiency improvements include the provision of means for extracting surplus heat from said electrolyte by an energy recovery system based on evaporative/condensing heat transfer technology.

16. An electrolytic process as claimed in claim 15, wherein said means for extracting surplus heat from the electrolyte include an array of evaporative heat extraction devices immersed in the electrolyte across the circulating stream in the metal collection chamber to transfer said surplus heat from the electrolyte to a condenser outside the cell.

17. An electrolytic process as claimed in claim 16, wherein said array of heat extraction devices immersed in the electrolyte supply low pressure steam to a heat recovery system somewhere else in the plant and is fed with boiler-quality water via a pressure regulating valve responsive to a thermostat that senses and controls the temperature of the electrolyte.

18. An electrolytic process as claimed in claim 17, wherein each said evaporative heat extraction device is provided with an individual level control valve that responds to a float located close to the bottom of the evaporator, said level control valve to avoid flooded conditions in said evaporator by its throttling action and therefore providing automatic protection against unsafe operation.

19. An electrolytic cell apparatus that produces molten magnesium with the process of claim 1.

20. An electrolytic cell apparatus that produces molten magnesium with the process of claim 2.