

R&D

Carbon Ltd.

presents:

Anodes and Aluminum Production and Application

Anodes for the Aluminum Industry

Items to be discussed:

- Production of Aluminum metal.
- The contribution of the anodes in the production of aluminum.
- Anode production.
- The contribution of R&D Carbon Ltd. (RDC) to the production of anodes and for the optimization of the anode quality.

Aluminum Smelter



Aluminum Applications



Aluminum is mainly applied in the transportation industry, in the building industry and for packaging.

Bauxite



Bauxite is the raw material for the production of aluminum metal.

Bauxite

- Named after “Les Baux” in France, the first place where bauxite was found.
- Mainly found in South America, Africa and Australia
- Consists for approximately 50% of aluminum oxide Al_2O_3 , also called alumina.
- The remainder consists mainly of silicon and some iron, responsible for the red/brown color.

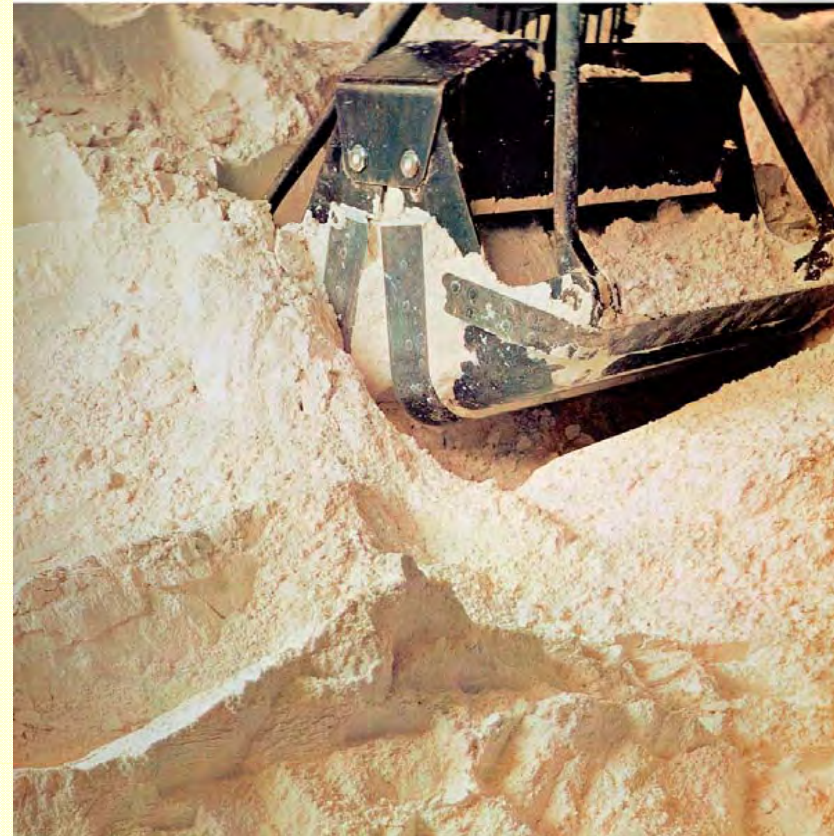
Alumina Plant



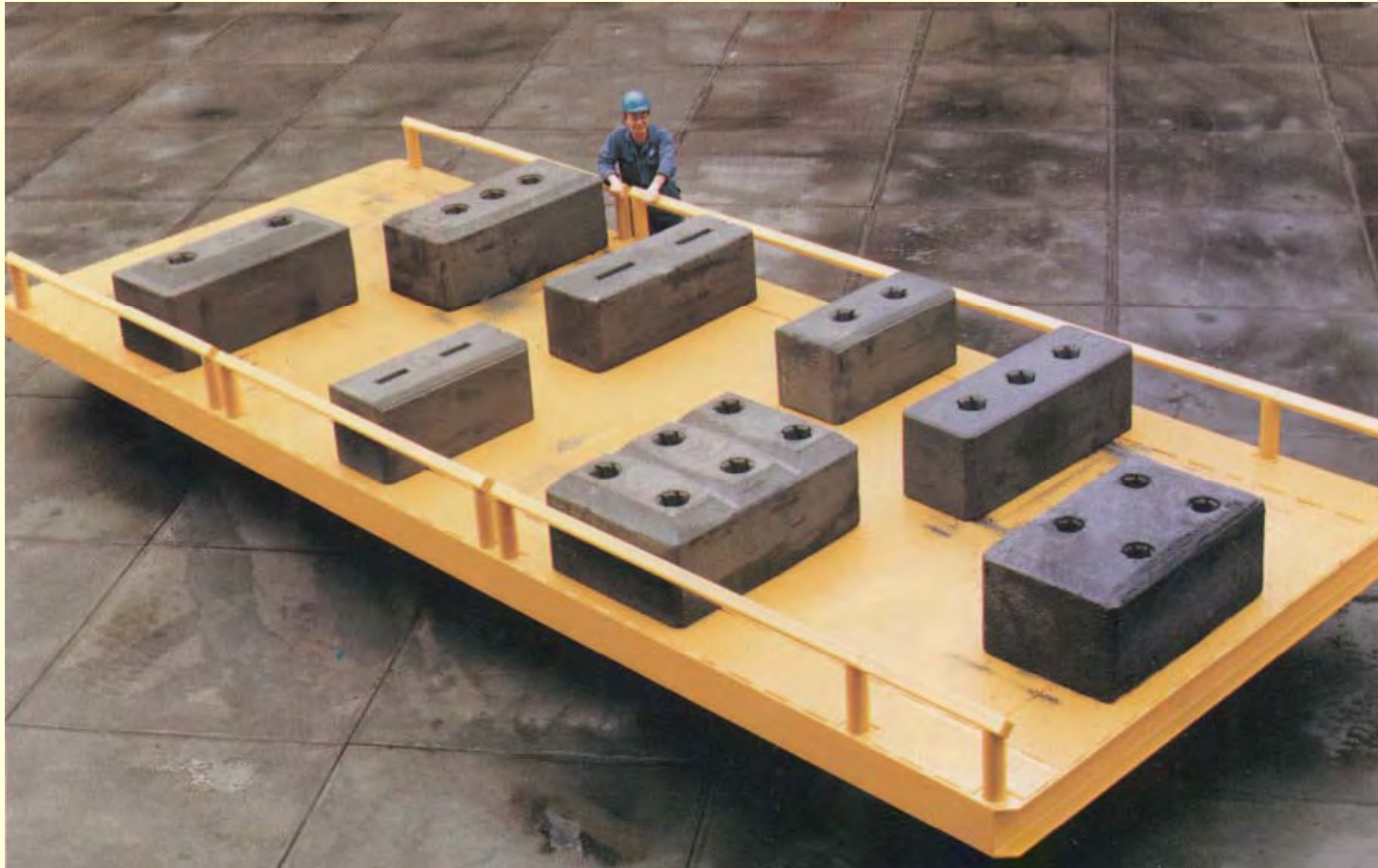
- In a chemical process (the so-called “Bayer process”) the alumina is separated from the impurities.
- After dumping of the remainder in the opencast mining area the area is planted again.

Alumina

- Alumina is composed from aluminum and oxygen.
- Alumina is not only used for the production of aluminum metal but e.g. also as an abrasive.
- Alumina is chemically extremely stable.
- The separation of the oxygen from the aluminum takes place in an electrochemical process called “aluminum reduction”.

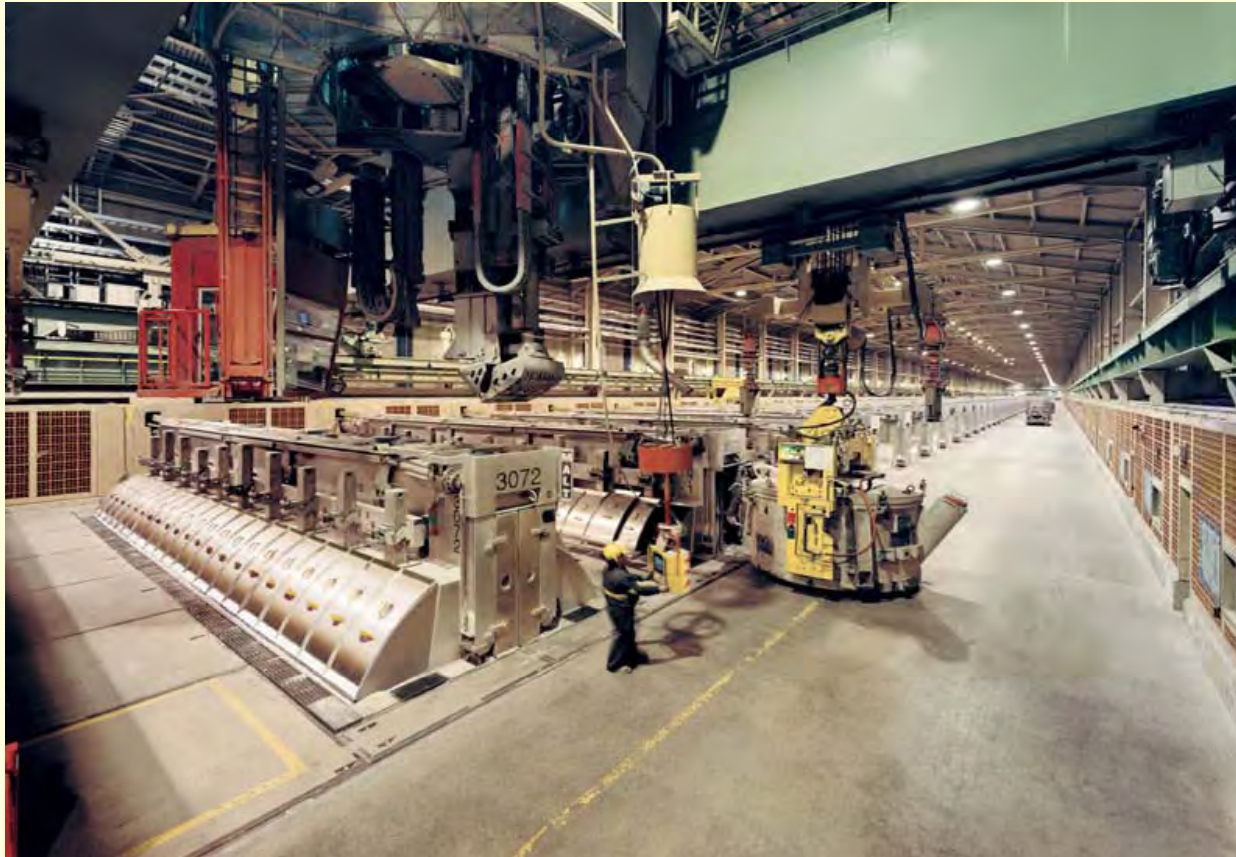


Anodes



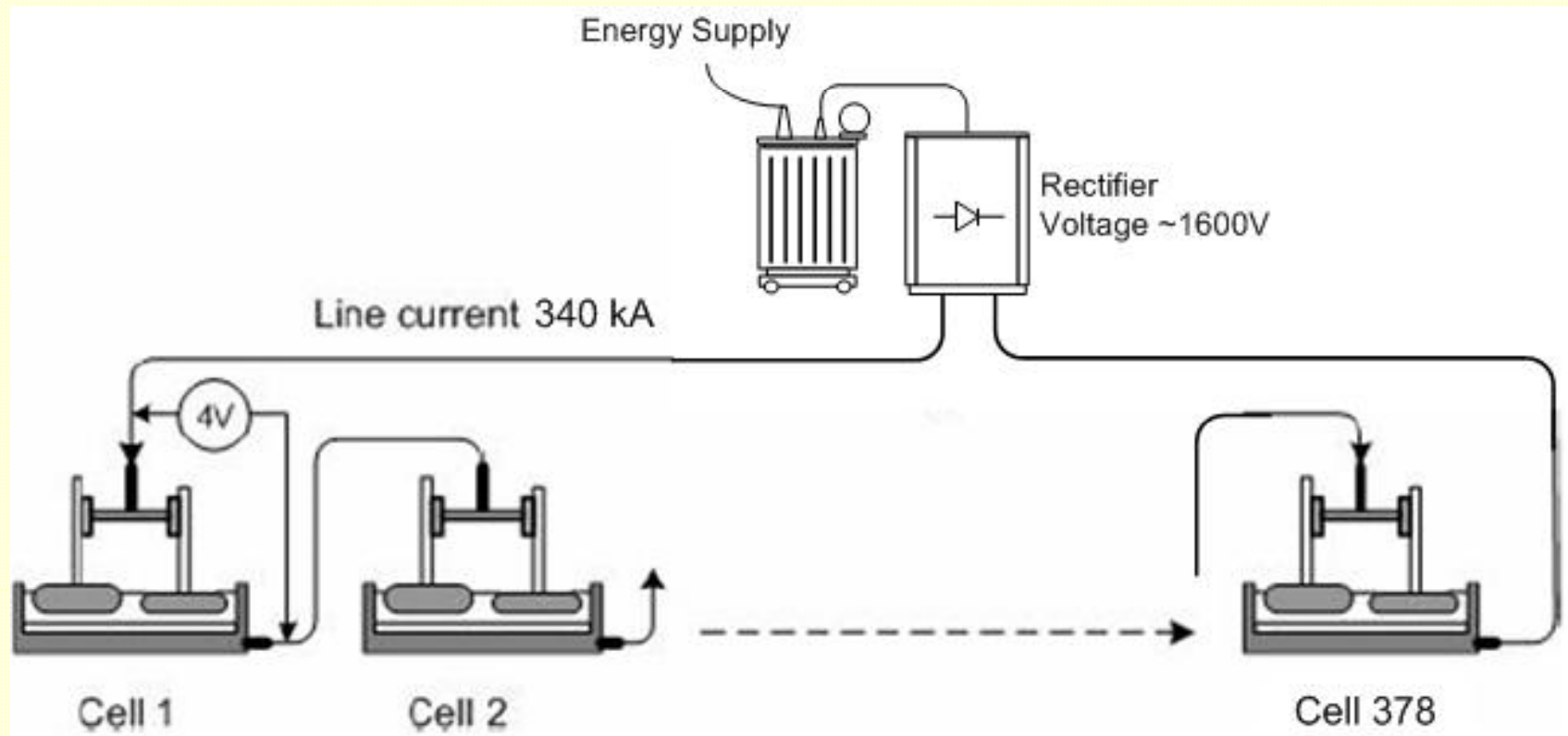
Anodes are required for the production of aluminum.

Reduction Cell in Potline



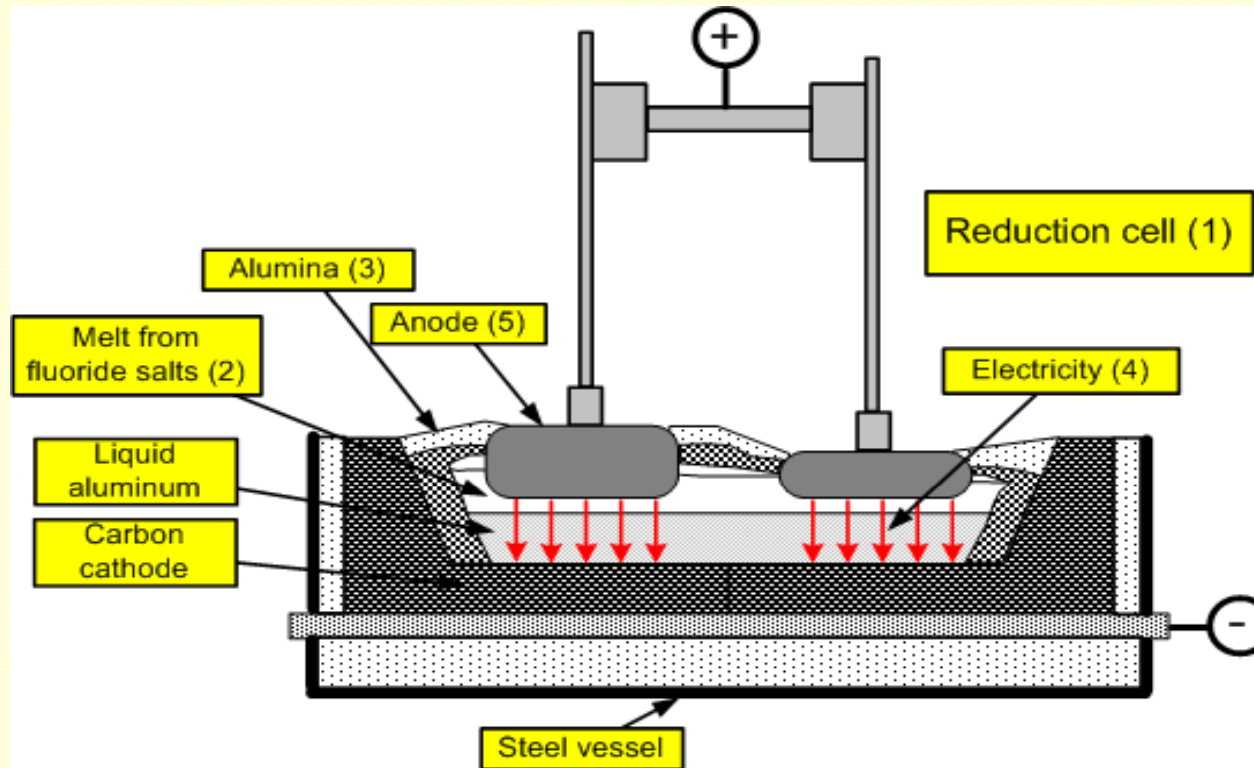
A "reduction cell" consists of a shallow steel vessel, \pm 4 meters wide and 10 meters long, lined with carbon blocks.

Typical Modern Potline



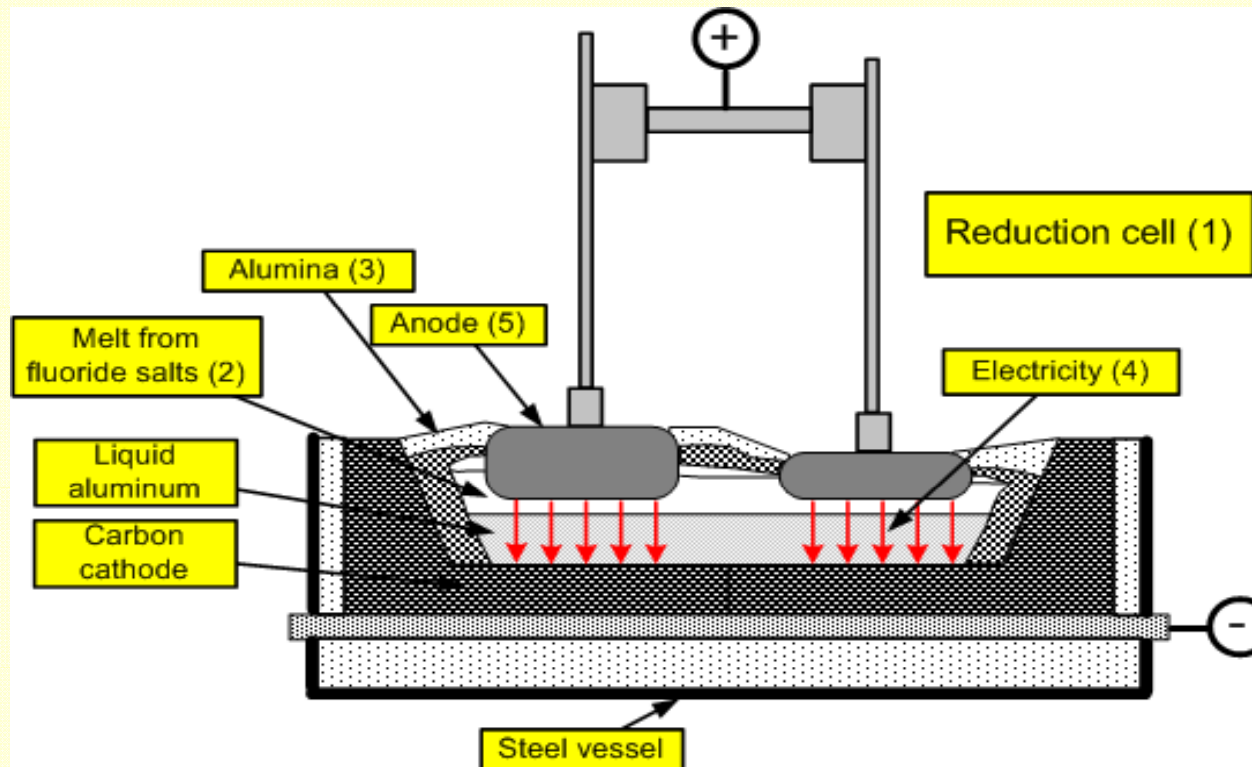
The number of cells is limited by the rectifier voltage that can be handled with today's technology.

Reduction Cell (schematic)



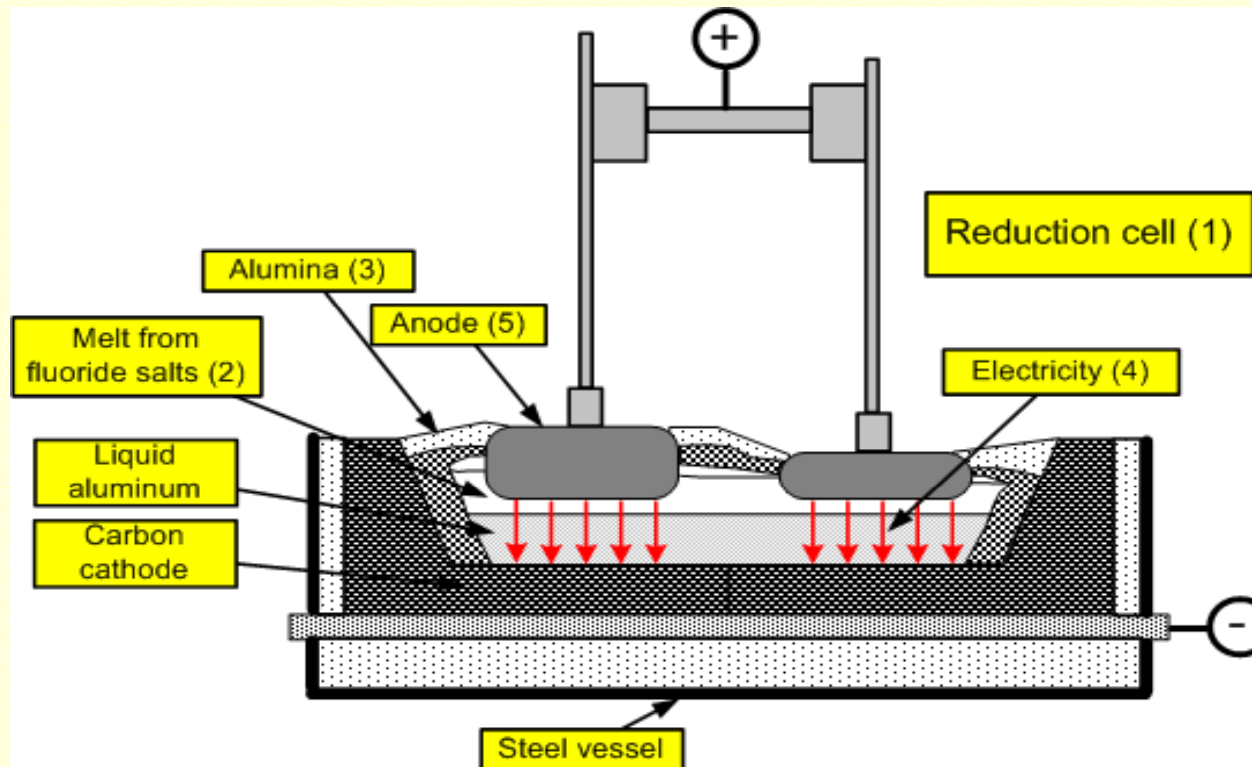
In the vessel a liquid melt of fluoride salts at a temperature of approximately 950 °C will be found.

Reduction Cell (schematic)



Through an electrical current the alumina is dissolved into aluminum metal and oxygen. The oxygen reacts with the anode carbon by forming carbon dioxide, escaping in gaseous form.

Reduction Cell (schematic)



In regular intervals, alumina is supplied, anodes are exchanged and aluminum metal is tapped.

Reduction Cell



Setting of a new anode in a reduction cell. Anodes have a service life of approximately 4 weeks.

Anode Failure Modes



Left: corner cracking due to thermal shock. Middle: carbon dust floating on the melt due to poor anode resistance against CO_2 attack. Right: anode attacked by ambient air.

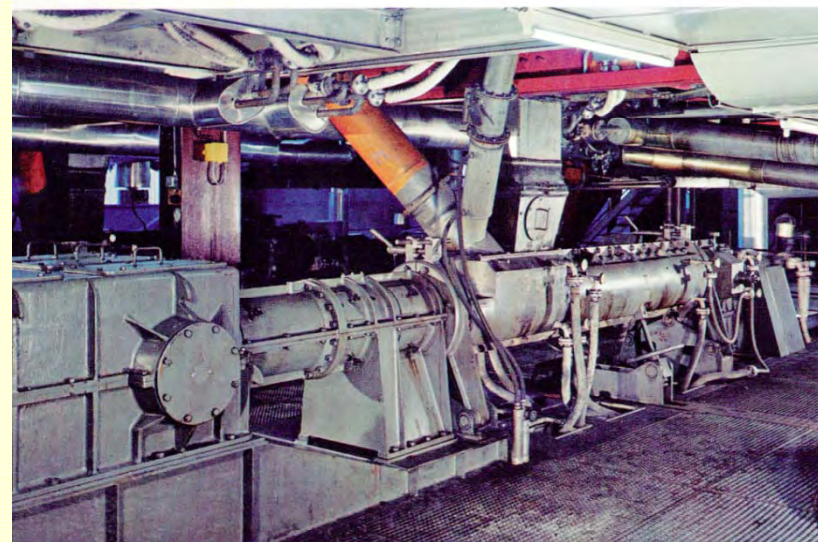
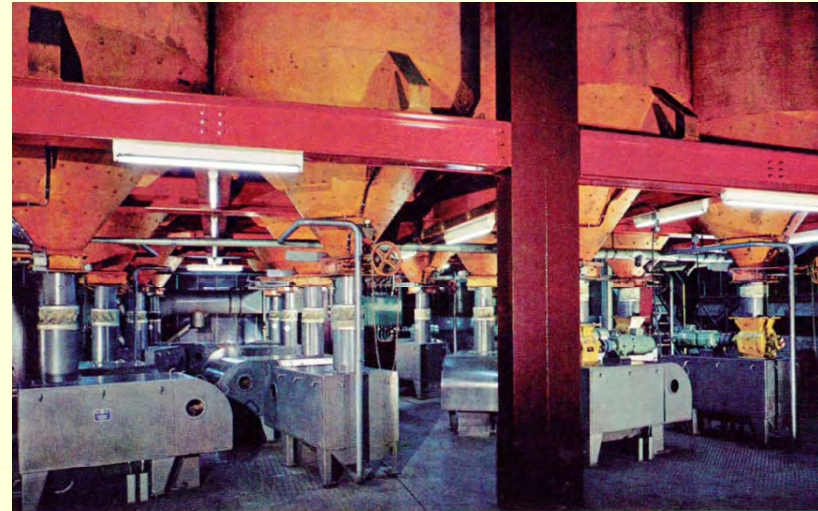
Anode Raw Materials

Green anodes consist typically of:

- 65 % “Calcined Petroleum Coke” (CPC), produced by a heat treatment from “Green Petroleum Coke” (GPC), a by-product from crude oil refining.
- 25 % “Anode butts”: recycled anode material that has not been consumed in the aluminum reduction for technical reasons.
- 15 % Pitch, a distillation product produced from tar, a by-product of the production of coke from coal.

Anode Production

- Petroleum coke and anode butts are crushed, sieved, milled and mixed with liquid pitch.
- By kneading, the so-called 'anode paste' is produced.



Anode Production

- The anode paste is molded to so-called “green” anodes.
- Molding is either by presses or by vibrating machines.

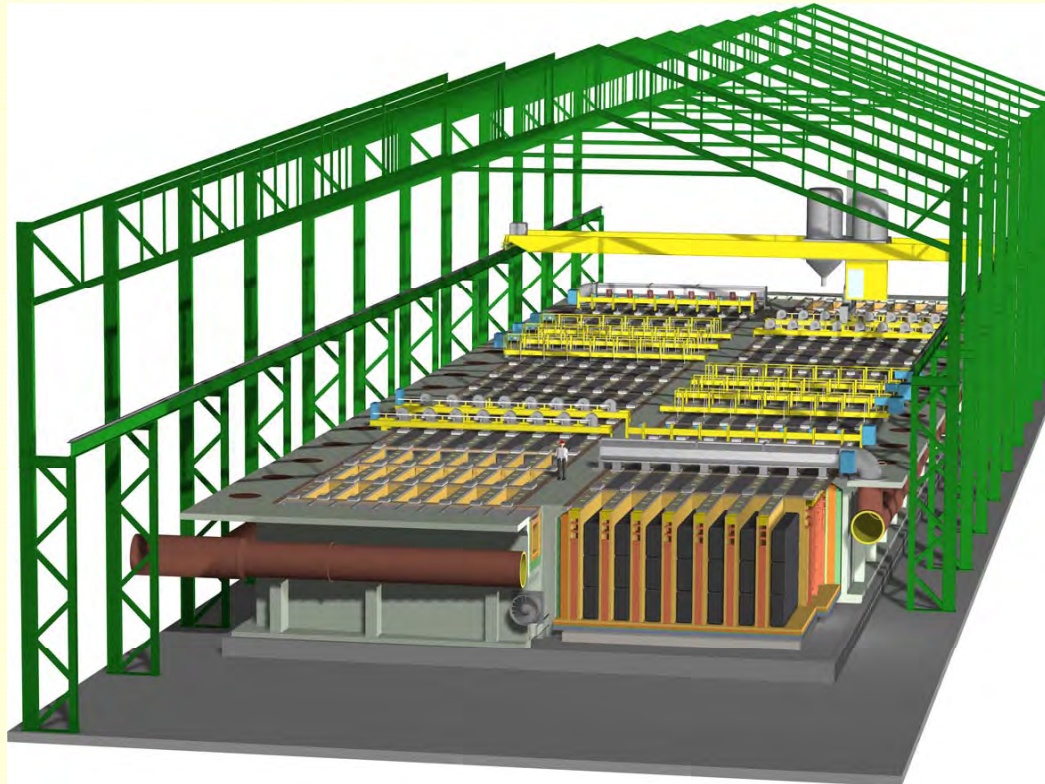


Anode Baking



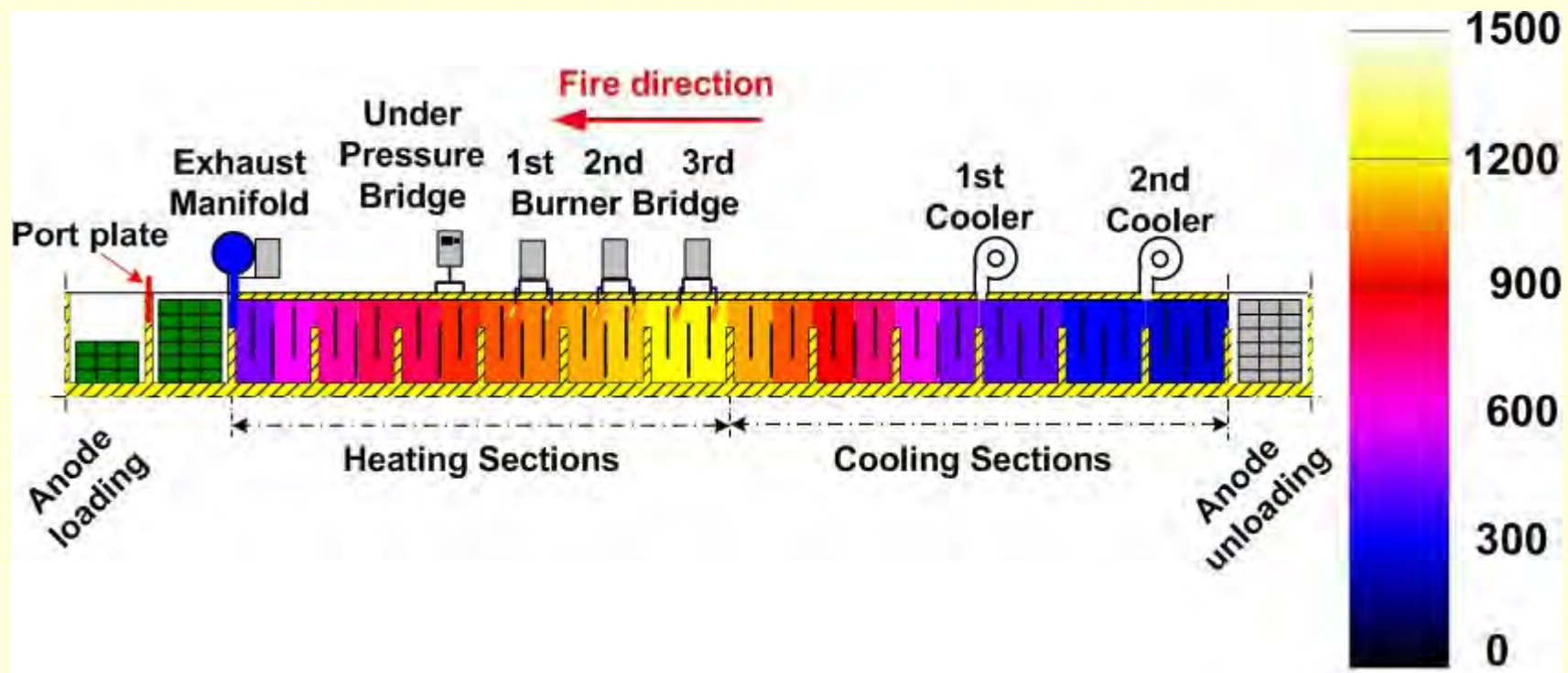
- State-of-the art anode baking is in a “ring type” furnace
- In this type of furnace, the anodes remain “on place” and the fire zone is moving around the furnace.

Anode Baking



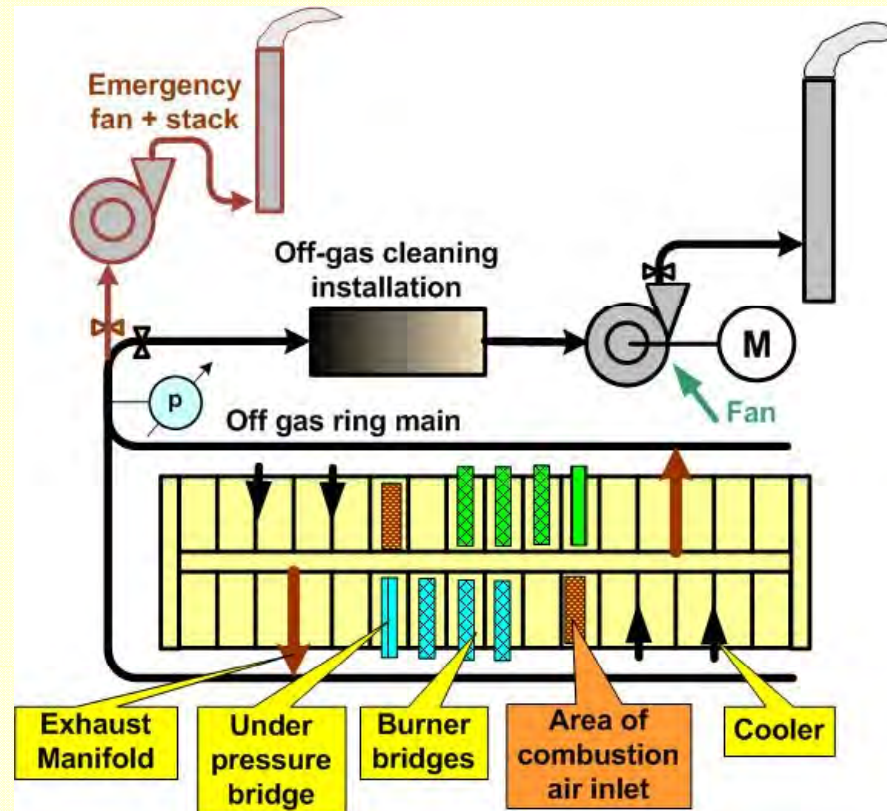
- Anodes are packed in “pits” arranged in “sections”.
- The pits are separated by “flues” with cavities acting as heating chambers and as heat exchangers.

Anode Baking



- Once the fire has been advancing one section, all the equipment has to be shifted one section, called 'fire move'.
- At the same sequence, one section of baked anodes has to be unpacked, and a section with green anodes packed.

Off-gas Cleaning



A sophisticated off-gas cleaning installation is provided to capture any impurity for minimizing any negative impact on the environment.

Anode Quality Control

- In regular intervals, test cores will be drilled from the anodes.
- These cores will be used to determine the chemical and physical anode properties.
- Most of the methods worldwide applied today have been developed by R&D Carbon Ltd.



Anode Testing



Apparatus for the measurement of anode resistance to the attack of CO₂ gas in the reduction cell.

Anode Quality Control



In Sierre (Switzerland) RDC operates a modern laboratory. RDC is prepared to help customers to solve any anode problems.

RDC's activities

RDC is active in the following fields:

- Research & Development
- Laboratory Test Equipment / Calibration Standards
- Technical Services
- Bake Furnace Process Control
- Conceptual Design / Engineering
- Training
- For more information: www.rd-carbon.com

R&D Carbon Ltd. Sierre



Phone: +41 27 459 29 29

Fax: +41 27 459 29 25

e-mail: rdc@rd-carbon.com

Web: www.rd-carbon.com

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