

PRE-COURSE ASSIGNMENT

Postgraduate Certificate in Light Metals Reduction Technology and Industry Training Programme

DUE

*Parts A-C: Hard copy on first day of lectures, **November 17, 2008.***

Part D: To be presented during weeks 1 and 2 of the course.

The purpose of this assignment is to prepare you for the 3 week lecture programme by:

- Doing some background reading and answering some short answer questions.
- Collecting some data to bring with you to the course, and in some cases, do some preliminary analysis of the data.
- Preparing a short presentation to present to the group.

A. The Electrolyte

1. What are the features that make cryolite one of the few suitable electrolytes for the aluminium reduction cell?
2. What are the two main additives used in the cryolite-alumina molten salt and what positive and negative impacts do they have? What are their optimum levels?
3. What is the best material for maintaining the electrolyte level consistently in the target range in all cells? Specify also its composition range and why.
4. What is the accepted world definition of an anode effect?

B. The Operating Cell

1. What is the overall cell reaction which produces aluminium?
2. Define current efficiency and the major processes which limit current efficiency.
3. What is the main cathode reaction in the aluminium reduction cell?
4. Make a sketch of the cell showing the main components and the inputs and outputs.
5. For each input and output, give the approximate temperature of the material and the mass going in or coming out.
6. In order of size, what are the three biggest thermal effects on the cell, from the inputs and outputs you have described above?
7. Why does sludge build-up occur in cells and how can it be prevented?

C Anodes and Cathodes

1. What are the differences between pre-baked anodes and Soderberg anodes used in aluminium reduction cells?
2. Describe the typical formulation of an industrial anode.
3. What are the reactions which lead to increased carbon consumption over that required for Al production, and how can they be minimised?
4. List the desirable features of a formed cathode.
5. Describe the important abnormal operating features of a newly commissioned cell.
6. What are the main cathode failure mechanisms?

D. Presentation:

Prepare a short (no more than 10 minutes/5slides) Power Point presentation on ONE of the following.

1. **Outline a Process map** of your specialist area.

- Describe the Process Steps
- Identify the Outputs of the process
- Indicate how the outputs relate to the key performance indicators for the smelter
- Identify the decision points in the process (on the map) and what the decisions are.

2. **Describe a measurement** (e.g bath temperature, anode green density, etc) that is used in your work area as a basis for decision making. Give an assessment of its repeatability and reproducibility.

Data to bring with you:

- Voltage distribution on a potline for a day (histogram showing the variation across all pots on the line). Be prepared to talk about your data and describe and explain the variation between pots.
- Sample of raw (unfiltered, 1 or 2 second) cell resistance for a single cell for one hour.
- Primary and secondary (reacted, fluorinated) alumina analyses for a period of a couple of months.
- T and AlF_3 data showing variation for one cell for a period of a couple of months.
- Metal analysis (Si and Fe) for one potroom for one day.
- Alumina Specification sheet

Recommended reading materials

1. K. Grjotheim and B.J. Welch "Aluminium Smelter Technology" 2nd Edition, Aluminium-Verlag 1989, ISBN 3-37017-162-6.
2. J. Thonstad, G. Haarberg and H. Kvande "Aluminium Electrolysis: Fundamentals of the Hall-Heroult Process". Aluminium-Verlag, Dusseldorf, 2001.
3. Proceedings of the 7th Australasian Smelting Technology Workshop and Conference, Melbourne Australia, 11-16 November 2001. ISBN 0 7334 1851 1
4. *Thermochemical Energy Calculations – Chen, Taylor and Welch, Erzmetall **45** (1992) Nr 9, 468-470. * - *electronic version accompanies this assignment.*