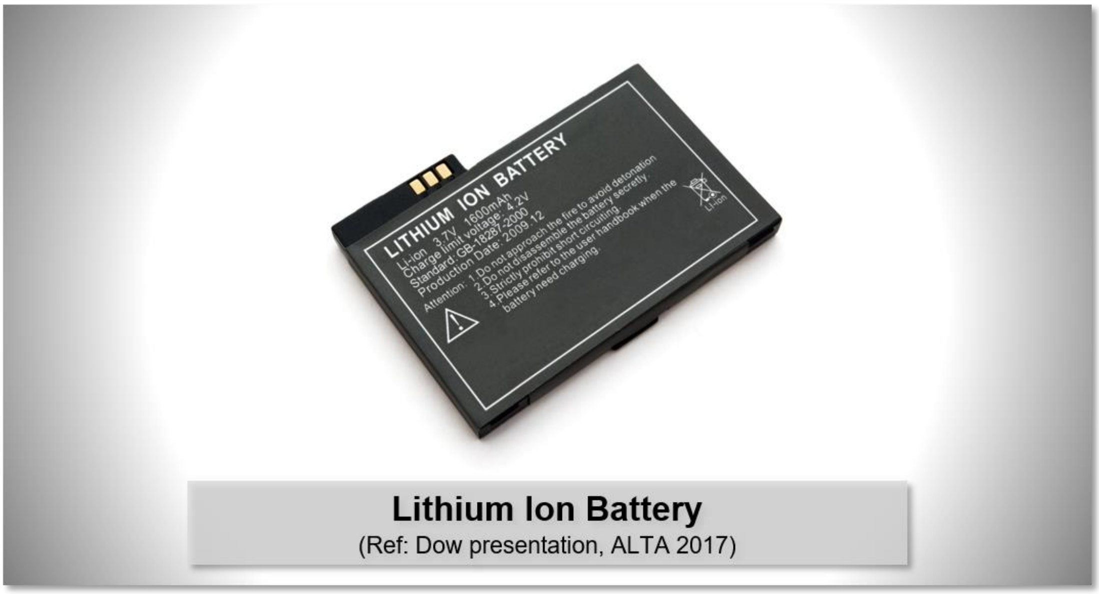

Lithium Ion Battery
(Ref: Dow presentation, ALTA 2017)

ALTA 2017 LITHIUM PROCESSING PANEL DISCUSSION

May 2017

The panel discussion was held Friday, 26 May, immediately following the Lithium Processing Forum during the Uranium-REE-Li Sessions at ALTA 2017 in Perth, Australia.

Panel Chair: Mike Dry (MD), Arithmetek (Canada)

Panel Participants: Adrian Griffin (AG), Lithium Australia (Australia); William Pickard (WP), Curtin University (Australia); Grant Harman (GH), Lithium Consultants (Australia); Jaco Bester (JB), Dow Water and Process Solutions (Netherlands); Chris Griffith (CG), ANSTO Minerals (Australia)

Editor's Note*: The contributions of the panel members and delegates are not presented verbatim, but rather have been paraphrased and condensed for clarity and brevity. They are not recorded in order, but are grouped into major topics. Also, it is not feasible to include all contributions made during the discussions, and they are limited to some that are representative of the key points raised and debated.*

Operating Costs

MD, Chair, opened the discussion by inviting comments on lithium processing operating costs. He said he has seen numbers higher than the ones included in his conference paper which he estimated from published reports adjusted to 2016 US$.

GH, Panel, responded by commented on the estimated opex of around 1900 US$/t lithium carbonate equivalent (LCE) given in MD's paper for the Couchari-Olaroz project in Argentina. GH noted that Orocobre recently published a figure of 3600 $/t based on a production of 12,000 t/a for their Olaroz operation, while the Deutsche Bank's Global Cost Curve (included in his and AG's conference papers) indicates an opex of about 4200 US$/t. He concluded that these higher figures do not support MD's estimated figure for Couchari-Olaroz.

Editor's notes: MD's paper states that the Couchari-Olaroz *project targets the production of 20,000 t/a of lithium carbonate by the treatment of brine from wells by solar evaporation, with an estimated opex of US$1978/t*. *Olaroz is an existing operation adjacent to the Couchari-Olaroz project.*

Battery Grade Product

GH, panel, referred to a query by CG on the definition of battery grade, as being one of the most important topics to discuss in the panel. He advised that lithium carbonate content is not determined by direct analysis. Rather, the procedure is to analyze for other components and impurities, then subtract from 100%. The two largest components, in his experience, are moisture at about 0.12% and LOI (loss on ignition) at around 0.2%, for a typical combined content of about 0.3%. Also, if the process includes bicarbonatation, this increases the combined figure. So, when someone says they produce an EV (electric vehicle) grade of 99.99, they must not be taking account LOI and moisture, and the question arises as to what else they have not accounted for, which makes the grade figure meaningless. In fact, users typically run their own an analysis to assess offered products against their in-house specification.

CG, panel, agreed that product grade is only meaningful when there is a target specification to compare against.

AG, panel, added that most end users and some producers do publish specifications, but unfortunately they all tend to vary, highlighting one of the problems in dealing with a commodity which doesn't have a terminal market. Ultimately the supplier has to produce something that potential customers are willing prepared to buy.

MD, Chair, raised the issue, based on previous industry experience with manganese dioxide, that users may not be willing to commit to buying until they are able to test actual product from a commercial plant.

GH, panel, responded that for one project he is involved with, no profit has been allowed for the sale of lithium carbonate for the first year for the reason raised by MD. This represents the lead time required to be confident of meeting the required specification at a normal production rate.

CG, panel, said that problems with batteries, such as catching fire or not holding the charge, can damage the credibility of battery producers, which leads to them to be being “hard-nosed” with potential product suppliers.

GH, panel, added that grade consistency is sometimes more important than the actual level of impurities in achieving market acceptance. Variations can have serious ramifications for the battery producer.

Goutam Das (GD), CSIRO (Australia), floor, said that, based on from laboratory experience in achieving battery grade material for a client, while the impurities play an important role, the determining characteristics for acceptance is the number of cycles that can achieved. In response to a query by MD on ability to replicate this in a commercial operation and be accepted by the buyer, GD said that laboratory tests show what impurity levels can be tolerated while achieving the required cycles, setting the target for an acceptable commercial product.

Alternatives to Lithium

MD, Chair, asked whether there are any alternatives which could surpass lithium for batteries?

AG, panel, responded that two important characteristics to consider in assessing a battery technology are weight and energy density. For some applications, there will be substitutes. For example, some of the redox flow batteries are good technologies, though, at the moment, drawbacks include higher cost per unit of storage, larger volume, and heavier weight. One of the things very few people take into account is that vanadium redox batteries only return about 70% of the power input. In comparison, a lithium-ion battery theoretically returns 100%, which reduces to 92% when fitted with a management system (without a management system the battery will go permanently flat on discharge, or will catch on fire during charging). Lithium on this basis will be hard to surpass.

GH, panel, added that Lithium is the best material for cars and mobile devices, due to its lightness, and is likely to remain the best choice for a long time. For static storage, where mass is less of a concern, other technologies will probably be gain acceptance.

Cause of Battery Fires

MD, Chair, asked for views on the cause of Samsung batteries catching fire.

GH, panel, said that he had heard it was due to fitting too large a battery into too small a space, and not allowing for expansion when it heats up during operation - perhaps due to rushing to the market too quickly without understanding all the aspects.

CG, panel, said he had heard that the problem was due to internal shorting, a view that was supported by MD.

Summary of Key Points:

- Deutsche Bank's Global Cost Curve is a publicly available guide to lithium processing operating costs.
- There is no meaningful standard battery grade specification, and published figures from users and suppliers vary.
- Grade consistency is sometimes more important than the actual level of impurities in achieving market acceptance, as variations can have serious ramifications for the battery producer.
- Users will typically run their own an analysis to assess offered products against their in-house specification.
- The time required to reliably achieve the required product specification can significantly affect the profit.
- Lithium battery technology has significant advantages in lightness and low power loss. It is the best available technology for cars and mobile devices, while alternative technologies may applicable for static storage where mass is less of a concern.

We acknowledge the efforts of the volunteer from Murdoch University, Rorie Gilligan, for providing notes on the discussion.

Lithium Processing is again the featured the topic for the ALTA 2018 U-REE-Li Forum and Panel, which will be held 19-26 May in Perth, Australia.

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MetBytes are metallurgical commentary and insights written by Alan Taylor who has 40+ years' experience in the metallurgical, mineral and chemical processing industries. He has worked in metallurgical consulting, project development, engineering/construction, plant operations, plant start-up and technology development. Projects and studies have involved copper, gold/silver, nickel/cobalt, uranium, base metals, phosphates and alumina.