Liberator Cell Hood

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Background

High grade copper is refined in a process known as electrorefining. In this process, 99% pure copper plates are dissolved and electroplated onto to steel plates, forming new copper plates with 99.99% purity. Electroplating copper requires a chemical solution containing arsine (AsH_3), which is toxic, and can escape as a mist from the cell. The liberator cell hood is designed to safely remove the mist and route it to a scrubber that can dispose of it properly.

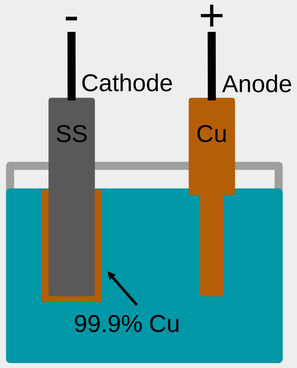
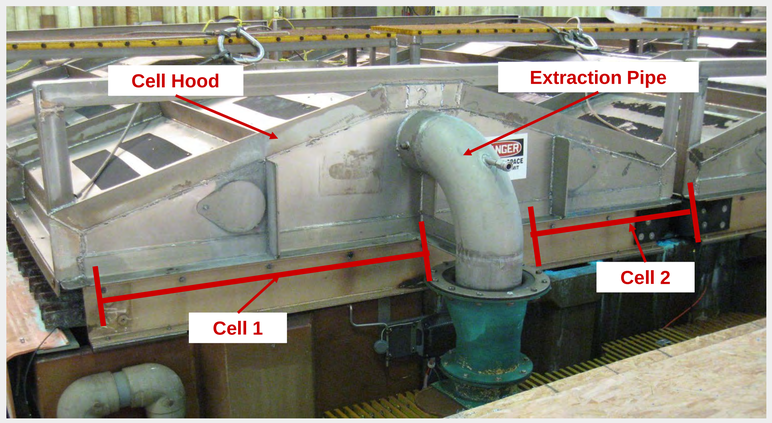


Diagram of the copper electroplating process

Electrorefining cell at Rio Tinto without the hood.

Rio Tinto's Current Cell Hood Design



Problem

Liberator cell hoods currently cover two cells each. The chemical environment causes bluestone buildup in the cell which leads to shorting and inefficiencies. The bulky design also limits access to the interior of the hoods, requiring a crane to perform the routine cleaning needed to prevent shorting caused by bluestone buildup between electrical contacts.

Solution

Structure

- 316L Stainless Steel Frame - strong with high chemical resistance
- EPDM rubber seal - high temperature and chemical resistance
- Polyvinyl ester - nonconductive channel to prevent shorting

Accessibility

- Openable lids allow the cell to be cleaned without using a crane to remove the entire hood. The lids are lined with EPDM U-channels for sealing

Removability

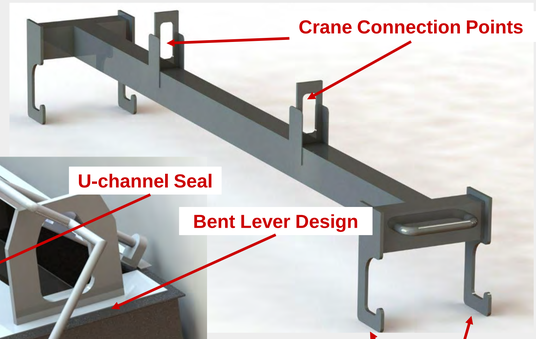
- Designed four lifting lugs with spreader bar to prevent unwanted rotation with a two point crane

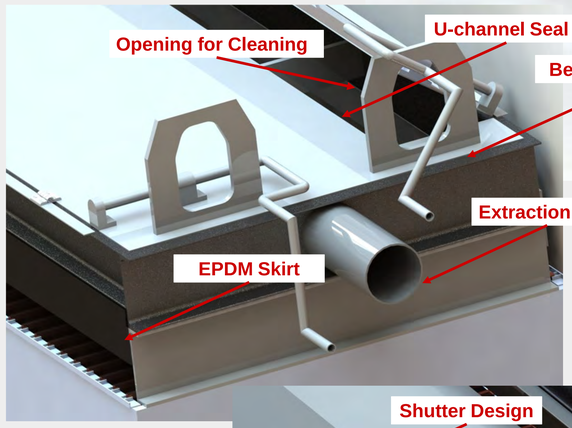
Ergonomics

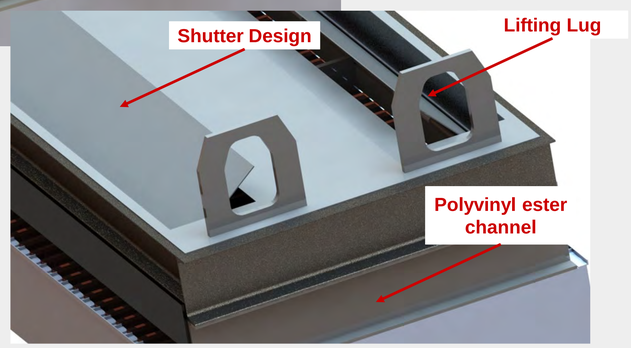
- Lid design is biomechanically favorable for lifting

Lever v. Shutter

- Lever allows a wider angle to reach the extraction pipe
- Shutter has fewer complex parts that must be maintained in chemical environment
- Shutter requires less force to open





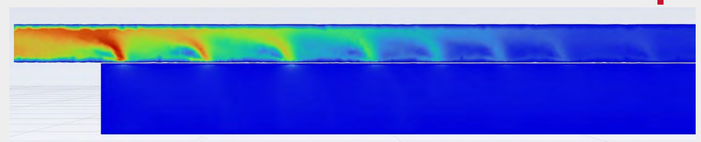


Results

Our design achieves more air changes per hour, allowing more of the mist to be sent to the scrubber system, keeping the workers and environment safe. The design meets the crane weight limit criteria, and fits within the width of a single cell. The airflow of a set of new hoods well exceeded the target. The flow diagram illustrates where most of the fluid is flowing from.

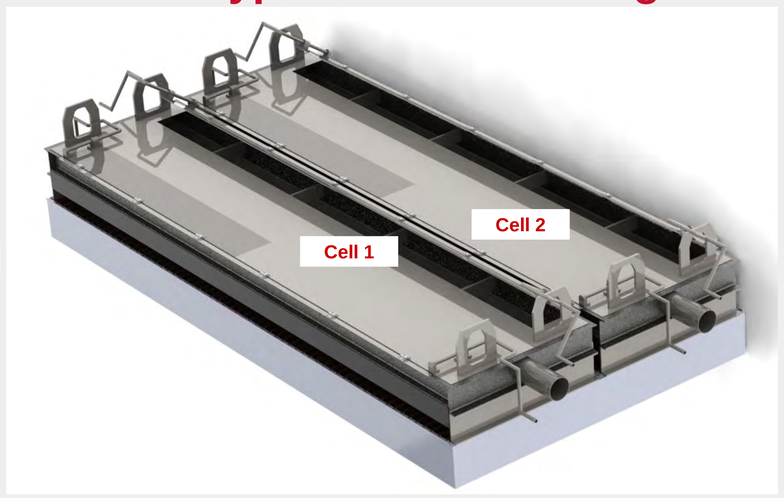
Metric	Target	Results
Airflow	192 ACPH	184 ACPH
Strength	> 8 MPa	205 MPa
Width Constraint	< 48.5 in	46.5 in
Weight Limit	< 0.75 tons	0.48 tons

Fluid Flow Within Extraction Pipe



Simulation of the fluid flow through the prototype hood. Red indicates where the flow is the fastest and allows us to see the flow dynamics in our extraction pipe. CFD was used to calculate air changes per hour of our prototype hood.

Prototype Cell Hood Design



Conclusion

We have designed two different opening mechanisms for Rio Tinto to choose from. The designs tradeoff maintenance, accessibility and seal effectiveness. The hood design achieves adequate airflow and fits within the smaller footprint.