In the rotainer

Intermodal Solutions Group

Robert Dunn, Dr Laurance Donnelly at Alfred H Knight, UK, and *Bruce Mulleny* at New Gold Inc., Canada, share a logistical solution for adhering to testing and inspection certification when transporting copper concentrate.

Above: A rotainer discharging cargo into the hold of a vessel using a crane and rotating tippler system

Rotainers are an innovative solution to provide a cost-effective and practicable alternative method for the bulk transportation of material, such as copper concentrate, from a mine to be directly loaded onto a vessel.

Rotainers are similar in appearance, shape and size to shipping line containers and compatible with existing intermodal infrastructure. However, rotainers have a detachable lid which is operated by a tippler system and removed at the point of discharge into the hold of a vessel (shown in the image above). This method has environmental and economic benefits – dust suppression, the reduction of cargo losses, the mitigation of cross-contamination, reduced handling time and therefore reduced handling costs.

Leading logistics

Rotainers are typically stored at the port of loading prior to loading onto a vessel. As such, there is a limited opportunity to access the contained copper concentrate to obtain representative samples for testing, which is a requirement in accordance with the *International Maritime Solid Bulk Cargo (IMSBC) Code*, published biennially by the International Maritime Organization (IMO).

Copper concentrate is a 'Group A' cargo, which means it may liquefy (or become fluid) if shipped at a moisture content more than its transportable moisture limit (TML). A fluid cargo in motion has the potential to destabilise a vessel, causing it to list (lean), and even capsize, with the resulting loss of cargo, vessel and, in some cases, the lives of the crew, such as the sinking of the Emerald Star in 2017.

The IMSBC Code requires shippers of copper concentrate in bulk to ensure representative samples of the cargo are obtained prior to shipment for testing of moisture content and TML. Furthermore, the IMSBC Code (IMO 2020) stipulates, "The interval between sampling/testing and the date of commencement of loading shall never be more than seven days."

The point at which cargo is loaded into the rotainers, such as at a mine site, presents the opportunity to obtain representative samples, as it is possible to achieve access to the entire cargo.

However, the time taken for rotainers to be transported to the port and loaded onto a vessel can often far exceed the permitted seven days, and up to several weeks. A combination of IMSBC Code requirements and the limited access to cargo in rotainers presents a challenge to shippers, independent inspection companies, vessel Captains (Masters), owners and national regulatory bodies ('competent authorities').

Hatching a solution

Alfred H Knight was commissioned by Canadian mining company New Gold Inc. to conduct experimental test work on the copper concentrate contained within the rotainers. The principal objective was to verify the characteristics and behaviour of the copper concentrate during transportation from the mine in Canada to a port. Two access hatches were incorporated into the proposed design of each rotainer lid, for the purpose of obtaining samples for pre-shipment moisture determination in compliance with the IMSBC Code.

The sampling from a single rotainer was conducted on four occasions. Firstly, on day zero at the mine during loading of the rotainer. Secondly, on day one upon reception of the rotainer at a storage facility, approximately 250km from the mine on the west Canadian coast. Thirdly, on day 28 at the same storage facility, and finally on day 29 during the discharge of the rotainer at the mine.

Sampling prior to and after transportation of the rotainers by road to the storage facility simulated the action of transporting rotainers from the mine to the port. The third sampling, at the storage facility after a period of 28 days, replicated the typical storage time of the rotainers at the port prior to vessel loading.

Taking samples

Sampling at the mine (shown in the top images overleaf) was performed manually using a 50mm diameter and 1,200mm long sampling spear to take increments from the full depth of the copper concentrate in each loading bucket of a front-end loader.

At the storage facility, the rotainer lid was removed and sampling was performed manually using the same type of spear (1,800mm long) to obtain vertical increments (core samples)

Feature

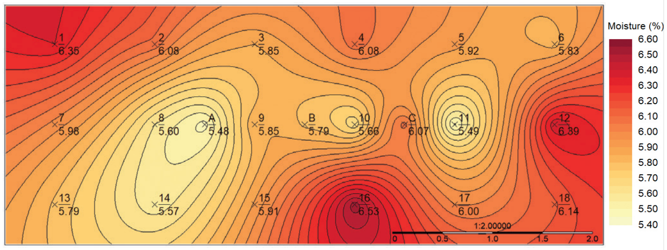


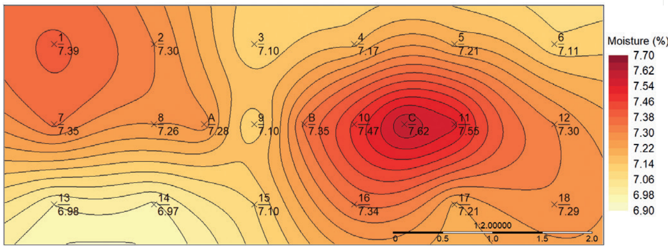
Top to bottom:

Rotainer loading at New Gold's New Afton Mine in Kamloops, Canada

Spear sampling at the storage facility in Canada.

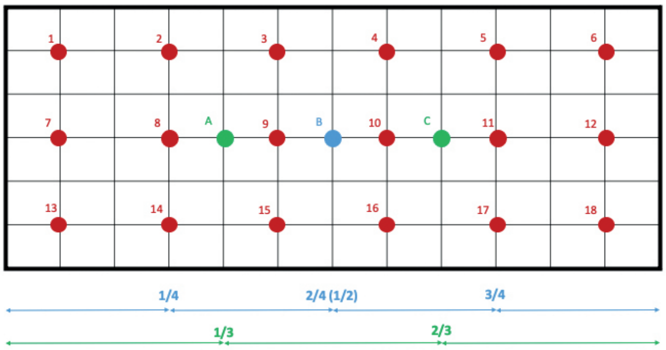
An access hatch on the retainer lid.





Above: Sampling stage two showing the average moisture content for samples (above). Sampling stage three, average moisture content for samples, both obtained from a 21-point sampling template, (shown in image 2) representing the entire depth of the material (scale in metres)

Below: Plan view of a static rotainer sampling template with 21 positions, 1 to 18 and A (beneath access hatch 1), B and C (beneath access hatch 2)



from the surface through the full depth of the material.

Spear increments were obtained at 21 points as determined by using a systematic sampling template, which included points beneath the position of the proposed two sampling hatches (shown in points A and C of the figure above).

At each sampling point, the extracted spear sample was divided into three sub-increments of approximately equal mass, with each sub-increment representing one third of the material depth (i.e. top, middle and bottom) to enable testing of moisture content at different depths. The manual sampling of the copper concentrate inside the rotainer was repeated on day 28 in the same manner.

The final sampling operation was performed at the mine upon the discharge of the copper concentrate, by using a sampling spear to take 20 full depth increments at equidistant points from a levelled stockpile. Each increment or sub-increment was individually analysed for moisture content according to (ISO 10251:2006) compliant methodology.

Moisture determination

Moisture determination tests performed on 22 samples obtained at the mine on day zero, and 63 samples obtained at the storage facility on day 28, gave an average moisture content of 7.88% and 5.92%, respectively. For the same dataset, the moisture content range increased from 0.71% to 1.72%, respectively.

Weather conditions during the duration of the investigation were recorded by Canadian Government weather stations with an average temperature of 21.6°C and a high of 43.7°C, with no precipitation.

Moisture determination results for samples obtained during stage two and stage three sampling show the distribution of moisture content within each layer – upper, middle and lower – and an average moisture result was calculated for each sampling position (see image above).

The moisture content of samples obtained from beneath the proposed sampling hatches during sampling stages two and three were 0.15% higher and 0.37% lower than the respective average moisture content of the material in the rotainer at each stage.

There does not appear to be a significant and materially relevant change in relative moisture with increased depth. However, the results indicate a relative increase in moisture towards the rotainer walls and corners. This could be explained by diurnal fluctuations in temperatures adjacent to the steel walls of the rotainer, leading to cycles of evaporation and condensation.

Furthermore, it is possible that simultaneous loss of moisture by evaporation, associated with high temperatures, was more prevalent towards the centre of the rotainer.

Sampling using the sampling hatches in the lid of the rotainers may provide moisture results lower than an equivalent dynamic sampling method, when there is full access to the copper concentrate, as conducted at the mine. Therefore, the possibility that a bias exists between these two methods cannot be excluded.

The use of sampling hatches could, however, provide an indication of the copper concentrate moisture content and confirm a previously determined moisture content taken at the mine during the loading of rotainers.

This investigation has been based on a limited number of samples. More detailed investigations are recommended to test further these preliminary and indicative results. Nevertheless, the use of rotainers has the potential to transport copper concentrate from the mine to the port, with environmental and economic benefits. However, the limitations with respect to testing inspection and certification should be considered on a case-by-case basis to develop and approve procedures for sampling, testing and controlling the moisture content of the cargo that are cost-effective and practicable.