Hydroprocess2015
7th International Seminar on Process Hydrometallurgy

Emerging applications for floating covers in the mining and energy sectors

Brian Fraser
Layfield Environmental Containment, Canada

Andrew Mills
Layfield Canada Ltd., Canada

Carlos Bone
Membrantec, Chile

ABSTRACT

Floating geosynthetic covers have been used over the past 30 years to protect water resources by government water authorities and agricultural owners in the United States, Canada, Australia and South America. Driven by climate change and growing shortages of fresh water, governments and industry are increasingly looking at new technology to help protect our diminishing fresh water resources. Floating covers are an important technology designed to protect water from costly evaporation losses while protecting water from contamination including dust and debris prevention. Increasingly floating covers are being used by both the energy and mining sectors to help save costs from water losses while providing an important sustainability strategy for their communities. This paper outlines the growing trend of expanding the use of engineered floating covers into mining and processing applications and specific examples of floating covers used in mining. These applications include evaporation control, preventing water contamination and maintaining consistent fluid temperatures for a variety of mining process applications. The paper also addresses the importance of choosing the correct materials for floating covers. This includes information of the special fortified geomembrane materials designed to provide enhanced longevity, mechanical and flexibility properties. The paper also outlines the best practices required for designing, fabrication and installation of floating cover systems.

Keywords: Floating covers, evaporation control, potable water, CSPE, Chlorosulphonated Polyethylene, fortified geomembranes, salt water, brine, Langelier, temperature control, insulated covers, dilution control, pregnant solution

INTRODUCTION

Floating covers are the most effective method of containing and storing large volumes of water. They are less expensive than other storage methods yet the covers provide protection of the water from the environment. Floating covers have been in use for many years for the storage of potable water and are being used more and more for applications in mining and energy extraction. Floating covers typically protect against the loss of water due to evaporation but can also prevent dilution of treated process water such as heap leach solutions. Specialised insulated covers can be used for temperature control and all covers provide debris control. The most effective floating covers will require the selection of skilled and experienced designers and installers.

BACKGROUND

Floating covers are an established technology that has been used to protect water resources for many years. The first floating covers were developed to protect potable water (drinking water) in municipal facilities. Much of that work was done in California where they have a large demand for potable water and limited sources. In 1976 the Burke Company was awarded a patent for what we now call the defined-sump floating cover which is now the most common floating cover type (Burke et al., 1976). Since that time floating covers have evolved into a reliable and effective water storage method.

The California potable water system is very interesting as it is based on a limited number of water treatment plants working year-round to make potable water and then extensive storage facilities to adjust for changes in demand. A lined reservoir with a floating cover has proven to be the most cost effective storage method for potable water in California and in a number of other jurisdictions. They are a less expensive storage option than other covered storage techniques such as tanks or reservoirs with a structural roof. It is possible to make a floating cover reservoir much larger than a tank or reservoir with a structural roof as there are no structural support limitations with a floating cover. In areas where large volumes of water need to be stored floating covers are often the best option. A good example of these large water storage reservoirs is the Upper Chiquita Reservoir (Figure 1) which was a 923 mega liter reservoir was completed in 2011 for at a cost of US$ 53 million (Mills and Falk, 2013).

Figure 1 The Upper Chiquita Reservoir in the Santa Margerita Water District

Floating covers create a barrier between the water in the pond and the environment. This barrier provides important benefits including:

- Prevention of loss of water to evaporation
- Prevention of loss of chlorine to evaporation
- Exclusion of debris and contaminants
- Exclusion of sunlight which can prevent:
    - The growth of plants that can foul the water
    - The formation of trihalomethanes which affects drinking water taste
    - The absorption of heat so that the water stays cool

Depending on the location of the floating cover certain benefits may be of more value than others. Here are a couple of examples.

In the US there is an EPA regulation in place to control disinfection byproducts called the Stage 2 Disinfectants and Disinfection Byproducts Rule (S2DBPR 2006). This has led to additional floating covers being installed across the US, and especially in California, to limit the formation of trihalomethanes in stored water. Trihalomethanes can affect the taste of the water and are considered to be a risk to health.

In Nova Scotia, Canada floating covers were used on a number of small open-topped reservoirs. In this instance the key benefit was reduced chlorine use and lower operating costs.

In Australia they have been adding floating covers to municipal reservoirs to prevent the evaporation of water. Parts of Australia have been experiencing a prolonged drought so the key benefit of the floating cover in their location has been the preservation of water volumes.

FORTIFIED FLOATING COVER MATERIALS

In order to be used for a floating cover a material needs to be flexible and strong. For many years the standard material for potable water floating covers has been Chlorosuphonated Polyethylene (CSPE). CSPE is a type of rubber that can be welded during fabrication and installation but then cures in service to create a durable, flexible material. CSPE has been used in floating covers for over 30 years and has excellent UV resistance and longevity. CSPE is still the preferred material for potable water floating covers in California and many other parts of the US. CSPE is widely available for floating covers.

Recently the authors have been working on the development of new materials with lower initial costs, improved longevity, and ease of repair over the long term. One of the key developments in this area has been the development of fortified geomembrane technology. Fortified geomembranes use additional UV and heat stabilizers to increase the longevity of the material and to provide a larger reservoir of stabilizers that can resist the attack of chemicals over a longer term.

The initial development of stabilized geomembrane materials was focussed on UV resistance which culminated in a 30,000 hour UV study published in 2009. This study showed that polyolefin geomembrane materials could reach extended life times if properly stabilized (Mills, Martin and Sati, 2009). As a result of this study a fortified polyolefin material was developed that has a 25-year warranty. This material has now been adapted for use in floating covers.

Further development explored the long term chemical resistance of fortified geomembranes. One key chemical in mining and energy extraction is salt water or brine. The authors developed a long-term elevated-temperature brine test which showed that fortified materials were better able to resist chemical attack (Mills, 2015).

For many years a particular mine site in Australia was having difficulty with floating covers and liners used to store very pure process water. They had experienced a number of floating cover and liner failures over the years. Investigation showed that it was the purity of the water that was causing issues with the plastic materials. When the water is very pure there are no minerals present (especially calcium) and the water is said to have a low Langelier Saturation Index (LSI). Low LSI water can be created through reverse osmosis treatment methods or if the water is deionized. Water with a low LSI is particularly aggressive and can erode concrete water pipes, dissolve copper piping, and harm certain types of plastic cover and liner materials. In 2013 the authors developed a test method to explore the long term resistance of materials this unique water. The materials that were ultimately chosen for this application were fortified geomembrane and cover materials (Fraser and Mills, 2015). Figure 2 shows the liner and floating cover being installed for a 60 mega liter low LSI containment in Australia.

Figure 2 Fortified floating cover material at a mine site in Australia

Fortified floating cover materials are less expensive than previous floating cover materials such as CSPE but still retain the UV resistance needed for long life. In addition, the fortified materials have better resistance to chemicals and are easily repaired over the long term life of the cover.

NEW MINING AND ENERGY APPLICATIONS

With the advent of lower cost fortified cover materials the application of floating covers in mining becomes more cost-effective. In addition to containment of potable water and potable water with a very low LSI, there are other emerging applications that are specific to mining and energy exploration. These applications include evaporation control, temperature control, and dilution control.

Evaporation Control

Many mine sites are located in desert areas where water is difficult and expensive to obtain. Previously the cost of a floating cover has been too expensive to justify for evaporation. The authors have developed a new light-weight low-cost cover specifically for evaporation control that addresses the problem with cost. In areas with high evaporation rates and a high cost of water these evaporation covers are become more prevalent. Figure 3 shows an evaporation control cover in Texas used for water storage in energy exploration. This light-weight cover provides significant cost savings to the owner in preventing the loss of water. A recent paper discusses the advances of evaporation control covers in energy extraction (Fraser and Killian, 2015).

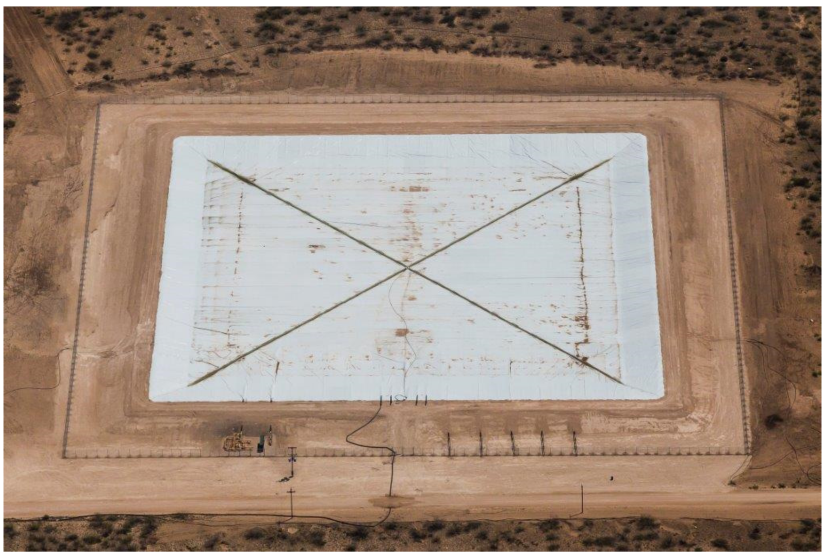

Figure 3 Evaporation control cover in Texas

Temperature Control

In many processes it is important to maintain water temperatures. This is usually accomplished by using an insulated tank to hold water. Now there are insulated floating covers that can be used on ponds. This creates a lower cost water storage while still be able to save money on temperature control. Insulated covers are sometimes used to keep water cool but most of the time insulated covers are used to retain heat in cold weather operations. Retaining heat can directly reduce operating costs if water needs to be maintained at a specific temperature. Insulated covers can also retain heat to help maintain temperatures for biological heap leaching applications. Other applications include preventing freezing of process water and preventing precipitation of chemicals due to a rapid drop in temperature. In figure 4 we show an acid clarifier at a mine site in northern Canada. This 200 mm thick cover was used to prevent freezing so that the clarifier could remain in operation throughout the winter. Other insulated cover types can be used to cover larger ponds.

Figure 4 200 mm thick insulated cover on an acid clarifier.

Dilution Control

In contrast to evaporation control covers which are used in dry locations a dilution control cover is used when a location is too wet. Locations where there is a lot of precipitation can have a problem with ponds talking on too much water. The additional water from precipitation dilutes the liquid in the pond which can lead to increased costs. If the pond contains a pregnant solution then dilution reduces the effectiveness of the solution and more chemical has to be added. If the pond contains saturated brine then dilution will usually mean that more salt has to be added to the water which leads to an excess of brine and a disposal problem. Figure 5 shows a run-off pond at a remediation site at a former lead smelter. Precipitation was diluting the run-off water which was increasing the amount of water that needed to be treated during remediation. Adding a temporary low-cost floating cover allowed precipitation water to be pumped off the cover directly to the environment which limited treatment to only the contaminated water that was under the cover.

Figure 5 Temporary floating cover at a remediation site

DESIGN AND INSTALLATION OF FLOATING COVERS

When designing a floating cover there are two guidelines available for potable water covers. These are the M25 Flexible Membrane Covers and Linings (AWWA, 2000), and the Reservoir Floating Cover Guidelines (CA/NV, 1999). These guides show the best practices in floating cover design for potable water.

There are two basic methods of floating cover installation. The most common method is to install the cover in a dry pond. This method is the most reliable and can be applied to all pond types including the largest sizes. Figures 1 and 2 illustrate installations in dry ponds. In the dry pond installation the liner is placed first and is completed and tested. Then the cover is assembled on top of the liner. The cover sheet material is placed first and thoroughly tested. Then the floats, weights, and fittings that make the cover operate effectively are placed on top of the sheet material. These floats and weights take up the slack in the cover as the water level changes in the pond. Done correctly and the cover will give many years of service. When the weight, floats, and fittings are not designed and done correctly then the cover will not provide the intended service. Selecting an experienced designer and installer is an important aspect of a successful installation.

The more challenging type of installation is when the cover must be placed on a pond that is full, or partially full of water. Figures, 3, 4, and 5 all show covers that were installed when there was water in the containment. Insulated covers (figure 4) are placed in sections so they are relatively easy to move out onto the water. What is more challenging is to float a large cover into service. The most important aspect of a wet installation is access to the pond. There must be sufficient access on one side of the pond to build the entire cover and then access on the opposite side to rig cables to draw the cover across the pond. In figure 5 the long, narrow profile of the pond was ideal for a wet installation with the cover being assembled on the right and then deployed across the pond to the left. It is even more important that a skilled designer and installer are selected for a wet pond installation.

CONCLUSION

Floating covers are a mature technique that are finding new applications in mining and energy extraction as more cost-effective materials and installation techniques are developed. Lined and covered ponds are one of the most cost-effective water storage options for large volumes of water. New fortified materials are allowing floating covers to move into other mining applications by maintaining longevity with less costly materials. In addition to the usual application of floating covers for the storage of potable water applications are emerging for evaporation control, temperature control, and dilution control. The design of a floating cover requires experience and skill and the selection of the designer and installer should be done with care.

The use of floating covers in mining and energy exploration is limited only by imagination. If a large volume of water needs to be contained and protected there is likely a floating cover solution.

REFERENCES

AWWA (2000) M25 Flexible Membrane Covers and Linings for Potable Water Reservoirs (2000), American Water and Waste Water Association, Denver CO, USA.

Burke, N. Kutnewsky, D. Price, V. Gerber, D. (1976) Reservoir cover and canalizing means, US Patent #3,991,900, US Patent and Trademark Office, Alexandria, VA, USA.

CA/NV (1999) Reservoir Floating Cover Guidelines, California –Nevada Section of the American Water and Waste Water Association, Rancho Cucamonga, CA, USA

Fraser, B. Mills, A. (2015) Geomembrane Performance Testing - Impacts of a Negative Langelier Saturation Index on Geomembranes Geosynthetics ’15, IFAI 1801 County Road B W Roseville, MN, USA.

Fraser, B, Killian, B. (2015) Emerging applications for evaporation control covers Geosynthetics ’15, IFAI 1801 County Road B W Roseville, MN, USA.

Mills, A. Falk, S. (2013) Upper Chiquita Reservoir Floating Cover and Liner, Geosynthetics ’13, IFAI 1801 County Road B W Roseville, MN, USA.

Mills, A. Martin, D. Sati, R. (2009) Long-Term Weathering Stability and Warranty Implications for Thin Film Geomembranes, Geosynthetics ’09, IFAI 1801 County Road B W Roseville, MN, USA.

Mills, A. (2015) Geomembrane Resistance to Hot Brine in Produced Water and Flowback Applications, Geosynthetics ’15, IFAI 1801 County Road B W Roseville, MN, USA.

US EPA Stage 2 Disinfectants and Disinfection Byproducts Rule (2006) Stage 2 Rule Page, Retrieved from http://water.epa.gov/lawsregs/rulesregs/sdwa/stage2/regulations.cfm