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Spent Potliner (SPL) is a solid waste produced by the aluminium manufacturing industry. SPL is a significant environmental concern which requires appropriate management, treatment and disposal. The greatest concern with SPL are the high concentrations of cyanides and fluoride that are readily leached. Due to its leaching potential, SPL is listed as a designated (K088) hazardous waste by the US Environmental Protection Agency (US EPA) and the land filling of this waste is now banned in many countries including North America (Gunnarsson, 2016).

Hydro Aluminium Kurri Kurri has proposed the use of a containment cell to encapsulate contaminated materials including the (mixed) waste currently stored in the area known as "Mount Alcan". The containment cell as outlined in Appendix 4 of the EIS, is also known in the scientific literature as the "dry tomb" landfilling approach. According to the US EPA this approach began in the 1970s, when compacted soil/clay liners were proposed for waste containment. However, it was soon found that compacted soil/clay has a finite permeability for water/leachate, which means that eventually it is subject to penetration by leachate, which can lead to groundwater pollution. This design soon evolved to the composite liner system commonly used today and proposed by Hydro Aluminium. However, as demonstrated in the scientific literature the same problem of infiltration and leakage applies to today's "best practice" composite liner systems and therefore the construction of an "impermeable" composite barrier (as proposed by Hydro Aluminium) is seldom, if ever, successful (Hauser, 2009).

Bentonite is one of the most common materials used in containment barriers as it exhibits properties desirable for containment of leachate. However, despite world-wide use of clays and geosynthetic membranes in waste containment systems, it has been acknowledged that they are still susceptible to damage from potentially harmful leachates (Yanful *et al.* 1988; Mott & Weber 1991; Christensen 1992; Seymour 1992; Wagner 1993 in Hauser, 2009).

Some researchers have expressed concern about the long-term resistance and stability of bentonite clays (in either single or composite form) in containment cell linings. The use of clays such as kaolinite and illite in composite liners rather than high swelling clay minerals like sodium montmorillonite is becoming more common because these clays are less chemically active and more resistant to chemical attack (Fiebiger & Schellhorn, 1994). Of particular concern with SPL leachate, the high pH (>9.0), salinity (ionic strength), and fluoride concentrations all play a role in decreasing the effectiveness of any clay barrier. This was first



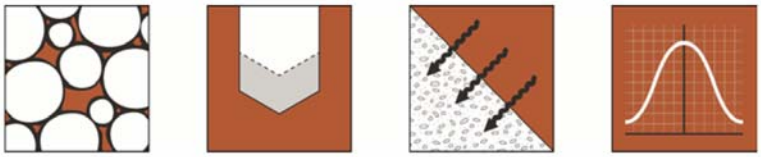

shown by Kau *et al.* (1998) who reported that the ability of kaolinite and bentonite clays to take-up (remove) fluoride from water decreases with increasing pH, and that increasing the salinity also increased the permeability of the clay. Additionally Kang *et al.* (2011) who studied the effect of SPL leachate on the clay liner of containment cells found that the movement of ferrocyanide and fluoride from SPL landfills was enhanced due to the physical effect of SPL leachate on the clay. Even in the absence of a measurable level of leachate inside the containment cell, movement of contaminants through the barrier occurs via the powerful process of diffusion (Lake & Rowe, 2005).

The combination of a natural clay liner with geosynthetic materials such as HDPE (high density polyethylene) as propsed by Hydro Aluminium, may reduce the risk of liner failure, however like clay liners, the chemical resistance of geosynthetic materials is not well documented (Metcalfe & Rochelle, 1999). Additionally, it has been shown that the presence of organic chemicals, once in contact with an intact (without holes) HDPE liner can pass through it in a short period of time. As discussed by Lee and Jones-Lee (2004) it has been found that solvents can pass through HDPE liners in a few days. The leachate from Mount Alcan has many organic chemicals contained within it (Turner, 2003) of which, the effects on clays and HDPE are unknown.

The use of geomembrane (HDPE liner) whilst good in theory are prone to leak as they are difficult to install without punctures. Board and Lane (1995; in Hauser, 2009) found 26 holes in the geomembrane liner of a 4 acre facility. Crozier and Walker (1995; in Hauser 2009) examined seven geomembrane installations and found holes ranging from pinholes to 2 m gashes with an average number of holes at two per acre. Even with good construction practice, some holes are likely in the geomembrane barrier. In a full-scale composite barrier, a single hole in the geomembrane has the potential funnel a very large volume of water into the waste or, if in the base liner, allow leachate to contact the clay liner. Studies by Dwyer (2001) and Albright *et al.* (2004; 2006b) (in (Hauser, 2009)) demonstrate that composite-barrier covers are likely to leak and that “large increases (of up to 765 times the initial as-built value) in the hydraulic conductivity of clay barriers with time are not uncommon.”

No data exists on the long-term stability of modern containment systems as the oldest one is only ~30 years old. However, a critical review of the processes that can take place in a landfill shows that a dry tomb landfill will eventually fail, becoming a waste containment system that will not prevent groundwater pollution for as long as the wastes are a threat. In a dry tomb landfill of SPL the wastes will be a threat to generate leachate, effectively forever. Consequently, the use of other techniques such as plasma-arc solidification should be used in place of the containment option which is not a remediation solution.

Summary:



- Spent Potlilner waste does not degrade or transform and remains a hazardous solid waste forever.
- No containment cell is “forever” and therefore eventual failure will result in environmental contamination.
    - Consequently, there is no assurance that there will be funds available to properly analyse and manage the leachate that will need to be collected “forever”
- The only literature available on the effects of spent potliner leachate on clay liners ((Kang et al., 2011) indicates that it “enhances the leachability of ferrocyanide and fluoride from SPL landfill sites.”
- Studies on clay minerals in the presence of fluoride and saline water also indicated an increase in the movement of contaminants through the containment cell wall
- The effect of organics and any other unknown chemicals in the “mixed waste” from Mount Alcan increases the probability of destruction of the plastic (high density polyethylene (HDPE)) membrane liner.

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