ISO 17025 ACCREDITED LABORATORY
ExcelPlas

Technical Note EP-49

How to Blooming Affects Welding of HDPE Geomembranes

1. Introduction

The ever increasing drive to reach greater durability with HDPE geomembranes has meant increased loadings of antioxidants and stabilizers are being incorporated into the polymer.

While this leads to very long OIT & HP-OIT values and >90% retention of HP-OIT after oven ageing it has also resulted in increased problems with additive blooming and consequently difficulties with fusion welding.

Difficulties with excess blooming can negatively impact on welding productivity with the needs to weld more slowly (e.g. 2/3 of normal welding speed) and regularly stopping to clean the brass wedges of the welding machine.

Excess blooming can also cause porosity in the weld zone leading to reduced seam strength.

Blooming or *exudation* (as it is technically known) is the migration and diffusion of the additives from the HDPE to the surface of the liner to form a greasy/waxy layer.

During welding the excess additives and polymer waxes that have bloomed from the HDPE accumulate on the hot wedges of the welding machines and then are pushed laterally to give excess squeeze-out and abnormally large squeeze out areas.

Furthermore the additive build-up on the heated wedges of the welder begin to decompose leading to volatiles (e.g. smoking wedges) and carbon build-up on the wedges (carbonized wedges).

Blooming of HALS additives is due to their relatively low solubility in polyolefin substrates and HALS reaching their saturation solubility in HDPE when levels exceed 0.5 wt.% (5000 ppm) and approach 1 wt.% (10,000 ppm).

In addition the base HDPE polymer may have high levels of cyclohexane extractables (CHE) which may also contribute to the excess squeeze-out problem by increasing the level of oligomers and waxes in the polymer.

2. Porosity in Weld Zone

The volatiles that form from the thermal decomposition of the additive bloom on the brass wedges of the welding machine can get entrapped in the weld interface leading to tracks of bubbles and porosity as shown in the photo below.

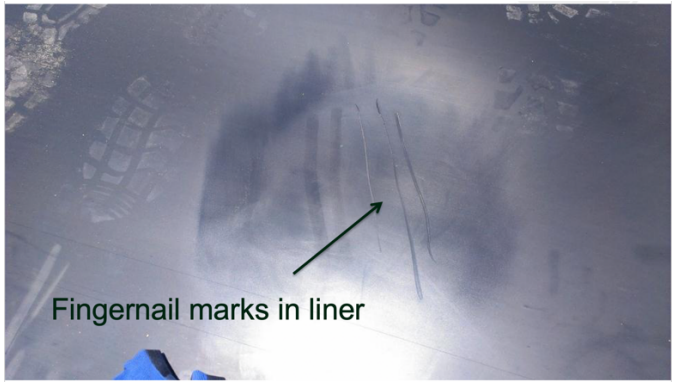
3. How Can Excess Blooming be Detected?

Excess blooming of HDPE geomembranes can be detected in the following ways:

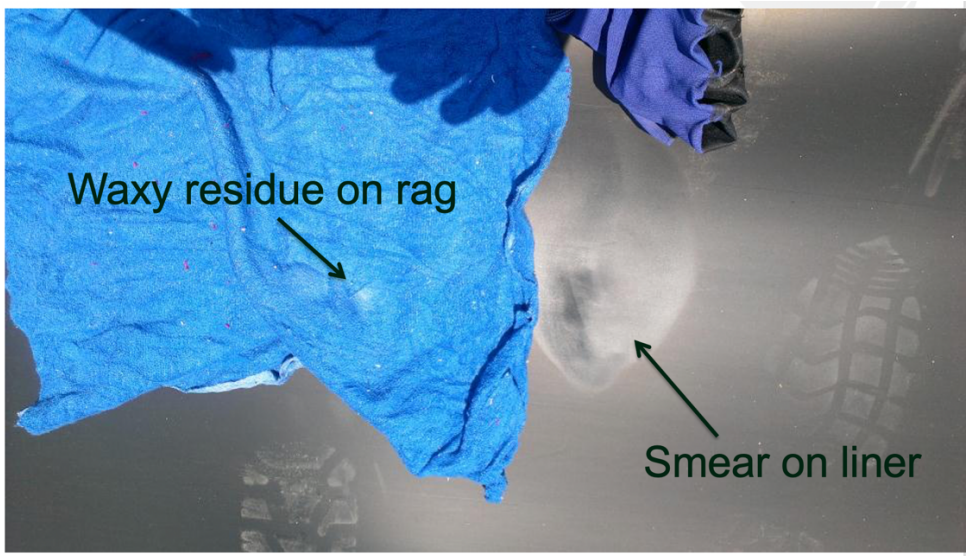
(1) By dragging your fingernail along the surface of the liner a whitish visible line will appear
(2) Observing smoking and blackening of the brass wedges during welding
(3) Observing rows of bubbles and porosity in the weld during a DT test
(4) An abnormally wide and/or thick squeeze out zone
(5) A larger than normal amine IR absorption peak in the FTIR spectrum at 1535 cm^{-1}*

* a very weak band at 1535 cm-1 indicates the presence of hindered amine stabilizers in HDPE geomembrane using the ATR method. However a significant or very obvious 1535 cm^{-1} band indicates the presence of a waxy HALS stabilizer boom on the surface of the liner.

The photograph below shows the bloom on a HDPE geomembrane after removal by a fingernail (image courtesy Wayne Potter).



The photograph below shows the bloom on a HDPE geomembrane after removal by a dry rag using the "double rub" test leading to a noticeable smear on the liner and a white waxy residue on the blue rag (image courtesy Wayne Potter).



4. Conclusions

Blooming and exudation is most prevalent with geomembranes that are highly stabilized with AO and HALS as their limited solubility in the PE means that the excess migrates and blooms to the surface of the geomembrane.

During wedge welding of the liner, the excess molten polymer with additives and waxes is laterally extruded and deposited on the liner adjacent to the weld tracks and manifests itself as an extra-large squeeze out area.

Large squeeze out zones are not a welding issue *per se* since varying the weld parameters does little to alter the end results. Regular cleaning of the wedges does reduce the incidence of the excessive squeeze out but at the expense of continuous welding and productivity. Large squeeze out zones are more a geomembrane material issue as opposed to a welding issue and have only observed with very well stabilized liners with very high % retention of HP-OIT after oven ageing.

5. Preventative Measures

Possible preventative measure to reach excess squeeze out arising from excess wax/additive migration are as follows:

(1) Test the geomembrane before welding for presence of waxy layers of bloomed additives and waxes using the "fingernail test" and the FTIR scan.
(2) Use ethyl acetate solvent wipes to clean the laps and remove excess bloom and waxes before wedge welding.
(3) Regular cleaning of the brass wedges but at the expense of welder productivity.

6. Further Reading

Scheirs, J. '*A Guide to Polymeric Geomembranes*' Published by John Wiley and Sons (2009) pp. 49-50, 421-422, 428, 443-444.