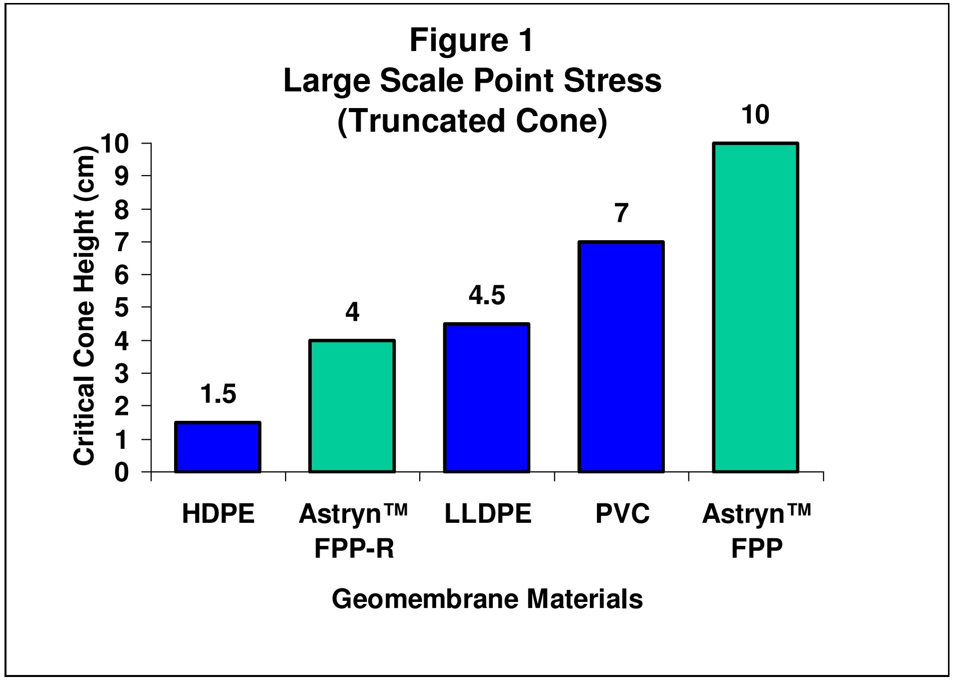
PVC x PEAD

ESCOLHAS e RENUNCIAS

Todo material tem caracteristicas técnicas que o diferenciam dos demais, conheça estas caracteristicas para decidir qual o “melhor” para a sua aplicação

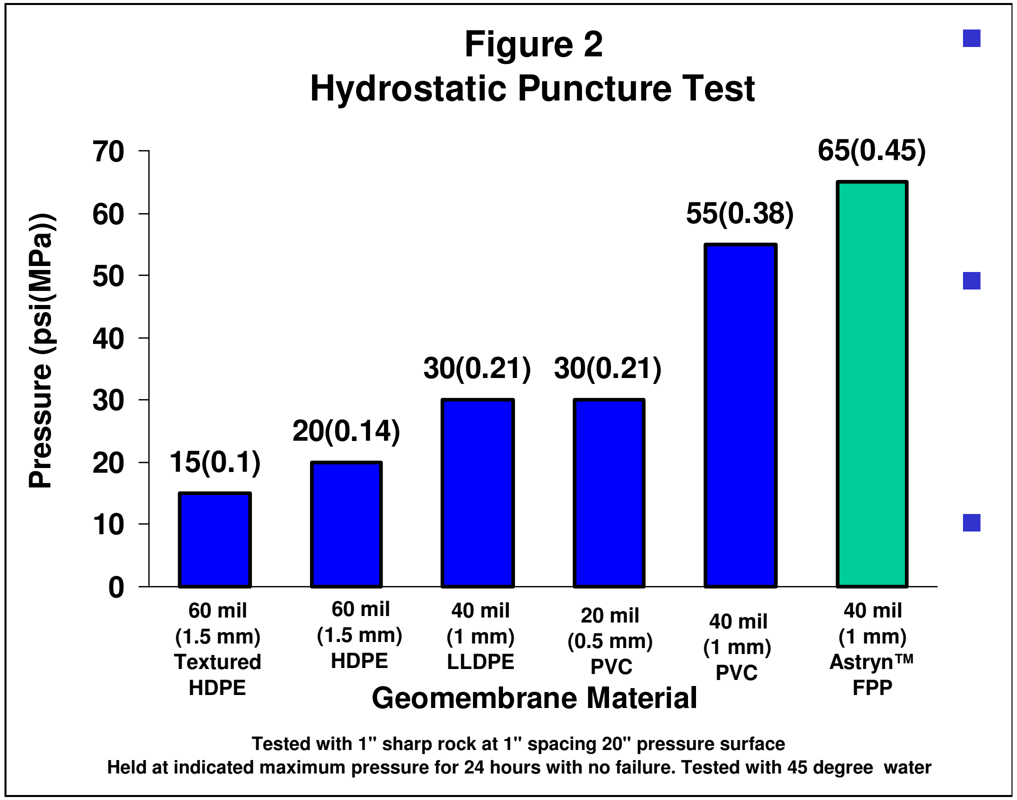
TESTE DE PUNCIONAMENTO

(Truncated cone)



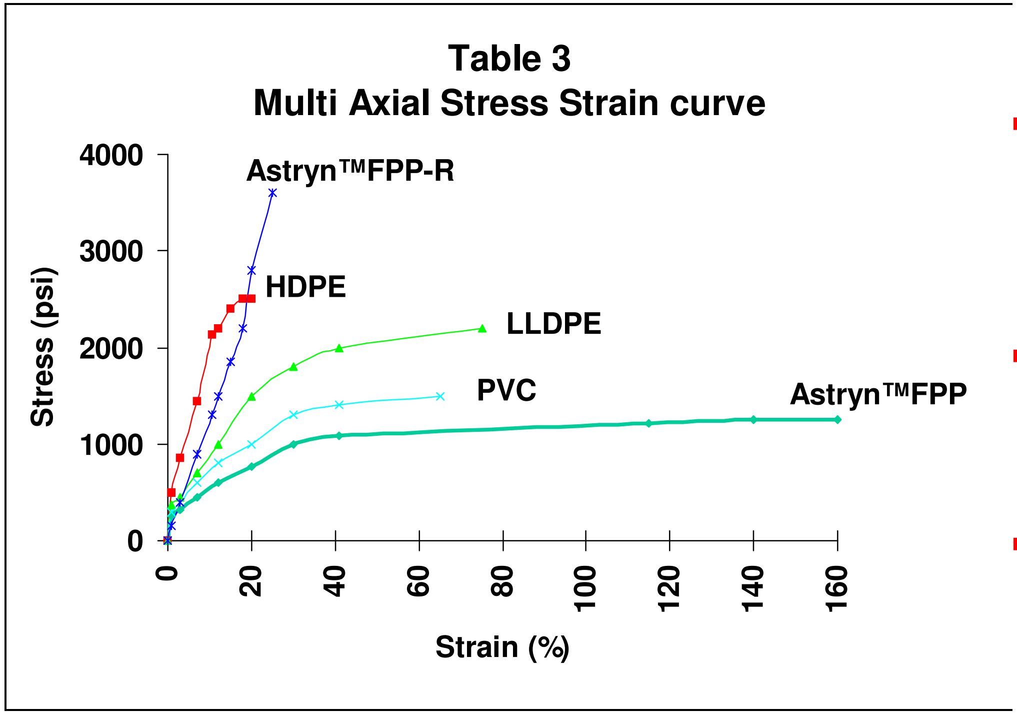
- Este teste pode ser usado para estudar o mecanismo de falha na geomembrana, por objetos pontiagudos sobre o substrato. Por exemplo o PEAD rende-se com alongamento maior de 20% e então não consegue deformar-se sobre a saliência, tendo por resultado o furo por puncionamento.

RESISTENCIA A PERFURAÇÃO



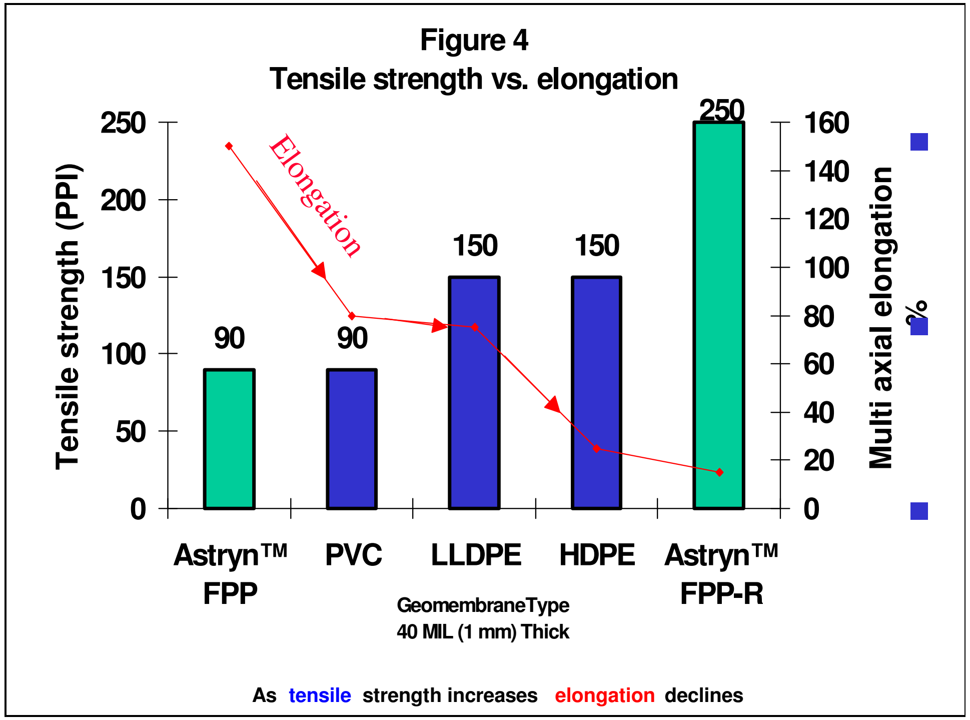
- Este grafico ilustra o desempenho relativo dos vários materiais do geomembrana colocados sobre a rocha afiada de 1".
- Sob estas circunstâncias os geotextiles grossos são requeridos frequentemente como uma camada protetora para o geomembrana.
- A resistência ao puncionamento do PVC, pode permitir o uso de uma geomembrane mais fina e/ou um geotextile protetor mais leve.

Tensão Multi-axial



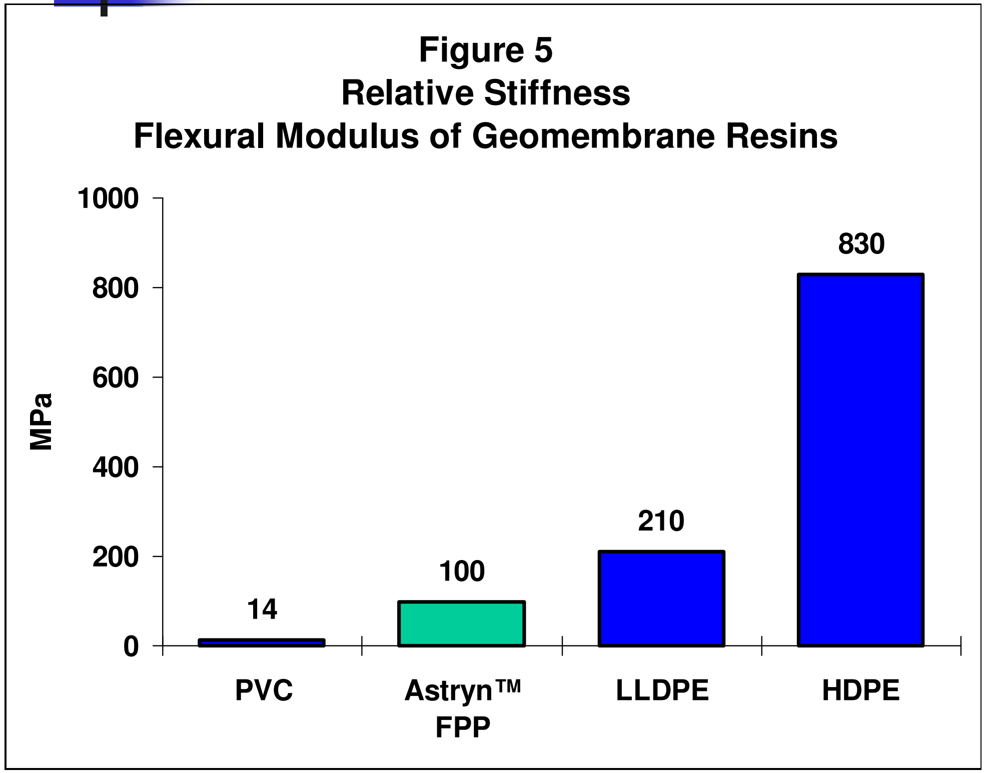
- Muitos Projetistas sentem que o teste multi-axial da tensão de ruptura, ASTM D 5617-94 simula mais realisticamente a situação real campo.
- O teste usa um espécie de anel com diâmetro de 27" e a geomembrana apertada ao instrumento. A pressão do ar ou da água é introduzida com pressão de 1 psi/min até que a falha ocorra.
- As amostras do diâmetro grande deste teste permitem a avaliação de mecanismos da falha. As geomembranas do PEAD falham tipicamente rasgando no sentido da máquina.
- O PEAD falha prematuramente quando testado com riscos (isto é um corte 20% da espessura).

Tensão x Deformação



- As propriedades fisicas dos materiais são importantes para o coordenador de um projeto civil.
- Quando definir a geomembrana deve-se balançar a tensão contra a deformação.
- Tipicamente os geomembranas com força tensão elevada têm pouca habilidade de absolver deformações fora do plano.

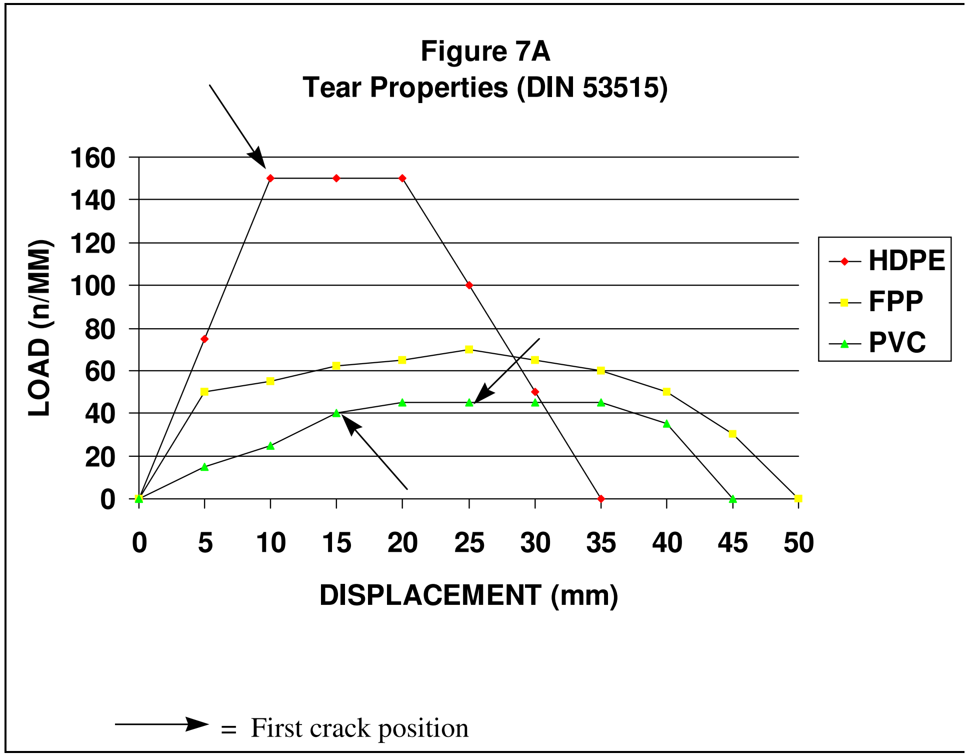
FLEXIBILIDADE DA RESINA



As geomembranas
feitas com resinas flexíveis as
seguintes propriedades desejáveis:

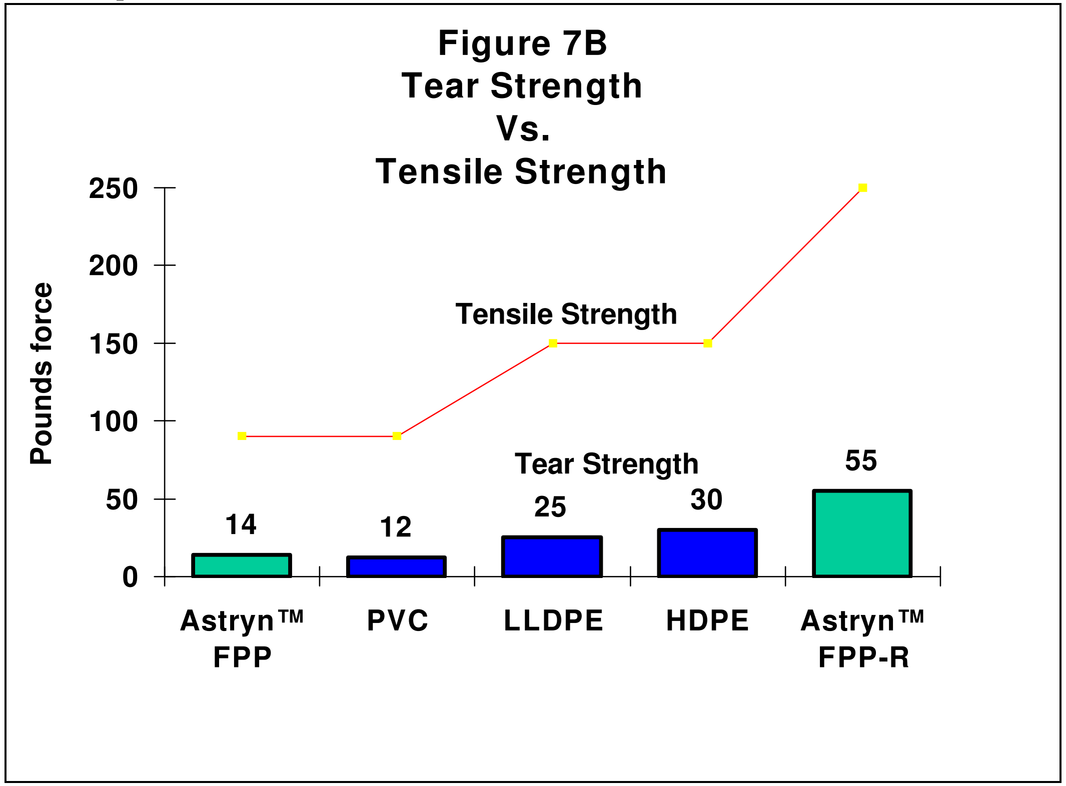
- Conformabilidade sobre o substrato
- Gera reduzido e/ou pouco
- Enrugamentos durante a instalação. Os ângulos do fricção são muito elevados tendo por resultado uma liberdade maior do projeto.

RESISTENCIA AO RASGO



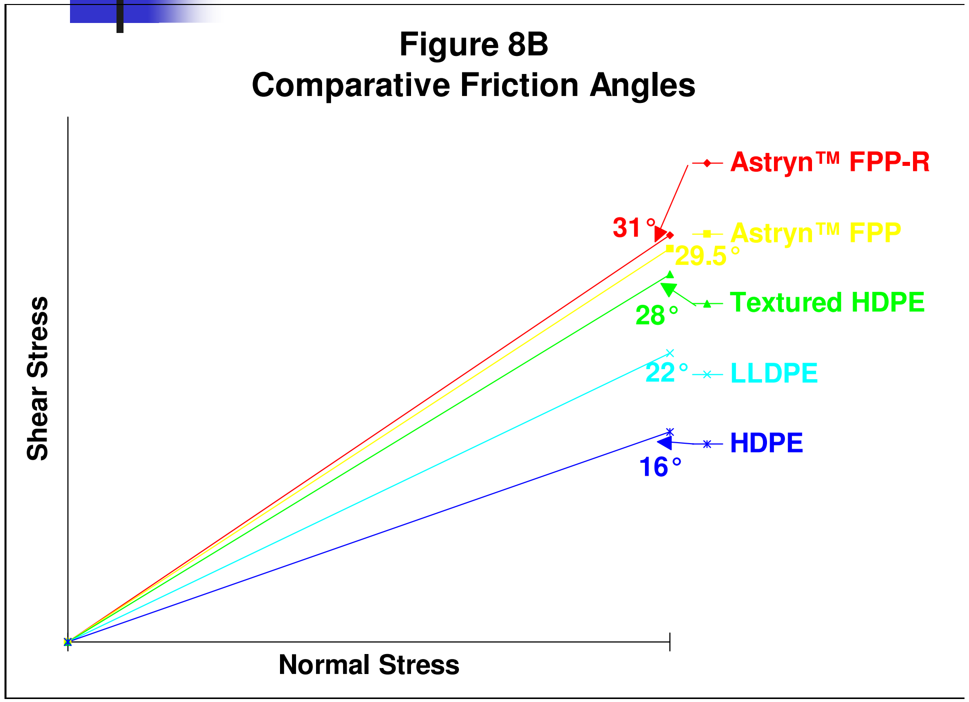
- Geomembranas feitas com resina flexível tem excelente resistência à iniciação e propagação ao rasgo.
- Num eventual rasgo, o rasgo não propagará prontamente mesmo quando sob forte tensões, tais como aquelas experimentados em inclinações laterais.
- Como mostrado a figura , a propagação da ruptura e de rachadura ocorra somente após um grau elevado de deformação (PVC 2,5 vezes maior do que o PEAD).

RESISTENCIA AO RASGO



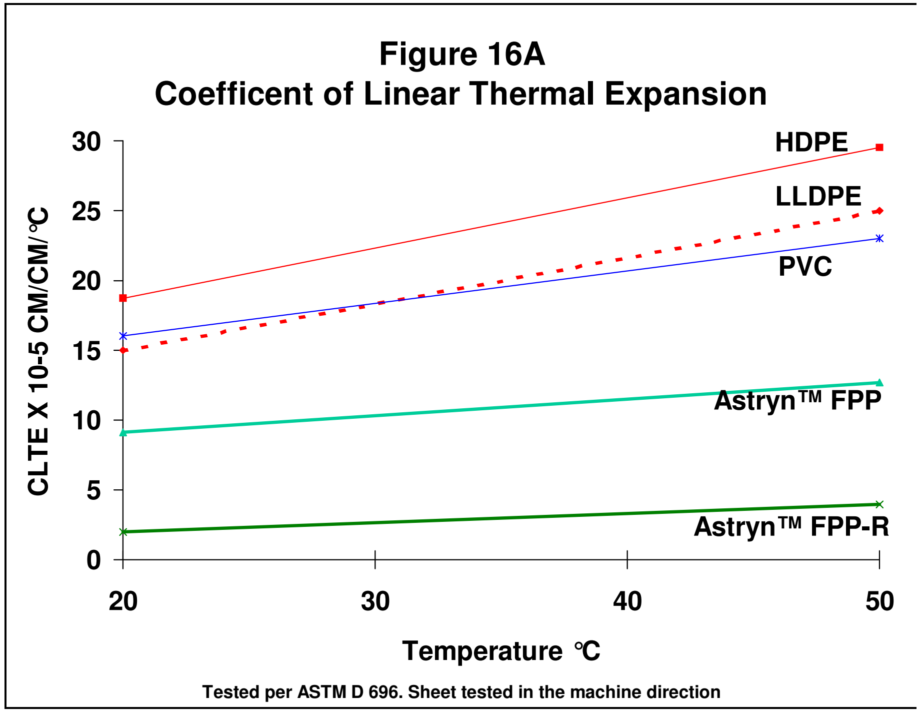
- O teste demonstra que a geomembrana não possui resistência ao rasgo sobre uma força de tensão aplicada e não mostra a dificuldade de propagar o mesmo

Angulo de Atrito



- O atrito da membrana com o solo é crítico ao projeto, devido a necessidade de inclinações laterais nos Aterros Municipais, nos reservatórios e nos canais.
- Um ângulo da fricção elevada oferece uma liberdade maior aos Projetistas.
- Isto pode permitir a construção de obras com inclinações laterais mais íngremes, que possam aumentar uma capacidade de armazenamento.

DILATAÇÃO TERMICA



- Quando um geomembrana é aquecida durante o dia pela exposição à luz solar direta e experimenta então refrigerar rápido e significativo na noite, a geomembrana experimentará a dilatação e a contração.
- Caso a geomembrana não tenha liberdade de movimento podem ocorrer grandes tensões localizadas.
- Estas mudanças podem ocorrer durante e/ou após a instalação.

Trabalho Tecnico

Comparativo PVC x PEAD

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Chemical Compatibility:

The main advantage of HDPE geomembranes is their better chemical resistance to hydrocarbons and solvents (Vandervoort 1992). However, this data was generated using EPA Method 9090, which does not consider chemical resistance under the stresses that will be imposed on the liner system. The semi-crystalline nature of HDPE may make it more susceptible to stress cracking when tested under stress in the presence of leachate. In addition, this testing was conducted using HDPE and not MDPE geomembranes. MDPE geomembranes are less chemically resistant than HDPE geomembranes because chemical resistance increases with resin density. While the chemical resistance of HDPE to hydrocarbons is desirable, it results in a number of less than desirable characteristics including stress cracking, poor subgrade conformance, low interface friction, and poor axi-symmetric tensile elongation (Koerner 1998). Vandervoort (1992) showed the difference in chemical resistance between HDPE and PVC may be significant for allphatic and aromatic hydrocarbons and chlorinate, oxygenated, and crude petroleum solvents. Since municipal solid waste (MSW) leachate has been found to be fairly neutral, pH around 7, and the major inorganic constituents are lead and cadmium (Oweis and Khera 1998), PVC geomembranes are very suitable for MSW landfills (see photo below). Successful 9090 testing of numerous PVC geomembranes supports this conclusion and PVC geomembranes have been used for MSW landfill liners since approximately 1980. It should be noted that PVC geomembranes can be formulated to provide chemical resistance to specific environments, e.g., oil-resistant PVC, which will be the subject of a future PGI Technical Bulletin. In summary, HDPE and PVC geomembranes should be formulated to resist the site-specific environment but it appears that both geomembranes will provide adequate chemical resistance for MSW landfills.

Stress Cracking:

Polyethylene is formed by the polymerization of compounds containing an unsaturated bond between two carbon atoms. This results in a high crystallinity that makes it resistant to a wide range of chemicals but also increases its tendency to rupture under stress. Stress cracking, which has been frequently observed in the field, refers to failure of the geomembrane under stress in a brittle manner exhibiting little or no elongation adjacent to the failure surface (Hsuan 1998). The fundamental governing factor for stress cracking is the polymer characteristics, among which crystallinity and molecular weight are most important (Hsuan 1998). Of course, PVC is an amorphous thermoplastic, and not a crystalline thermoplastic, and thus is not susceptible to stress cracking. However, it can be susceptible to plasticizer migration, which has been addressed by the manufacturers who have developed new primary plasticizers and stabilizers to enhance plasticizer retention.

PVC geomembrane being installed as a MSW landfill liner.

- A principal vantagem da geomembrana de PEAD é sua maior resistência química aos hiodrocarbonetos e solventes (Vander VOORT 1992).
- Decerto, este dado se gerou utlizando o método 9090 da EPA, que **não** considera a resistência aos produtos químicos abaixo dos esforços que lhe serão impostos ao sistema de revestimento.
- A natureza semi-cristalina do PEAD pode faze-lo mais suscetível ao esforço stress cracking quando se realiza a prova ao esforço na presença do lixiviado.
- Ainda quando é resistente o PEAD aos produtos químicos e hidrocarbonetos, isto dá como resultado um certo número de característica menos desejáveis que inclui o esforço ao stress cracking, mal integridade com o substrato, baixa fricção na interface, e mal alongamento à tração aximétrica (KOERNER 1998) .

Trabalho Tecnico

Comparativo PVC x PEAD

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Comparison of 30 mil PVC and 60 mil HDPE Geomembranes

According to ASTM D 4439 Standard Test Method, a geomembrane is a geosynthetic membrane or barrier with low permeability used with any geotechnical engineering related material so as to control fluid migration from a man-made project, structure, or system. Two common materials used to manufacture geomembranes are polyvinyl chloride (PVC) and high density polyethylene (HDPE). At present HDPE and very flexible polyethylene (VFPE) account for 60 to 65% of the geomembrane market while PVC geomembranes account for 20 to 25%. Other types of geomembranes, e.g. chlorosulphonated polyethylene and flexible polypropylene, account for the remainder of the market. The main objective of this technical bulletin is to illuminate the advantages of PVC and HDPE geomembranes. This will be accomplished by comparing various properties for each of these materials.

Thickness:

Of course, the first difference between PVC and HDPE geomembranes is that the US EPA regulations require a thickness of 30 mil for PVC and 60 mil for HDPE geomembranes. A thicker HDPE geomembrane is required for a number of reasons including the ability to weld without damage to the liner, increased strain to tensile yield, greater stress crack resistance (discussed subsequently), and less susceptibility to folding which can lead to stress cracking.

Formulation:

The commonly used formulations for HDPE and PVC geomembranes are shown in the following table.

It can be seen that the HDPE formulation contains no plasticizer and that the majority (96-97%) of the formulation is the HDPE resin. It should be noted that the composition of the HDPE resin differs from manufacturer to manufacturer. Manufacturers have tried to develop HDPE resins that are more resistant to stress cracking, chemical attack, oxidation, and more cost effective. This allows HDPE geomembrane manufacturers to differentiate their products. It should also be noted that HDPE is a misnomer in the industry because the density of the HDPE resin ranges from 0.934 to 0.938 mg/l (Koerner 1998), which is actually in the medium-density range (MDPE). Of course, geomembrane durability increases with increasing resin density; however increased resin density also results in increased stress cracking and cost. In fact, two major reasons for using MDPE instead of HDPE for geomembranes is increased stress crack resistance and lower cost.

In summary, HDPE is a geomembrane "trade" name and different resins and formulations are used to create MDPE, i.e. HDPE, geomembranes. Conversely, a plasticizer is added to impart flexibility and processability to PVC geomembranes. If a significant amount of plasticizer is lost due to improper use, one of the most important advantages of PVC geomembranes, flexibility, will be reduced. (The yield point for HDPE geomembranes occurs at a strain of 5-15% whereas PVC geomembranes undergo 200-300% strain before yield.) As a result, the new generation manufacturers utilize primary plasticizers that enhance plasticizer retention. Based on this discussion it is recommended that site specific testing of geomembranes be conducted to ensure that the desired properties will be achieved because each geomembrane is different.

Polymer	Resin (%)	Filler (%)	Carbon Black or Pigment (%)	Additives (%)	Plasticizer (%)
HDPE	96-97	0	2-3	0.5-1.0	0
PVC	55-60	0-5	1-5	2-3	25-35

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Sinópse

- Objetivo principal deste boletim técnico é destacar as vantagens das geomembranas de PVC e PEAD, isto pode acontecer uma vez que se compare as numerosas propriedades de cada um destes materiais.
- De certo, que a primeira diferença entre as geomembranas de PVC e PEAD é que as normas da EPA (Orgão Ambiental dos USA) requerem uma espesura minima de 0,75 mm para geomembrana de PVC e de 1,50 mm para geomembranas de PEAD
- Pode-se verificar que na fórmula do PEAD não contém plastificante e que a maior parte do PEAD é a resina (96/97%) .
- Verifica-se que na composição da resina do PEAD difere de um fabricante para outro.

Trabalho Tecnico

Comparativo PVC x PEAD


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Technical Bulletin ......April 1999

Installation and Wrinkles:

It is universally recognized that field prepared seams are potentially the most problematic. PVC geomembrane rolls are factory seamed to produce large panels that greatly reduce the number of field seams. In a given liner area, the length of field seam required in a PVC liner may be 80% less than that required for a similar polyethylene geomembrane. This reduces the potential problems associated with field seaming and the cost and duration of field installation. PVC and polyethylene geomembranes can be seamed using either single or dual-track wedge welding equipment. This allows long continuous seams to be constructed in a wider range of environmental conditions. In addition, the use of a dual-track wedge welder allows air-channel testing to be conducted to nondestructively test seams of both PVC and polyethylene geomembranes. In summary, the same techniques for conducting CQA and CQC programs can be used for both PVC and HDPE geomembranes because both liners can be seamed using a dual-track wedge welder.

HDPE geomembranes provide less conformance to subgrade materials due to their stiffness and relatively high coefficient of thermal expansion. This can lead to large wrinkles or waves in the liner system (Koerner et al. 1997) that preclude conformance with regulations which require intimate contact between the geomembrane and underlying CCL or GCL. In addition, these waves can disrupt the leachate collection and removal system by creating obstructions to flow and result in less than 1 foot of drainage material being placed above the wave. The presence of these waves can also delay construction because it may be undesirable to place the soil or geosynthetic drainage material over the geomembrane during the hottest part of the day. At the hottest part of the day, the waves are the greatest and they can be increased by the placement or spreading of the drainage material. It is more desirable to wait for a cooler time of the day so the HDPE waves will be smaller and the equipment is less likely to encounter and damage a wave. Giroud (1995) showed that the amount of wrinkling decreases with an increase in interface strength between the geomembrane and the subgrade. As a result, Giroud (1995) concludes that flexible geomembranes, such as PVC, exhibit smaller wrinkles than smooth HDPE geomembranes because of the higher interface strength. PVC also has a lower coefficient of thermal expansion and its high elongation allows for better field performance, especially where differential settlement is a concern.

Interface Strength:

A number of slope failures, e.g. Boschuk (1991) and Seed et al. (1990), have shown the importance of soil/geomembrane and geosynthetic/geomembrane interface strengths on the stability of geomembrane lined slopes. A large amount of literature is available on geomembrane interface strength and it is clear that the smoother, harder geomembranes, e.g., HDPE, exhibit lower interface friction values than softer and rougher geomembranes, e.g., PVC. In recent years, textured HDPE geomembranes have been used to meet or in some cases exceed the interface strength developed with a smooth PVC geomembrane.

Summary:

PVC and HDPE geomembranes have performed well in the past. If they are designed and installed properly they will continue to perform well in MSW landfills in the future. However, when considering construction and performance factors, such as placing cover soil over wrinkles, stress cracking at folds, wrinkles, and welds, interface friction, and installation CQA/CQC, PVC may be the liner of choice.

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- O PEAD é formado pela polimerização de compostos que contém uma adesão não saturada entre dois átomos de carbono. Isto dá como resultado uma alta cristalinidade que o faz resistente a uma ampla gama de produtos químicos mas que também aumenta sua tendência

  à ruptura e pequenos esforços.
- De certo, o PVC é um termoplástico amorfo, e não um termoplástico cristalino, e portanto, não é suscetível ao stress cracking. Sem dúvida, pode ser suscetível à migração do plastificante, que foi manipulado pelos fabricantes .
- No PEAD é reconhecido a nível mundial , que as soldagens preparadas em campo são potencialmente mais problemáticas. Os rolos de geomebranas de PVC se unem em fábrica para produzir grandes painéis que reduzem de modo considerável o número de soldagem em campo.