ExcelPlas Independent Materials Testing

Geomembrane Durability Tests & Corresponding Accelerated Methods

Dr. John Scheirs

www.excelplas.com

ISO 17025 ACCREDITED LABORATORY ExcelPlas

GMB DURABILITY TESTS AND CORRESPONDING ACCELERATED METHODS

Conventional Test	Typical Time for Completion	Accelerated Test	Typical Time for Completion
SP-NCTL-SCR Stress Cracking ASTM D5397	500 hrs	Strain Hardening Modulus (SHM)	5 hrs
GM-13 Oven Ageing	90 days	30 & 60 day oven Ageing extrapolation	30 – 60 days
GM-13 UV Ageing	1600 hrs	Deformulation & Carbon Black Particle Size Analysis	50 hrs
Immersion Testing on 2.5 mm liner ASTM D5747	3-6 months	Thin Film Immersion (TFI) 250 µm	2 weeks
Oily water Compatibility test ASTM D5747	1-2 months	Jar Test & Elongation at Break	1 day

ExcelPlas Independent Materials Testing

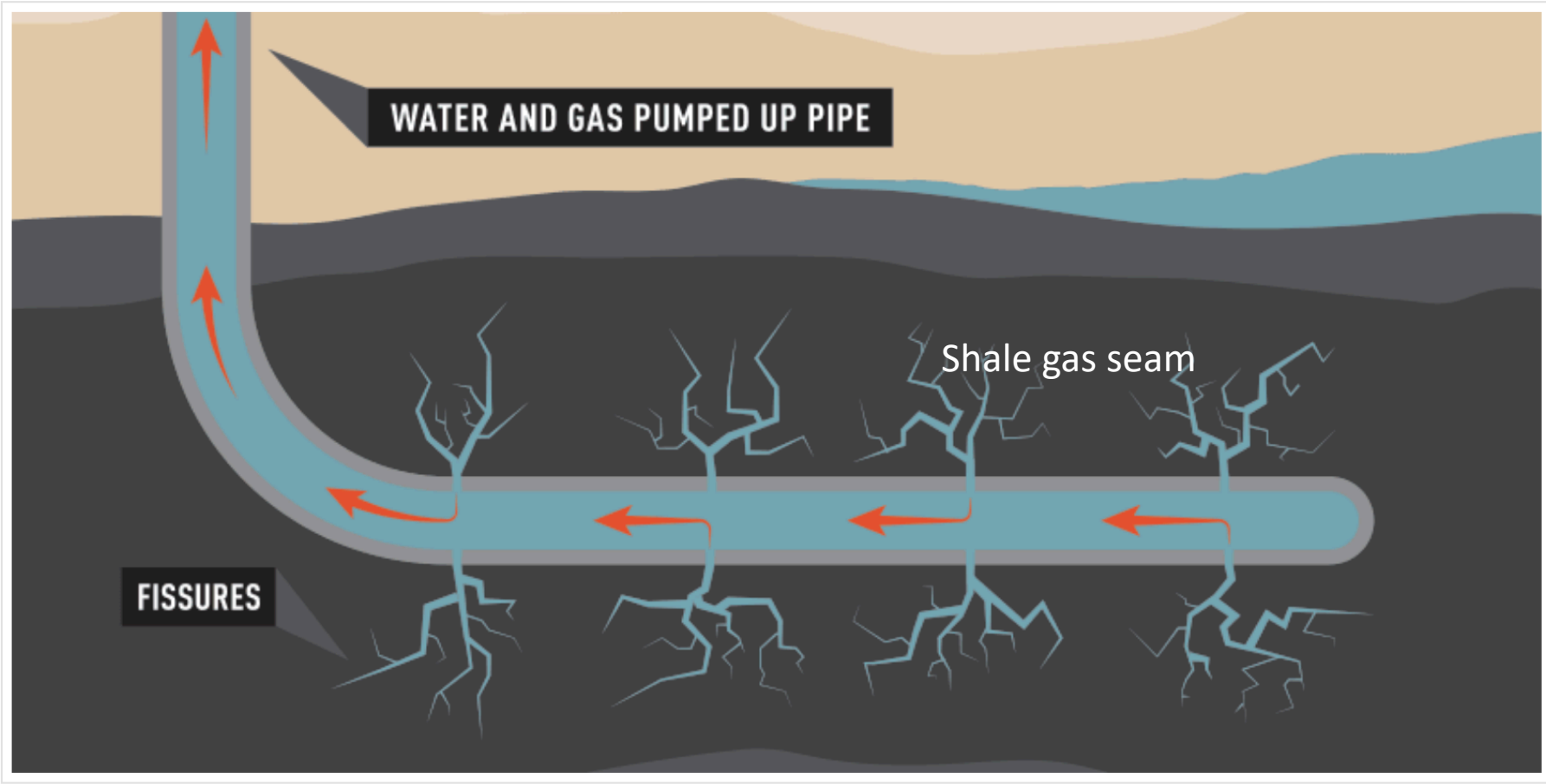
'Jar Test' for Screening Effect of Hydrocarbons in Fracking Water on Polyolefin Geomembranes

Dr. John Scheirs

www.excelplas.com

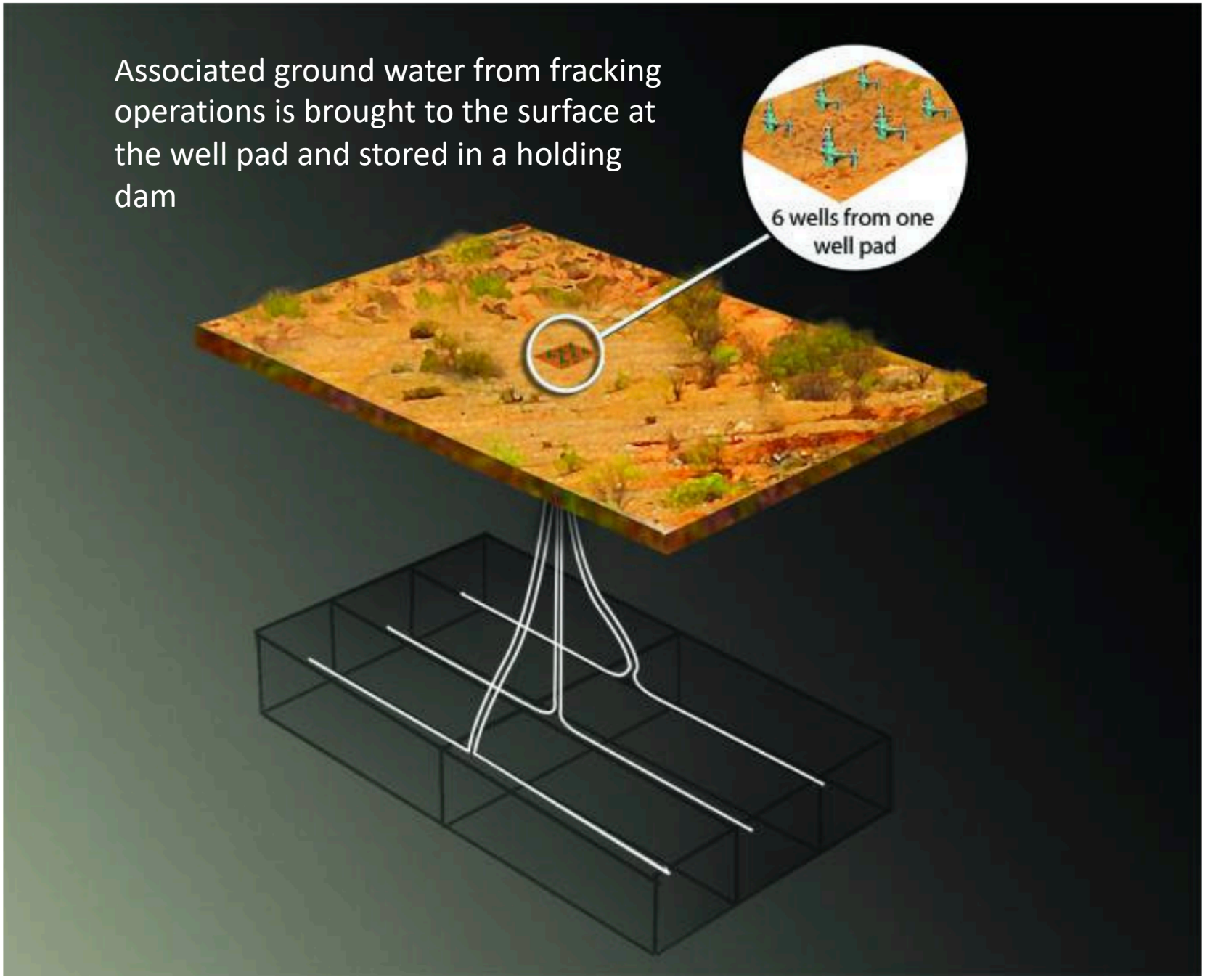
ISO 17025 ACCREDITED LABORATORY ExcelPlas

Hydraulic fracturing

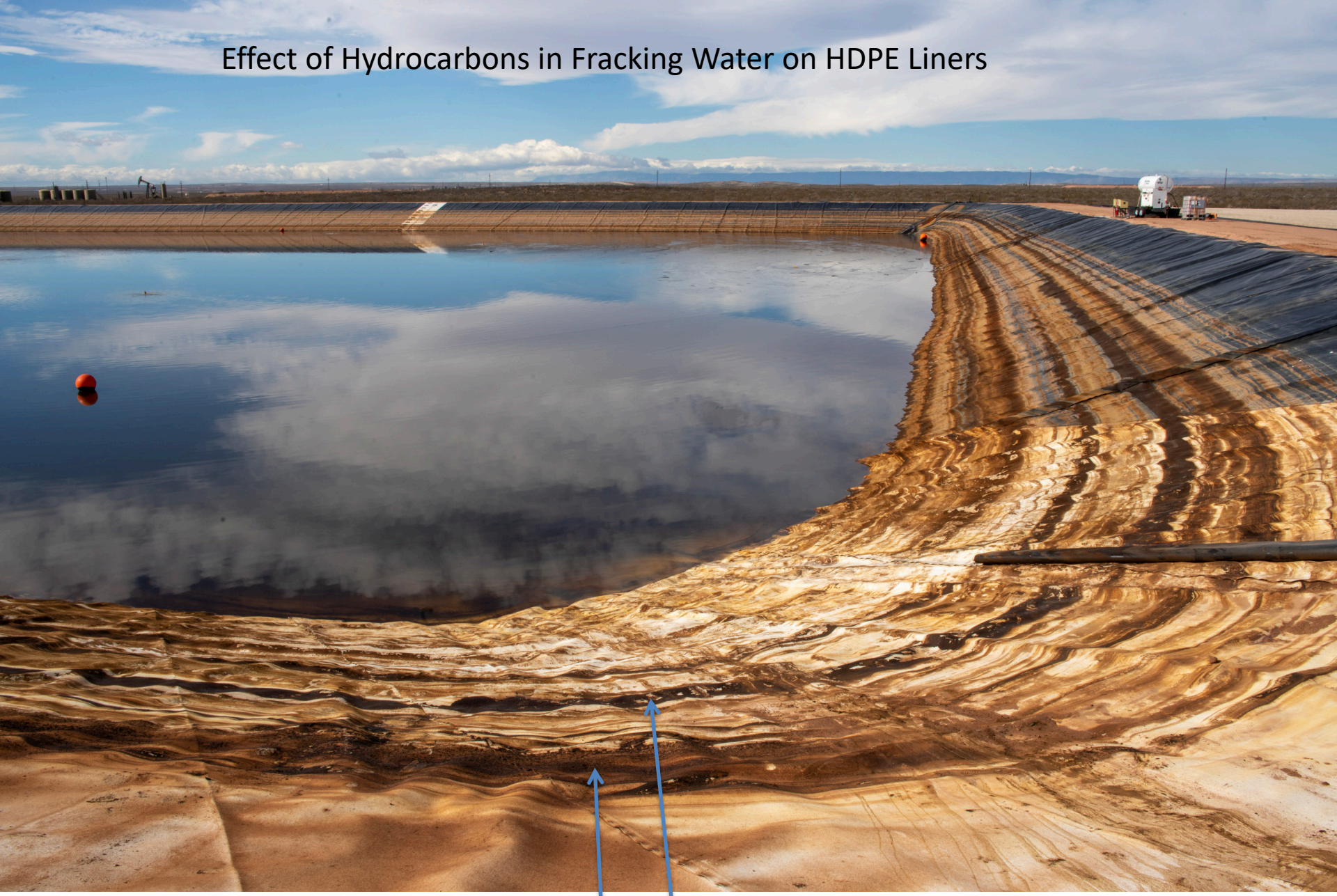


Associated ground water from fracking operations contains a mixture of hydrocarbons

Associated ground water from fracking operations is brought to the surface at the well pad and stored in a holding dam



Effect of Hydrocarbons in Fracking Water on HDPE Liners

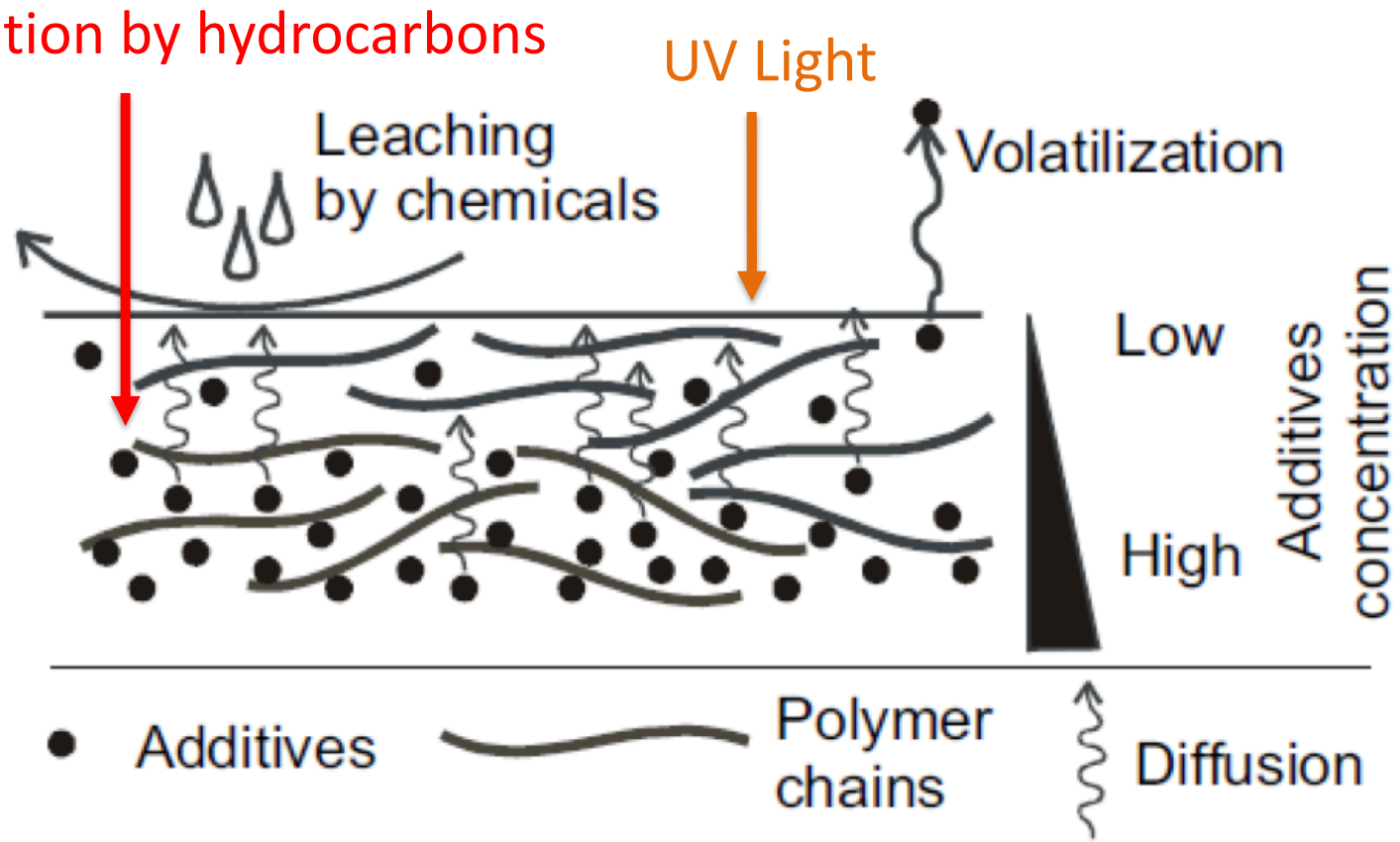


Oily hydrocarbon residues concentrated on HDPE at waterline can cause “unzipping” failure of the liner at point of tension

Introduction

- We often get asked about suitability of different geomembranes with ”*oily water*” or “*foamy water*” obtained from fracking and/or drilling operations associated with unconventional gas.
- Generally the client wants an immediate answer (desk audit) or only has 1-2 weeks for the decision.
- We have developed a simple but sensitive *‘Jar Test’* to determine the effect of such oily water on HDPE geomembranes.

Mechanism of Additive Loss



Seven S's of Chemical Resistance

- Solubility in water (miscibility)
- Solubility Parameter
- Specific Gravity (SG<1, SG>1)
- Surface Area to Volume (thickness)
- Stress/Strain
- Structure (aliphatic/aromatic)
- Speciation (Cl^- vs $Cl^\cdot$ vs Cl_2)

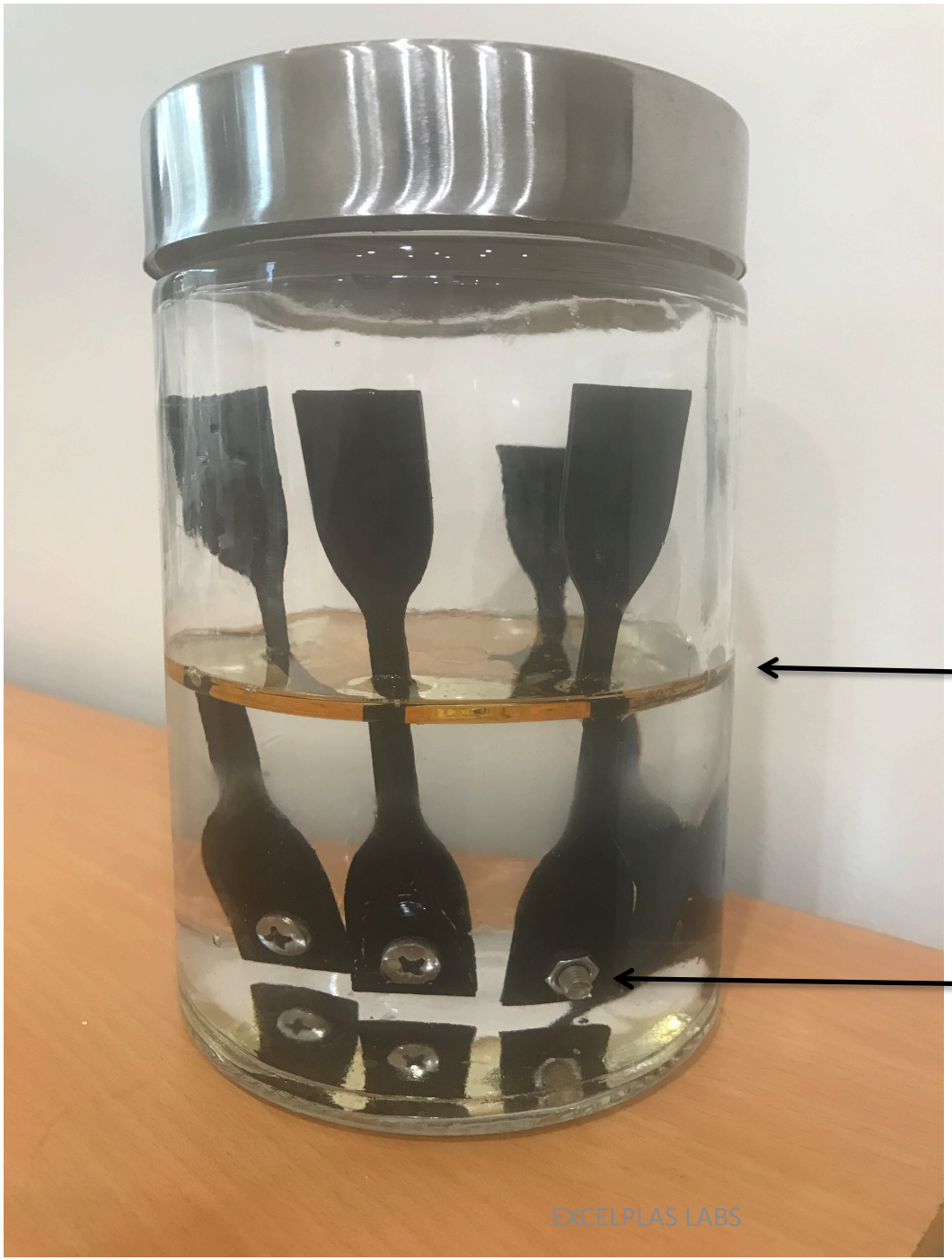
ISO 17025 ACCREDITED LABORATORY
ExcelPlas

"Mason Jar Screening Test" for Exposing dog-bone coupons

Temp. = 60 deg.C

Time = 1 day

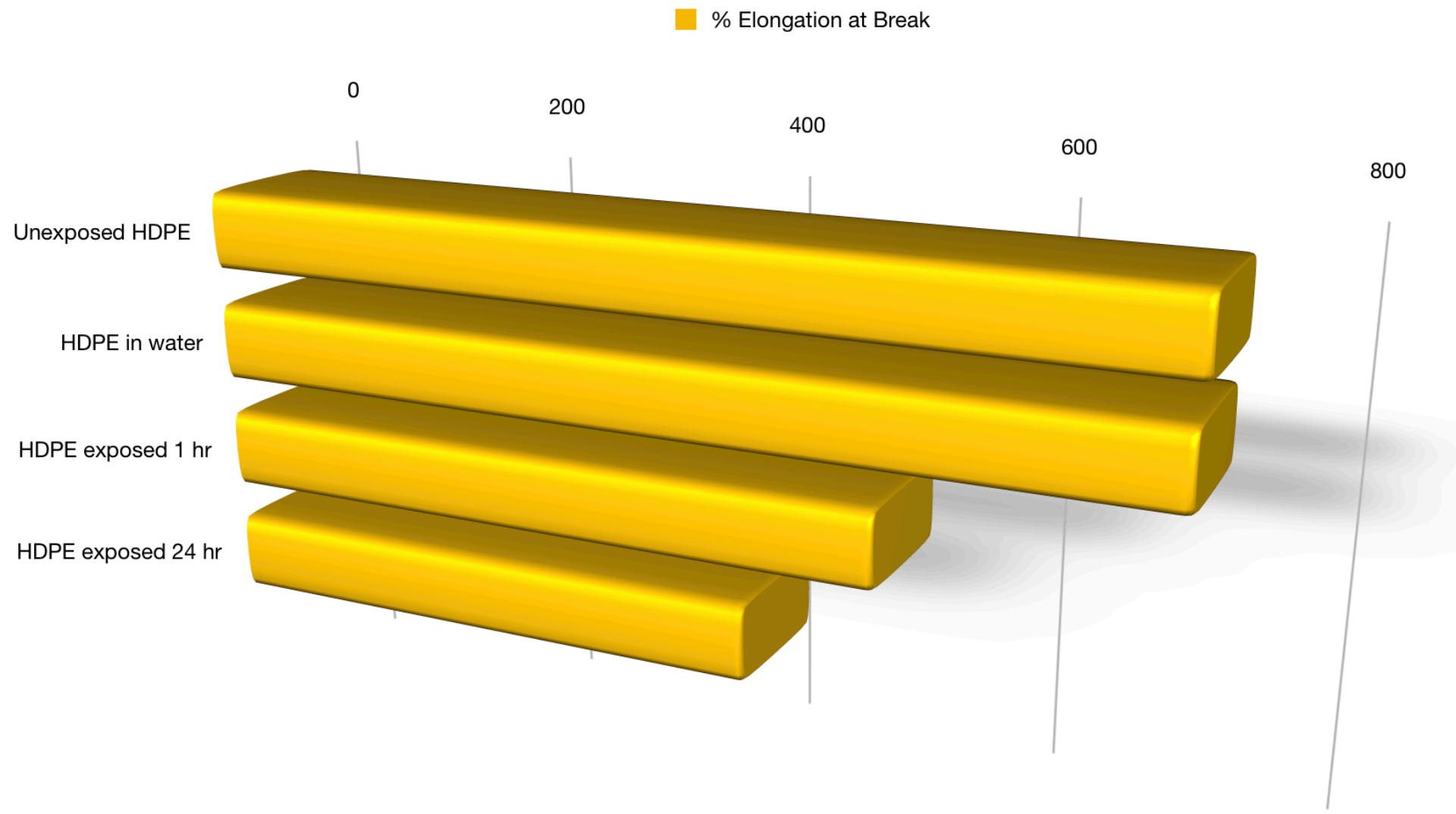
Strain at break is very sensitive to solvation effects and plasticization by hydrocarbons



ISO 17025 ACCREDITED LABORATORY
ExcelPlas

Note concentrated layer of separated oil

Stainless steel nuts and bolts for ballast


% Elongation at Break
0
200
400
600
800
Unexposed HDPE
HDPE in water
HDPE exposed 1 hr
HDPE exposed 24 hr

Advantages of Mason Jar Test

- Rapid test: 1 day
- Affordable: low cost for immersion, tensile testing and report
- Sensitive: Elongation at Break
- Quantitative: % retention of Elongation at Break

Chemical Resistance Criteria

Type of resistance :

(R) Resistant: Excellent, little or no swelling or softening or surface deterioration
(< 10% swelling, < 15% loss of tensile strength,little or no chemical attack)

(L) Limited: Limited chemical resistance, moderate chemical attack. Conditional service.
(< 20% swelling, < 50% loss of tensile strength, moderate chemical attack)

(N) Not recommended: Severe attack, swelling or softening. Not recommended.
(> 20% swelling, > 50% loss of tensile strength, material is attacked)

Effects of Chemicals on HDPE

- Solvation (internal lubrication)
- Stress cracking and Stress Rupture
- Extraction of antioxidants/stabilizers

Typical Oily Water Results

59	C6 - C9 Fraction	mg/L	20	284000	270000
60	C10 - C14 Fraction	mg/L	50	49000	259000
61	C15 - C28 Fraction	mg/L	100	178000	580000
62	C29 - C36 Fraction	mg/L	50	11200	35400
63	C10 - C36 Fraction (sum)	mg/L	50	238000	874000
64	C6 - C10 Fraction	mg/L	20	338000	355000
65	>C10 - C16 Fraction	mg/L	100	91200	358000
66	>C16 - C34 Fraction	mg/L	100	136000	436000
67	>C34 - C40 Fraction	mg/L	100	1780	8230
68	>C10 - C40 Fraction (sum)	mg/L	100	229000	802000
69	Benzene	µg/L	<1	705	799
70	Toluene	µg/L	2	6300	10600
71	Ethylbenzene	µg/L	2	1390	2180
72	Total Xylenes	µg/L	2	20000	34200
73	Sum BTEX	µg/L	1	28400	47700
74	Naphthalene	µg/L	5	1800	4790

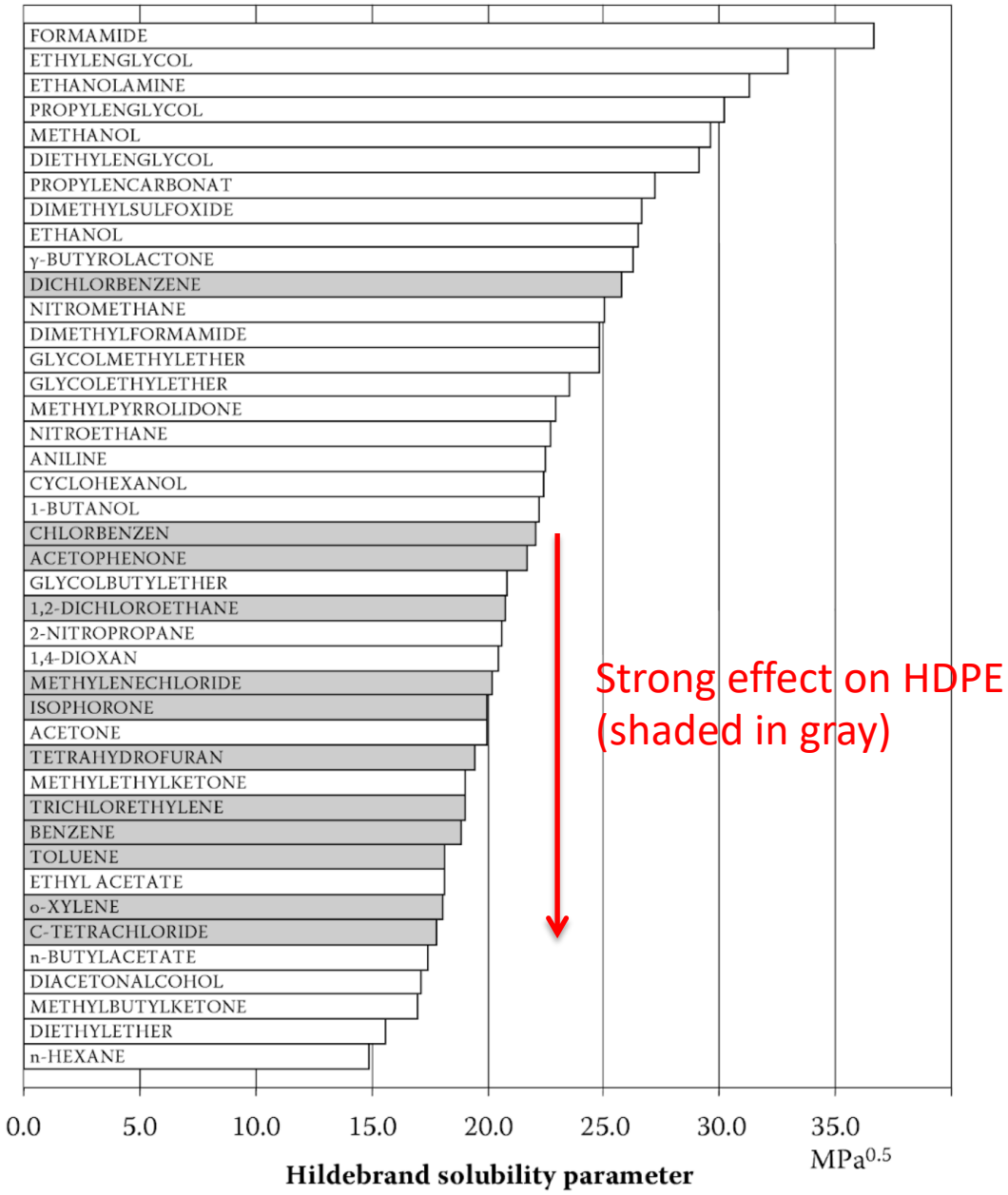


FIGURE 9.1 Solubility of bitumen No 1 (Table 9.1) in different solvents of known Hildebrand solubility parameter. White bars = poor solvents, gray bars = good solvents.

About ExcelPlas: With more than 25 years' experience, ExcelPlas is acknowledged as a leading provider of specialist analytical and technical capabilities for the geosynthetic and poly pipe industries in the area of polymer analysis. ExcelPlas Labs use a range of analytical techniques to assist facility owners, design consultants, insurers, installers and other stakeholders to provide advice relating to the performance properties, lifetime prediction, composition, failure and durability of geosynthetic and poly pipe materials. ExcelPlas is a NATA-accredited laboratory and is ISO/IEC 17025 compliant.

www.excelplas.com


ExcelPlas
MATERIALS TESTING