ACETex® AND ACEGrid® PET REINFORCEMENT GEOSYNTHETICS DURABILITY (HYDROLYSIS)

ACETex® woven geotextile and ACEGrid® geogrid are composed of filaments of high tenacity polyester (PET). The weave construction that is used in ACETex® and ACEGrid® reinforcement geosynthetics produces a dimensionally stable product suitable for a wide variety of long term soil reinforcement applications. The major attribute of this family of reinforcement geosynthetics is the ability to deliver a wide range of tensile strengths, at low, soil compatible strains.
Applications of product use include soil reinforcement of slopes, walls, embankments, void bridging and speciality applications over piles and load transfer platforms. The available strengths range from 30kN/m to well over 1000 kN/m allowing a wide range of engineering soil reinforcement applications to be addressed.
ACETex and ACEGrid are constructed from high molecular weight, low carboxyl end group high tenacity polyester yarns. It has been long recognised that the use of such polyester yarns are not subject to hydrolytic degradation when exposed to conditions within a broad range of pH. The major conclusion of past research is that with these new generation polyester yarn types provided that:

- Minimum Molecular Weight M_N > 25,000 g/mol and
- Maximum Carboxyl End Group < 30 meq/kg

then a service life in excess of 100 years can be expected in a fully saturated soil with a pH 2 to pH 9 with the use of the ACE geosynthetic polyester soil reinforcement products.

ACE polyester geosynthetic products have been extensively tested for resistance to hydrolysis (EN 12447) and the results are tabulated below. Polyester geosynthetic products that retain greater the 50% tensile strength when tested to EN 12447 are estimated to have retained strengths exceeding 95% in saturated soil pH 4-9 at temperatures of 25° C after 25 years. Using Arrhenius' equation, this implies an activation energy of approximately 105366 J/mol.

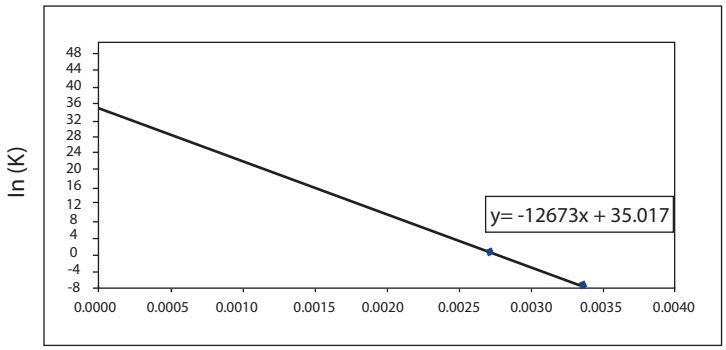
The value of the activation energy may be experimentally determined by measuring the rate of reaction at several different temperatures.

By taking the logarithm of both sides of the Arrhenius rate law, the following equations are obtained.

$$K = A.Exp(-\Delta H/RT) \rightarrow \ln K = \ln A - (\Delta H/R).(1/T)$$

where,
K = the rate of reaction,
A = a proportional constant,
ΔH = the activation energy of the process,
R = the universal gas constant,
T = the absolute temperature (in degrees Kelvin)

These equations show that a plot of the natural logarithm (ln) of the rate of reaction against the reciprocal of the absolute temperature will give a linear plot whose slope contains only the activation energy of the reaction, ΔH, and known constants.



Reciprocal of temperature, 1/T (K°)
Figure 1: Plot to determine the activation energy

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Step 1- Experimental Reference Data (Source: Elias, Schmidt et al.)

X	Y
(1/T), °K	lnK
0.0027	0.5798
0.0034	-7.5093
Slope=	-12673

Step 2- Solutions

→ R= 8.3144 kJ/(K.kmol) – **given constant**

→ **Hence, ΔH= 105366 J/mol =R. slope**

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(1/T), °K	lnK
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0.0034	-7.5093
Slope=	-12673

Input - Test Result of ACEGrid - EN 12447 :

Test Temp.	**=**	**95°C = (273+95 = 368 ° K)**	
Test period	=	28	day
Retained T.S. - MD=	86.52	%	
Retained T.S. - CD=	81.55	%	

From test results, calculate constant value, A (=4.34X10^{12})
Then, by using Arrhenius' equation, the rate of degradation at the service temperature required is calculated.

Output - Tensile Strength Loss Rate :

Service Temperature=		**20**	**°C**
→	K MD=	0.000071	%/day
	K CD=	0.000098	%/day
Design Life Time=		**100**	**year**
Retained T.S.-MD=	97.39	%	
Retained T.S.-CD=	96.43	%	

Reduction Factor for Durability=

→ RF_{MD}= **1.03**

RF_{CD}= **1.04**

The above is a rational approach for justification of a reduction factor for durability of 1.03 for a design life of 100 years based on the use of ACETex or ACEGrid polyester soil reinforcement products. This is an upper bound number and is conservative based on uncoated fibers and saturated conditions in a highly alkaline environment and tested at elevated temperatures. ACE polyester filaments are of the highest quality and well exceed the recommended minimum molecular weight and the recommended maximum carboxyl end group count for polyester fiber. The effect of hydrolysis in aggressive alkaline environments is minimised and well within accepted practice.

APR.16