WHITE PAPER

Chemical Stability

During the lamination process or the use-phase of the final composite structure, the foam core may be exposed to industrial chemicals, solvents, or other contact substances. The contact with chemicals can impact material properties.

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ArmaPET™

ArmaPET™ CHEMICAL STABILITY

Introduction

The resistance of plastic materials against chemicals, solvents and other contact substances is an important criterion of selection for many applications. When contacting such substances, different properties of polymer-based products, including PET foams, can be affected. Chemicals can impact strength, flexibility, surface appearance, colour, dimensions or weight of products made of polymers.
The basic modes of interaction which cause these changes are:

// **Chemical attack on the polymer chain, with reaction of functional groups in the chain and/or depolymerisation.**

// **Physical change, including absorption and permeation of solvent through the plastic, resulting in softening and swelling of the plastic.**

// **Stress cracking from the interaction of simultaneous presence of three factors: Tensile stress, a stress cracking agent and the inherent susceptibility of the plastic to stress cracking[1].**

Additionally, mixing and/or dilution of certain chemicals can be potentially dangerous. The substances which on their own have been proven safe may negatively influence the product's performance when mixed. The reactive combination of different chemicals may cause an increased temperature, which can affect chemical resistance.
As temperature raises, material's resistance to attack decreases. Other factors affecting chemical resistance include pressure and internal or external stresses (e.g. centrifugation), length of exposure, or concentration of the chemical.

This white paper provides a survey on the behaviour of ArmaPET towards common contact substances. The test conditions simulate direct exposure, which is rather rare for PET-based core, which in a final application is covered by external reinforcing (and protective) layers to form a sandwich.
Therefore, this information should be considered as a general guide. Moreover, multiple factors may affect the chemical resistance of a polyester-based product, it is recommended to test the core foam in a final application, and under the specific conditions of application.

Test conditions

The evaluation is made based on the DIN 53428[2] standard ("Determination of the behaviour of cellular plastics when exposed to fluids, vapours and solids"). The samples have been exposed to vapours of respective contact substances and fluids (by direct immersion). Their stability has been examined in terms of compressive properties evolution (compressive strength and modulus) after 7, 14 and 28 days of direct exposure at room temperature.

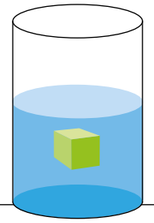
The symbols in the results table reflect the properties change:

+ Negligible effect - good resistance, no reduction in physical properties → **Property change in a range of 0-5%**

0 Limited absorption or attack - suitable for most applications, little reduction in physical properties → **Property change in a range of 5-10%**

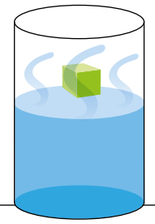
- Extensive attack - material is damaged or significant changes in physical properties occur after exposure to the substance → **Property change in a range >10%**

EXPOSURE TO FLUIDS



Type of chemical		Compressive modulus			Compressive strength		
		1 week	2 weeks	4 weeks	1 week	2 weeks	4 weeks
Water	Tap water	+	+	+	+	+	+
	Salt water	+	+	+	+	+	+
Weak acids	Oxalic acid (11% aq. sat.)	+	+	+	+	+	+
Strong mineral acids	Hydrochloric acid (3% aq.)	-	-	-	-	-	-
Oxidizing mineral acids	Nitric acid (3% aq.)	+	+	0	+	+	0
	Nitric acid (35% aq.)	-	-	-	-	-	-
Alkaline solutions	Ammonia water (NH_4OH aq.) (25% aq.)	-	-	-	-	-	-
Alcohols	Ethanol	+	+	0	0	-	-
ASTM-Oils acc. to ASTM D 471	ASTM-Oil 1	+	+	+	+	+	+
	IRM 902	+	+	+	+	+	+
	IRM 903	+	+	+	+	+	+
Miscellaneous	Toluene	+	+	+	0	-	-
	n-pentane	+	+	+	+	+	+
	Styrene	+	+	+	0	0	0
	Brake fluid	+	+	0	0	0	0
	Kerosene	+	+	+	+	+	+
	Acetone	-	-	-	-	-	-
	TETA (triethylenetetramine)	-	-	-	-	-	-

EXPOSURE TO VAPOURS



Type of chemical		Compressive modulus			Compressive strength		
		1 week	2 weeks	4 weeks	1 week	2 weeks	4 weeks
Water	Tap water	+	+	+	+	+	+
	Salt water	+	+	+	+	+	+
Weak acids	Oxalic acid (11% aq. sat.)	+	+	+	+	+	+
Strong mineral acids	Hydrochloric acid (3% aq.)	0	0	-	0	0	-
Oxidizing mineral acids	Nitric acid (3% aq.)	+	+	+	+	+	+
	Nitric acid (35% aq.)	-	-	-	-	-	-
Alkaline solutions	Ammonia water (NH_4OH aq.) (25% aq.)	-	-	-	-	-	-
Alcohols	Ethanol	+	+	+	+	+	+
ASTM-Oils acc. to ASTM D 471	ASTM-Oil 1	+	+	+	+	+	+
	IRM 902	+	+	+	+	+	+
	IRM 903	+	+	+	+	+	+
Miscellaneous	Toluene	+	+	+	0	0	-
	n-pentane	+	+	+	+	+	+
	Styrene	+	+	+	+	+	+
	Brake fluid	+	+	0	+	+	+
	Kerosene	+	+	+	+	+	+
	Acetone	-	-	-	-	-	-
	TETA (triethylenetetramine)	-	-	-	-	-	-

Summary

The results of analysis are in line with general findings of publicly available reports on the chemical resistance of polyethylene terephthalate (PET)[3,4]. PET is stable against many different chemicals, but some are well known for their destructive impact on polyesters. Therefore, direct contact with these substances should be avoided. The examples are acetone, highly concentrated ammonia solutions or hydrochloric and nitric acid solutions, which cause chemical degradation, or hexafluoroisopropanol, or phenol/tetrachloroethane solution, which dissolve the polymer.

This leaflet has informative character only, thus it is strongly recommended to repeat testing for final sandwich structure obtained with the use of ArmaPET material, and applying the typical working conditions of final application.

References

1. A.L. Volynskii N.F. Bakeev "Solvent Crazing of Polymers" 1st Edition, Volume 13 (1995) Elsevier Science

2. DIN 53428, "Determination of the behaviour of cellular plastics when exposed to fluids, vapours and solids"

3. "General Chemical Resistance of PET -Products" http://www.plasticseurope.org/Documents/Document/20100705182216-050303GeneralChemicalResistanceofPET-20050303-003-EN-v1.pdf

4. "Chemical Resistance Chart" http://www.plasticsintl.com/plastics_chemical_resistence_chart.html

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