

PHTHALONITRILE

TECHNICAL DATA SHEET



AZKLM 0301 belongs to the family of high-performance thermosets capable of satisfying the stringent requirements of exigent applications. The high temperature performance of Phthalonitrile-Carbon and Phthalonitrile-glass composites are superior to that of any other thermoset-based composite currently in use for aerospace, marine, and other high temperature applications, and opens up applications that couldn't be realized through other resin systems.

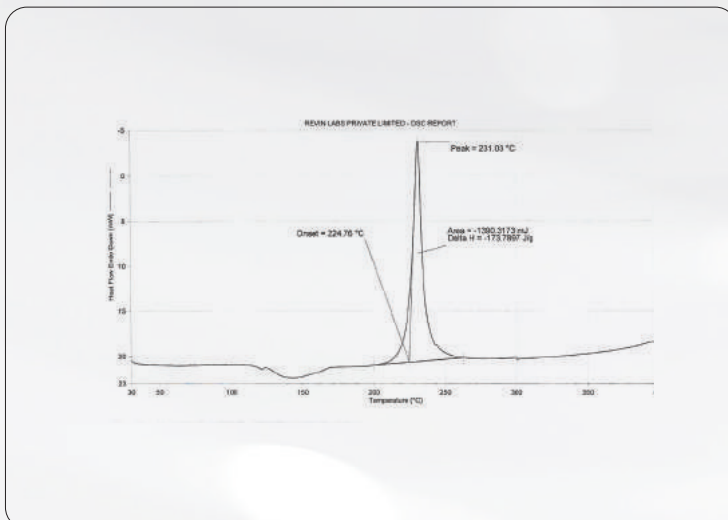


NEAT RESIN CHARACTERISTICS

CURED AT 375°C

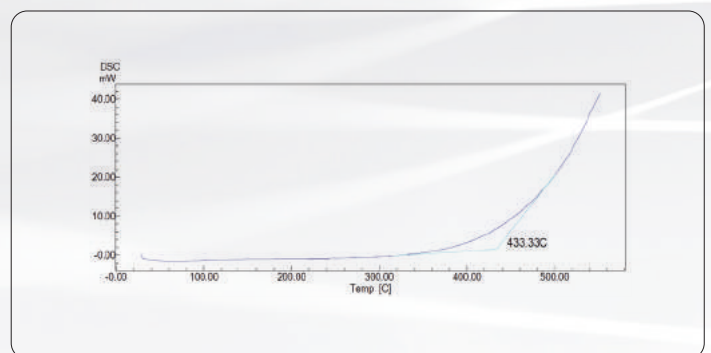
| | |
|--|-----------------------------|
| FLEXURAL STRENGTH, 3-POINT BENDING | 100 MPa |
| GLASS TRANSITION TEMPERATURE (T _g) | 435 °C |
| CHAR YIELD | 72% upto 1000°C (inert atm) |
| MOISTURE ABSORPTION (54 h at 60°C water) | 1.5 |
| DENSITY | 1.33 g/ CC |
| MELT VISCOSITY | < 50 cps at 150°C |
| DIELECTRIC CONSTANT (8.2 GHz) | 3.5 |
| DIELECTRIC LOSS (8.2 GHz) | 0.005 |

DSC (UNCURED)



Uncured resin, Ramp 10°C/min upto 350°C

DSC (CURED)

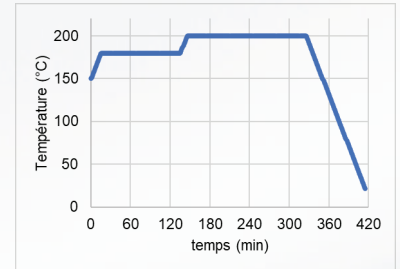


Post-cured at 375°C, Ramp 10°C/min upto 550°C

OPTIMISED PROCESS PARAMETERS FOR PHTHALONITRILE COMPOSITES (RESIN TRANSFER MOLDING METHOD)

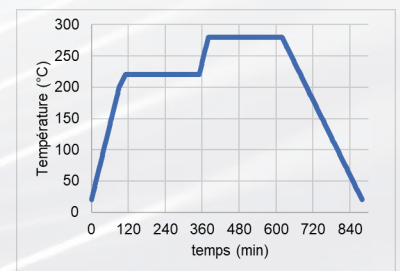
► Cure Cycle (In mold) [Tg 235°C]

- i. Temperature ramp at 2°C/min from 150°C to 180°C
- ii. 2hr hold at 180°C
- iii. Temperature ramp at 2°C/min until 200°C
- iv. Cooling rate < 1°C/min



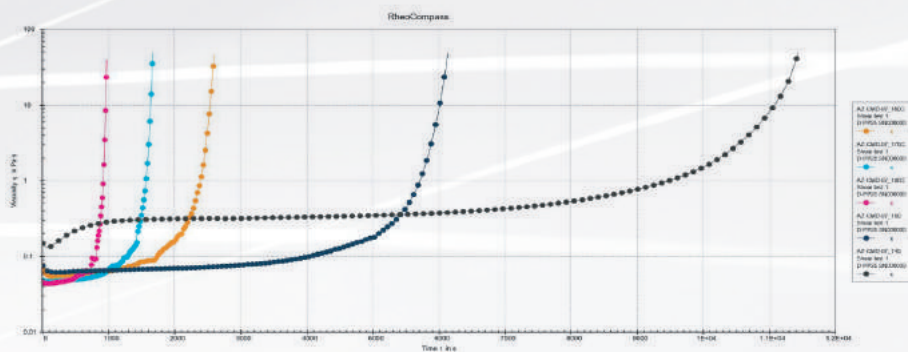
► Post-cure (out of mold) [Tg 335°C]

- i. Temperature ramp at 2°C/min from 20°C to 200°C
- ii. Temperature ramp at 1°C/min until 220°C
- iii. 4hr hold at 220°C
- iv. Temperature ramp at 2°C/min until 280°C
- v. 4hr hold at 280°C
- vi. cooling rate at 2°C/min

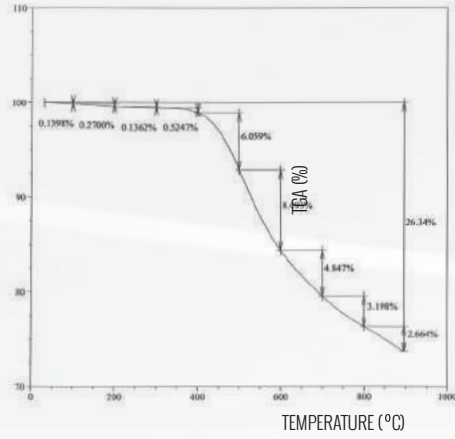


► Additional post-cure (if necessary) [Tg 478°C]

- i. Temperature ramp at 2°C/min from 20°C to 320°C
- ii. 4h at 320°C
- iii. Temperature ramp at 2°C/min until 375°C +
- iv. 6h at 375°C
- v. cooling rate < 1°C/min

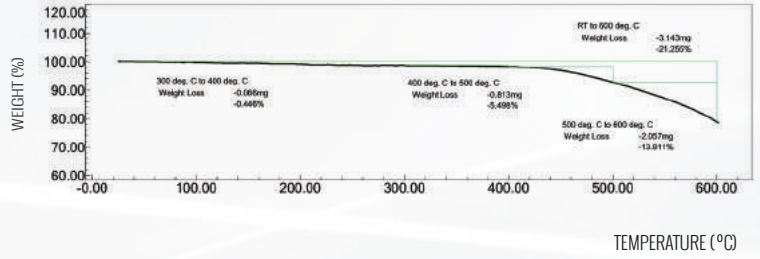


THERMOGRAVIMETRIC ANALYSIS (INERT ATM.)



THERMOGRAVIMETRIC ANALYSIS (IN AIR)

Post-cured at 375°C — Ramp 10°C/min upto 600°C



MECHANICAL PROPERTIES OF PHTHALONITRILE MATRIX COMPOSITES

(8H Satin Weave carbon fabric, T-300, 380GSM, 3.5Gpa)

| Test Charecteristic | Standard | Cured at 375 °C |
|--|------------|--|
| TENSILE STRENGTH | ASTM D3039 | 656 Mpa |
| INTERLAMINAR SHEAR STRENGTH | ASTM D2344 | 42.90 Mpa |
| COEFFICIENT OF THERMAL EXPANSION (RT) (IN-PLANE) | | 4.36 $\mu\text{m}/(\text{m} \cdot ^\circ\text{C})$ |
| TRANSVERSE THERMAL CONDUCTIVITY (RT) | | 1.070 W/m-K |

Drop Weight Impact Test

| PEAK FORCE (N) | PUNCTURE FORCE (N) | PEAK ENERGY (J) | TOTAL ENERGY (J) | PUNCTURE ENERGY (J) |
|----------------|--------------------|-----------------|------------------|---------------------|
| 11599.134 | 5782.936 | 17.637 | 19.872 | 21.073 |

AGED MECHANICAL PROPERTIES OF PHTHALONITRILE MATRIX COMPOSITES

(8H Satin Weave carbon fabric, T-300, 380GSM, 3.5Gpa)

| SAMPLE/PROPERTY | TENSILE STRENGTH | | | FLEXURAL STRENGTH | | | FLEXURAL MODULUS | | |
|---------------------------------------|------------------|------------------------|-----------------------|-------------------|------------------------|-----------------------|------------------|------------------------|-----------------------|
| | RTAS | 100 HRS AGING AT 300°C | RETENTION AFTER AGING | RTAS | 100 HRS AGING AT 300°C | RETENTION AFTER AGING | RTAS | 100 HRS AGING AT 300°C | RETENTION AFTER AGING |
| 2D GLASS FABRIC LAMINATE | 410 MPa | 350 MPa (RT) | 85 % | 590 MPa | 500 MPa (RT) | 85 % | 24 GPa | 14 GPa (RT) | 58 % |
| 2D CARBON FABRIC (STD. MOD.) LAMINATE | 510 MPa | 405 MPa (RT) | 79 % | 650 MPa | 480 MPa (RT) | 74 % | 45 GPa | 30 GPa (RT) | 67 % |

| test charecteristic | standard | cured at 375 °c |
|-----------------------|-------------|---|
| LIMITING OXYGEN INDEX | ASTM D 2863 | >70 % |
| FLAMABILITY TEST | ASTM D 635 | FLAME DOES NOT REACH 25-MM REFERENCE MARK |
| TOXICITY INDEX | NCD-1409 | 2.8 |

TOXICITY INDEX

| S.No | Gases | Reading | | Concentration of gas generated in test chamber (PPM) | Fatal Conversion Value per 100 gm | Toxicity Index of gas |
|----------------|---|---------|-------|--|-----------------------------------|-----------------------|
| | | Initial | Final | | | |
| 1 | ACRYLONITRILE-CH ₂ CHCN | 0 | 0.6 | 10.5 | 400 | 0.026 |
| 2 | CARBON MONOXIDE-CO | 5 | 35 | 525 | 4000 | 0.131 |
| 3 | CARBON DIOXIDE-CO ₂ in vol.% | 0.7 | 0.8 | 17500 | 100000 | 0.175 |
| 4 | NITROGEN OXIDE-NO-NO ₂ | 5 | 40 | 612.5 | 250 | 2.450 |
| Toxicity Index | | | | | | 2.8 |

Erosion Test

SET HEAT FLUX = 300 W/CM² (APPROX.)

| S NO | Sample Name/Sample Code | Weight Before Test(g) | Weight After Test (g) | Weight After char removal (g) | Final Weight Reduction (g) | Thickness Before Test(mm) | Thickness After test Test(mm) | Thickness After Char removal (mm) | Change in thickness (mm) | Erosion Rate (mm/ sec) |
|------|----------------------------------|-----------------------|-----------------------|-------------------------------|----------------------------|---------------------------|-------------------------------|-----------------------------------|--------------------------|------------------------|
| 1 | P-Thalonritile/ PAN CARBON 01 | 44.7 | 36.5 | 36.5 | 8.2 | 3 | 1.5 | 1.4 | 1.6 | 0.0088 |
| 2 | P-Thalonritile/ PAN CARBON 02 | 44.3 | 36.6 | 36.6 | 7.8 | 2.9 | 1.5 | 1.4 | 1.6 | 0.0083 |



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