

POLYURETHANE ADHESIVE WITH IMPROVED
HIGH TEMPERATURE PROPERTIES

by

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Dupont's Adiprene L-315 polyurethane resin with Hysol EA 9322 activator will cure at room temperature to give useful bond strengths over the temperature range of -184°C to $+149^{\circ}\text{C}$ (-300°F to $+300^{\circ}\text{F}$). The paste activator mixed with the liquid polyurethane resin provides an easily processible system with a pot life in excess of 1 h.

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| <ul style="list-style-type: none"> ● MSFC POTENTIAL INTEREST <ul style="list-style-type: none"> 1. TO BOND INSULATION ON AFT SKIRT OF THE SOLID ROCKET BOOSTER <ul style="list-style-type: none"> a. REFURBISHMENT 2. TO BOND INSTRUMENT ISLANDS ON THE LOX TANK OF THE EXTERNAL TANK <ul style="list-style-type: none"> a. HOT PRESSURIZING GASES MAY RAISE BONDLINE TEMPERATURE TO 177°C ● PRIVATE INDUSTRY POTENTIAL INTEREST <ul style="list-style-type: none"> 1. INSULATION OF CRYOGENIC TANKS AND LINES THAT MAY BE EXPOSED TO ELEVATED TEMPERATURES |
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Figure 1. Aerospace and private industry areas of potential interest.

HYSOL EA 9322 A/B* POLYURETHANE ADHESIVE			
FORMULATION			
EA 9322 A RESIN		100 pt	
EA 9322 B ACTIVATOR (EMULSION)		33.6 pt	
DOW CORNING D. C. Z-6040**		1.0 pt	
POT LIFE		4 hr	
TEST TEMPERATURE		TENSILE SHEAR STRENGTH	
$^{\circ}\text{C}$	$(^{\circ}\text{F})$	kN/m^2	(psi)
23.9	(75)	9720	(1410)
93.3	(200)	3930	(570)
148.9	(300)	NIL	NIL
* HYSOL DIVISION, THE DEXTER CORPORATION			
** GAMMA-GLYCIDOXYPROPYL TRIMETHOXY SILANE $\text{OCH}_2\text{CHCH}_2\text{O}(\text{CH}_2)_3\text{Si}(\text{OCH}_3)_3$			

Figure 2. Polyurethane adhesives investigated.

DuPONT LIQUID URETHANE RESINS		
	ADIPRENE L-100	ADIPRENE L-315*
AVAILABLE ISOCYANATE CONTENT, %	4.10 ± 0.20	9.45 ± 0.20
CURING AGENT, MOCA**, PPH	11.5	29
POT LIFE, MINUTES	120	1-3***
TENSILE STRENGTH, kN/m ² (psi)	27 580 (4000)	55 160 (8000)
HARDNESS, DUROMETER A	90	99+
DUROMETER D	43	79

* DuPONT LIQUID URETHANE ELASTOMER
 ** 4,4'-METHYLENE-BIS-(2-CHLORO ANILINE)-SUSPECTED CARCINOGEN
 *** POT LIFE IN EXCESS OF 1 h WHEN CURED WITH EA 9322B ACTIVATOR

MATERIAL	FORMULATION "A"	FORMULATION "B"
ADIPRENE L-315	100 pt	100 pt
EA 9322B (EMULSION)	72 pt	60 pt
D.C. Z-6040	3 pt	3 pt

CURE	TENSILE SHEAR STRENGTH		
	23.9°C (75°F) kN/m ² (psi)	93.3°C (200°F) kN/m ² (psi)	148.9°C (300°F) kN/m ² (psi)
FORMULATION "A"			
72 h AT 71°C	14 130 (2050)	2620* (380)*	124** (18)**
14 DAYS AT R.T.	10 960 (1590)	3590 (520)	2070 (300)
28 DAYS AT R.T.	12 200 (1770)	4270 (620)	2830 (410)
FORMULATION "B"			
72 h AT 71°C	17 170 (2490)	3520* (510)*	310** (45)**
14 DAYS AT R.T.	10 890 (1580)	3590 (520)	2480 (360)
28 DAYS AT R.T.	14 550 (2110)	5170 (750)	3100 (450)

* TESTED AT 121.1°C (250°F)
 ** TESTED AT 176.7°C (350°F)

MATERIAL	FORMULATION
ADIPRENE L-100	100 pt
EA 9322B (EMULSION)	34 pt
D.C. Z-6040	1.5 pt

CURE	TENSILE SHEAR STRENGTH		
	23.9°C (75°F) kN/m ² (psi)	93.3°C (200°F) kN/m ² (psi)	148.9°C (300°F) kN/m ² (psi)
48 h AT 71°C	9860 (1430)	4270 (620)	1310 (190)
15 DAYS AT R.T.	7240 (1050)	3310 (480)	69 (10)

Figure 2. (Continued).

TENSILE SHEAR STRENGTH – CURED AT R.T.							
TEST TEMPERATURE		L-315 FORMULATION "A"		L-315 FORMULATION "B"		L-100 FORMULATION	
°C	(°F)	kN/m ²	(psi)	kN/m ²	(psi)	kN/m ²	(psi)
-184.4	(-300)	34 060	(4940)	35 100	(5090)	36 270*	(5260)*
23.9	(75)	12 200	(1770)	14 550	(2110)	7 240	(1050)
93.3	(200)	4 270	(620)	5 170	(750)	3 310	(480)
148.9	(300)	2 830	(410)	3 100	(450)	69	(10)
176.7	(350)	34	(5)	55	(8)	NIL	NIL

*ALL SPECIMENS BROKE IN HOLDING FIXTURE.

CURE: 24 h ROOM TEMPERATURE PLUS 168 h AT 71°C			
MATERIAL	FORMULATION NO. 1	FORMULATION NO. 2	FORMULATION NO. 3
ADIPRENE L-315	100 pt	100 pt	100 pt
EA 9322B (EMULSION)	72 pt	60 pt	60 pt
D.C. Z-6040	2 pt	2 pt	3 pt

TENSILE SHEAR STRENGTH			
	23.9°C (75°F)	121.1°C (250°F)	176.7°C (350°F)
	kN/m ² (psi)	kN/m ² (psi)	kN/m ² (psi)
FORMULATION NO. 1	19 720 (2860)	4550 (660)	1100 (160)
FORMULATION NO. 2	17 170 (2490)	3240 (470)	1140 (165)
FORMULATION NO. 3	17 930 (2600)	4410 (640)	1240 (180)

Figure 2. (Concluded).

- ADIPRENE L-315 WITH EA 9322 ACTIVATOR WILL CURE AT ROOM TEMPERATURE TO GIVE USEFUL BOND STRENGTHS OVER THE TEMPERATURE RANGE OF -184°C TO +149°C (-300°F TO +300°F)
- TO OBTAIN ANY STRENGTH AT 177°C (350°F), AN EXTENDED CURE AT 71°C (160°F) OF APPROXIMATELY 150 h IS NEEDED
- THE PASTE ACTIVATOR MIXED WITH THE LIQUID POLYURETHANE RESIN PROVIDES AN EASILY PROCESSIBLE ADHESIVE SYSTEM WITH A POT LIFE IN EXCESS OF 1 h

Figure 3. Conclusions.