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MASTER

Physical Properties and Sensitivity of HMX/Estane 5713 and HMX/Estane 5714

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DEVELOPMENT DIVISION

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Normal Process Development
Endeavor No. 105

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ABSTRACT

Two small lots of LX-14 having the Estane 5702-F1 replaced with Estane 5713 and 5714 were formulated. The two formulations were subjected to skid tests, tensile tests, and drop hammer tests. These tests were intended as preliminary screening tests of the two Estanes to evaluate their potential as binder materials.

DISCUSSION

Estane 5713 and Estane 5714 were used as the binder material to formulate approximately 6.5 kg each of two lots of HMX based PBX's. The nominal by weight composition of both lots was 95.5/4.5 HMX/binder. The HMX used for both lots was a mixture of 65% Class A, 25% LX-04-1 type and 10% Class B by weight. Estane 5713, a polyester polyurethane elastomer, was used as the binder in Lot No. 6019-146-01 and Estane 5714, a polyether polyurethane elastomer, was used for Lot No. 6020-147-01. The lots were manufactured using the standard slurry technique. The manufacture was somewhat difficult due to the relative insolubility of both the Estane 5713 and 5714. The solubility of the Estane 5713 and 5714 is 5.8% and 3.4% by weight, respectively in ethylene dichloride at 60 C. In comparison, the solubility of Estane 5702-F1 is 8.0% in ethylene dichloride at 20 C.

One billet of each material was fabricated to provide parts for testing. The average density for all parts from Lot 6019-146-01 was 1.836 Mg/m^3 and from Lot 6020-147-01 was 1.825 Mg/m^3.

Skid testing was performed on both lots of material using the reduced charge skid test. Because of the limited amount of material available only a few skid tests were possible. The test results are shown in Table I. Included in the table are skid test results for two HMX/Estane 5702-F1 formulations with 5% and 4% binder by weight. The latter two sets of tests were done using full sized billets. As can be seen there is not a great deal of difference between Lot 6019-146-01 and Lot 6020-147-01. Both are just slightly more sensitive than the formulations containing 4% to 5% Estane 5702-F1 as a binder.

Tensile test results are given in Tables II through IV. The mean stress and strain at rupture for the tests are plotted in Fig. 1. Included in Fig. 1 for comparison is the rupture stress and strain at several different temperatures for LX-14, Lot 713-1. The plot shows that the two materials tested are stiffer than LX-14.

Drop hammer tests were made for these two materials using type 12A (sandpaper) tooling. The H_{50} values for Lots 6019-146-01 and 6020-147-01 were 31 ± 9 cm and 39 ± 3 cm, respectively. For comparison, the H_{50} for LX-14 is 35 ± 5 cm. These values indicate only a moderate sensitivity for either material and that they can be handled in accordance with standard high explosives procedures.

COMMENTS, CONCLUSIONS

Sensitivity testing (drop hammer and skid tests) show that both these materials have only a moderate sensitivity and that they can be handled using standard high explosives operating procedures. Mechanical properties testing were done to compare the materials with LX-14 and they were found to be slightly stiffer.

Table I. Skid Test Results

45°		14°	
Height (m)	Reaction Level	Height (m)	Reaction Level
Lot No. 6019-146-01			
1.52	NR	0.38	NR
		0.53	1
		0.76	3
Lot No. 6020-147-01			
1.52	NR	0.38	NR
		0.53	2
		0.76	NR, 3
HMX/Estane 5702-F1 (95/5)			
1.52	NR, NR, NR	0.53	NR, NR, NR
2.16	None Done	0.76	NR, NR, NR
3.05	NR, NR, 3	1.07	None Done
		1.52	1, 3
HMX/Estane 5702-F1 (96/4)			
1.52	NR, NR, NR	0.53	NR, NR, NR
2.16	NR, NR, NR	0.76	NR, NR, NR
3.05	5	1.07	4

Table II. Tensile Test at Constant Crosshead Speed of 0.002 mm/s at 49 C

(Lot 6019-146-01, Density 1.836 Mg/m^3)

Piece Number	Rupture Mode[a]	Initial Modulus[b] (GPa)	Rupture Time (sec)	Rupture Stress (MPa)	Rupture Strain (%)
24	4	2.4	194	1.71	0.295
26	5	2.7	181	1.62	0.260
Mean		2.5	188	1.67	0.278
Std. Dev.		0.3	9	0.07	0.025

[a] *1 and 7 are in the curved section, 2 and 6 are in the straight section outside the extensometer, 3 and 5 are at the knife edges and 4 is between the knife edges.*

[b] *Initial Modulus: (20% Rupture Stress)/Strain*

Table III. Tensile Test at Constant Crosshead Speed of 0.002 mm/s at 21 C

(Lot 6020-147-01, Density 1.825 Mg/m^3)

Piece Number	Rupture Mode[a]	Initial Modulus[b] (GPa)	Rupture Time (sec)	Rupture Stress (MPa)	Rupture Strain (%)
28	6	4.9	170	3.75	0.142
23	6	4.7	166	3.74	0.136
24	2	5.2	183	3.72	0.131
22	2	4.8	192	3.92	0.160
Mean		4.9	178	3.78	0.143
Std. Dev.		0.2	12	0.09	0.013

[a] *1 and 7 are in the curved section, 2 and 6 are in the straight section outside the extensometer, 3 and 5 are at the knife edges and 4 is between the knife edges.*

[b] *Initial Modulus: (20% Rupture Stress)/Strain*

Table IV. Tensile Test at Constant Crosshead Speed of 0.002 mm/s at 49 C

(Lot 6020-147-01, Density 1.825 Mg/m^3)

Piece Number	Rupture Mode[a]	Initial Modulus[b] (GPa)	Rupture Time (sec)	Rupture Stress (MPa)	Rupture Strain (%)
27	2	5.1	152	2.23	0.113
26	6	2.8	177	2.42	0.177
21	6	3.5	166	2.22	0.125
Mean		3.8	165	2.29	0.138
Std. Dev.		1.2	12	0.11	0.034

[a] *1 and 7 are in the curved section, 2 and 6 are in the straight section outside the extensometer, 3 and 5 are at the knife edges and 4 is between the knife edges.*

[b] *Initial Modulus: (20% Rupture Stress)/Strain*

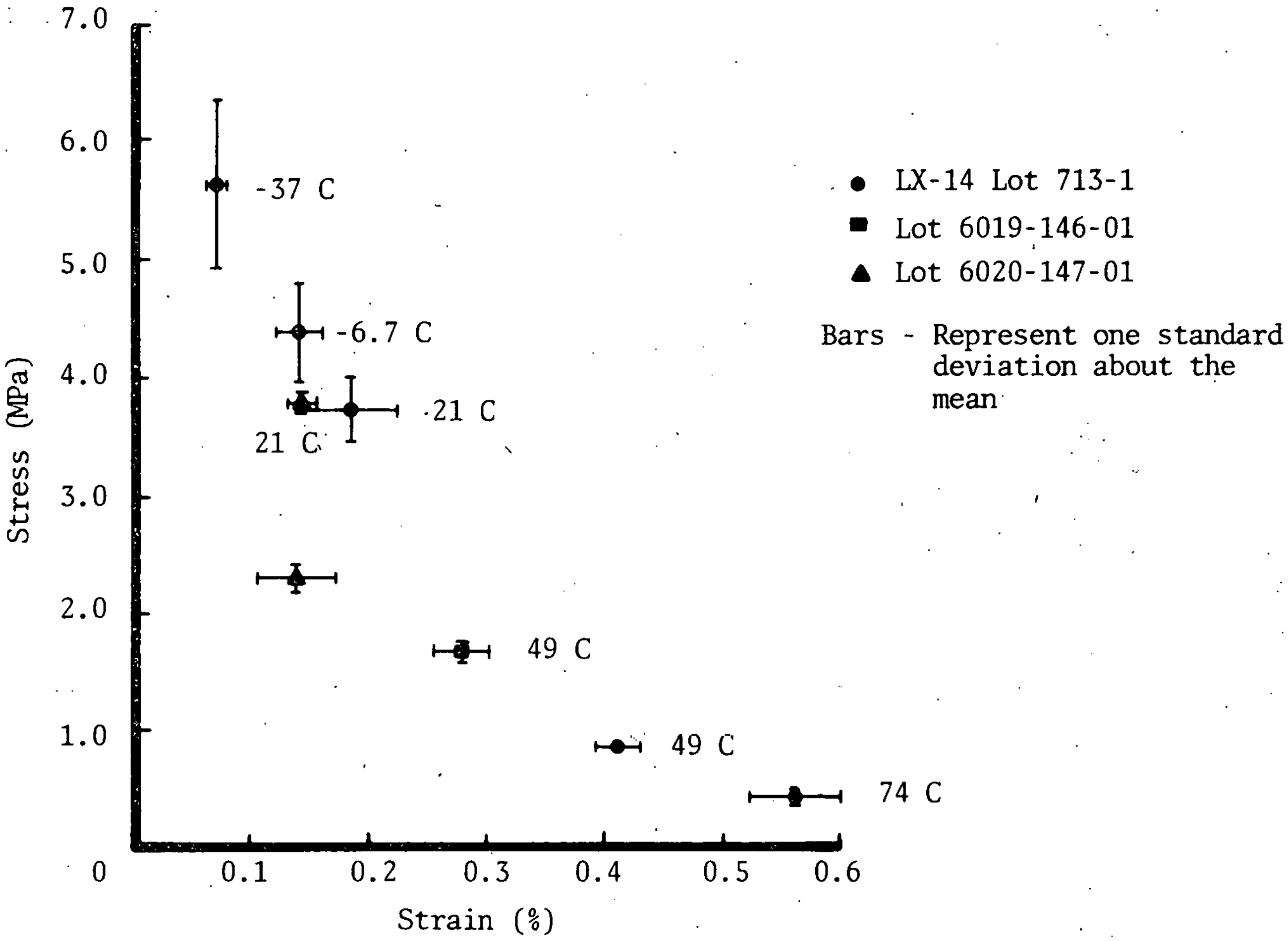

Fig. 1. Stress/Strain at Failure