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DEVELOPMENT OF FABRIC MATERIAL FOR PROTECTIVE BONDING LAYER OF THE INTERIOR THERMAL PROTECTIVE COATING

At present, solid rocket motors (SRM) are widely spread. In order to normalize the load-bearing shell performance, various-purpose thermal protective coating (TPC) isused.

Interior SRM case coating protects inner surfaces of motor cases from temperature impact and solid fuel combustion products. Interior coating consists of different materials: protective bonding layer (PBL), main thermal protection, and sealing layer. Previously Yuzhnoye SDO used materials manufactured by the Russian Federation to produce the interior thermal protective coating, namely PBL. In the present-day situation, it is required to replace technological elastic capron fabric TKET by a domestically manufactured analog. Yuzhnoye SDO ran out of technological elastic capron fabric TKET that is manufactured at Red Rose Factory in Moscow (Russian Federation), however, purchase of this material is economically unreasonable because it requires additional financial expenditures (filling in the customs documentation, receiving sanitary certificates etc.). [dx.doi.org/10.29010/89.2]

Keywords: *main solid rocket motor; technological elastic capron fabric; interior thermal protective coating; rubber 1001; highly elastic polyamide fabric-Ukrainian.*

Introduction

Yuzhnoye SDO assigned a task to develop domestic fabric material for protecting inner surfaces of motor cases from temperature impact and solid fuel combustion products based on environmentally safe components available in Ukraine to minimize dependence on import components delivery and produce main solid rocket motors (SRM) in time and without threat of technology violation.

In accordance with the assigned task, the woven material under development shall comply with the technical requirements given in table 1.

Table 1

The main characteristic of the fabric ТКЭТ

№ п/п	Name Indicator	ТКЭТ
1	Surface density	200÷450
2	Breaking load strip of fabric width of 50 mm, not less with a by lenght in width	 980 882
3	Relative elongation at the time of rupture of a strip of fabric 50 mm, % not less by lenght in width	 68 67
4	Nominal web canvas, cm	50+20

Yuzhnoye SDO monitored the market of Ukrainian enterprisers manufacturing elastic fabrics. Kyiv State Scientific and Research Institute of Textile and Haberdashery Industry (Kyiv SSRITHI) is one of these enterprises.

Yuzhnoye SDO and Kyiv SSRITHI jointly developed the woven material (PVP-U) to produce front and rear thermal protective coating PBL for bottoms and thermal protective coating for SRM case cylinder part. Kyiv SSRITHI supplied Yuzhnoye SDO with pilot batch of PVP-U fabric.

Hence, the aim of this work is to evaluate the possibilities of replacing capron elastic fabric with PVP-U to produce main motor demonstrator casings and using it for the newly developed casings.

A plate production program was issued to check physical and mechanical properties of the developed PVP-U and subsequently test the following properties for approval:

- breaking tension load of woven materials.
- tensile elongation of woven materials.
- ultimate strength and tensile elongation of PBL simulators.
- rupture stress in uniform break-off of PBL simulators.

Technological elastic capron fabric (TKET) and highly elastic polyamide fabric (PVP-U) were steeped and thermally treated prior to plate production.

In accordance with the developed test program, plates of 400±20×400±20 mm in size cured by the main solid rocket motor production mode were used to evaluate properties needed for comparing PVP-U fabric

Table 2

Plates 400±20×400±20 мм

№	Composition plates
1	Canvas PVP-U (TO) -2 layer + rubber compound 1001 thick 1 mm -2 layer
2	Canvas PVP-U (TO) -2 layer + rubber compound 1001 thick 0,6 mm -3 layer
3	Canvas PVP-U (TO) with tension 28% from the intial state 2 layer + rubber compound 1001 thick 1 mm -3 layer
4	Textile ТКЭТ (TO) -2 layer + rubber compound 1001 thick 1 mm -2 layer
5	Canvas PVP-U (TO)
6	Canvas PVP-U without (TO)
7	Textile ТКЭТ (TO)
8	Textile ТКЭТ without (TO)

under development and TKET fabric that are given in table 2.

The goal of testing upon uniform break-off is to determine rupture stress and ultimate elongation during tensile tests of PBL material simulations along the layers of the cured rubber 1001 and woven material (PVP-U or TKET) as well as rupture behavior. Tests results are given in table 3.

The goal of testing upon uniform break-off is to determine rupture stress in the direction perpendicular to layers of the cured rubber 1001 and woven material (PVP-U or TKET). Load is applied in the abovementioned direction through test accessories fixed in aluminum manufacturing pads. Tests results are given in table 4.

Table 3

Results test specimens of ZKS tension

Sample	Depth *t*, mm	Width *m*, mm	Movement *l*, mm	Destructive force *P*, kgf	Breaking stress σ, MPa	Elongation at break, ε_p, %
Plate № 1 (PVP-U, TO)						
1	2,1	6,0	296	10,56	8,2	592
2	2,3	6,0	335	12,02	8,5	670
Mean					8,4	631
Plate № 2 (PVP-U, TO)						
1	2,00	6,0	419	10,79	8,8	838
2	2,00	6,0	430	11,87	9,7	860
3	2,04	6,0	254	9,49	7,6	508
4	1,98	6,0	415	12,12	10,0	830
5	2,00	6,0	406	11,26	9,2	812
Mean					8,1	770
Plate № 3 (PVP-U with tension 28%, TO)						
1	3,04	6,0	330	13,88	7,5	660
2	3,06	6,0	316	13,68	7,3	632
Mean					7,4	646
Plate № 4 (ТКЭТ, TO)						
1	2,00	66,0	306	10,43	8,5	612
2	2,22	66,0	309	10,48	7,7	618
3	2,00	66,0	309	10,44	8,5	618
4	2,04	66,0	295	10,99	8,8	590
5	2,06	66,0	311	10,91	8,7	622
Mean					8,4	612

Table 4

Test results of samples of witnesses ZKS

Sample	Imitator ZKS: Rubber 1001+PVP-U (TO) Plate № 1	Imitator ZKS: Rubber 1001+PVP-U (TO) with tension 28%, Plate № 3	Imitator ZKS: Rubber 1001+ТКЭТ (TO) Plate № 4
Breaking stress σ, kgf/cm²			
1	21,85	19,80	25,36
2	21,72	21,12	27,83
3	22,07	19,87	27,18
4	23,00	20,41	26,06
5	23,07	20,64	28,20
Mean	22,34	20,37	26,92

Determining rupture stress and ultimate elongation of woven materials (PVP-U or TKET) has two goals:

- check properties of the material for compliance with standards (TU);
- compare properties of the material used for PBL production, namely TKET fabric, with properties of the new material of similar usage, namely PVP-U fabric, for replacing PBL material of the main motor casing.

Data is given in tables 5, 6, 7, 8.

Conclusions

1. Steep and thermal treatment technology for PVP-U fabric was tested and developed.
2. Technology for manufacturing PBL samples with PVP-U fabric was developed.
3. Values of breaking load obtained when testing PVP-U material are significantly higher that of the TKET material (thermally treated and thermally untreated).
4. Developed and issued TU in PVP-U.
5. PVP-U fabric is successfully tested and adopted for structure developed by Yuzhnoye SDO.

Table 5

Results test Canvas PVP-U (TO)

Sample	Breaking load, H	Relative extrnsion, %
length		
1	1066,04	142
2	1163,85	157
3	1227,45	165
4	991,47	137
5	1147,38	144
Mean	1119,24	149
width		
1	997,84	204
2	959,81	221
3	1089,17	202
4	1043,31	197
5	993,62	194
Mean	1016,75	204

Table 6

Results test Canvas PVP-U (without TO)

Sample	Breaking load, N	Relative extrnsion, %
length		
1	1547,23	138
2	1396,19	134
3	1598,40	152
4	1530,32	154
5	1534,15	152
Mean	1521,26	146
width		
1	942,96	342
2	953,24	340
3	969,95	380
4	917,89	336
5	1002,88	416
Mean	957,38	363

Table 7

Results test Textile ТКЭТ (ТО)

Sample	Breaking load, N	Relative extrnsion, %
length		
1	44,70	163
2	40,60	143
3	56,67	170
4	52,96	134
5	63,55	144
Mean	51,70 (527 N)	151
width		
1	42,68	119
2	40,70	133
3	42,48	126
4	37,80	124
5	43,72	121
Mean	41,10 (423 N)	125

Table 8

Test results textile ТКЭТ

Sample	Breaking load, Н	Relative extrnsion, %
length		
1	48,15	143
2	44,11	145
3	44,11	144
4	49,67	150
5	49,48	141
Mean	47,10 (480 Н)	145
width		
1	40,29	112
2	39,91	115
3	37,02	115
4	39,17	123
5	45,60	121
Mean	40,40 (412 Н)	117

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УДК 629.7.023.224+620.22

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РАЗРАБОТКА ТКАНЕВОГО МАТЕРИАЛА ДЛЯ ЗАЩИТНО-КРЕПЯЩЕГО СЛОЯ ВНУТРЕННЕГО ТЕПЛОЗАЩИТНОГО ПОКРЫТИЯ

В настоящее время широкое распространение получили ракетные двигатели твердого топлива (РДТТ). Для нормализации работы силовой оболочки РДТТ применяют теплозащитные покрытия (ТЗП) различного назначения.

Внутренние покрытия корпусов РДТТ необходимы для защиты внутренней поверхности корпусов двигателей от воздействия температуры и продуктов сгорания твердого топлива. Внутренние покрытия состоят из различных слоев материалов: защитно-крепящий слой (ЗКС), основная теплозащита, герметизирующий слой. Ранее в ГП «КБ «Южное» для изготовления внутреннего теплозащитного покрытия, а именно для ЗКС, применялись материалы производства РФ. В нынешних реалиях необходима замена ткани капроновой эластичной технической марки ТКЭТ на аналог отечественного производства. В виду того, что, ткань капроновая эластичная техническая закончилась на предприятии ГП «КБ «Южное» и данная ткань производится в РФ г. Москва ПФК «Красная Роза», то приобретение ткани ТКЭТ требует дополнительных финансовых затрат (оформление

таможенной документации, получение санитарных заключений и т.д.) , что делает покупку данного материала экономически нецелесообразным. [dx.doi.org/10.29010/89.2]

Ключевые слова: твердотопливный маршевый двигатель; ткань капроновая эластичная техническая; внутреннее теплозащитное покрытие; резина 1001; полотно высокоэластичное полиамидное-украинское.

Литература

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