

## KSR-III

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### A Study on the Insulation for the Outer Surfaces of KSR-III

Joon-Ho Lee\*, Bum-Seok Oh\*\*

#### Abstract

Outer surfaces of KSR-III are insulated to protect outer structure and inner payloads from the aerodynamic heating. The characteristics of insulation material (BMS 10-102), selected through careful tests and thermal analyses, are low heat transfer rate and low density. It is applied in a wet and continuous spray pattern for outer surfaces of KSR-III. In the present study, the honeycomb sandwich structure of nose fairing, which is one of the typical multi-layer structures of KSR-III, is thermally analyzed with insulation.

가  
 , KSR-III 가  
 BMS 10-102 가  
 ,  
 KSR-III  
 honeycomb  
 : KSR- , (launch vehicle), 가 (aerodynamic heating), (heat transfer),  
 (insulation)

**1.** 가  
 가  
 (environments) 가  
 가 (aerodynamic heating) 가 (conduction) 가  
 가

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\* /joonho@kari.re.kr

\*\* /obs@kari.re.kr



2.2

3

-A

1

, KSR-III

BMS 10-102

KSR-III

가

2

가

가 가

2.

	-A (As Received)		-B (After Heat Treatment)	
		500		500
$C_p$ [J/g-K]	1.1026	0.8266	0.7005	0.9843
$\alpha$ [cm <sup>2</sup> /s]	3.68E-3	4.60E-3	6.23E-3	6.162E-3
$\rho$ [g/cm <sup>3</sup> ]	0.32	0.30	0.277	0.277
$k$ [W/m-K]	0.1297	0.1140	0.1207	0.1679

3. 가

가

1

2

가

MINIVER

. MINIVER

NASA

가

A : As Received

B : After holding for 30 min at 500

2

-B

30 500

가

가

가

-A

KSR-III

BMS 10-102

(integral heat transfer)

, single location

point solution

가

가

. KSR-III

4

가

KSR-III

3. BMS 10-102

	-A (As Received)			
		500		
$C_p$ [BTU/lb. F]	0.2624	0.1974	-	0.25
$\rho$ [lb/ft <sup>3</sup> ]	19.98	18.73	19 21	20.0
$k$ [BTUsec/ft. F]	2.082E-5	1.830E-5	1.158E-5 ( ) 1.482E-5 (500. F)	2.0E-5

4.

	$C_p$ [BTU/lb. F]	$k$ [BTUsec/ft. F]	$\rho$ [lb/ft <sup>3</sup> ]
AL2024-T351	0.23	0.03 ~ 0.0324	174.53
Glass #823 / Phenol	0.30	2.778E-5	112.32
Fiberglass Honeycomb	0.27	9.259E-6 ~ 1.389E-5	4.5
Carbon-Epoxy	0.25	5.556E-4 ~ 9.722E-4	86.4

MINIVER

KSR-III

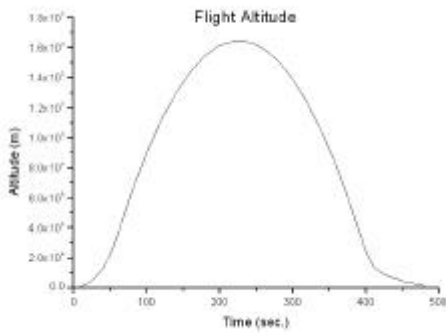
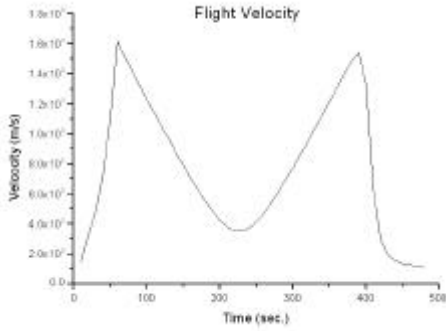
( ) : Fay & Riddell stagnation

가

: Tangent Cone

: Eckert/Spaulding & Chi Flat plate

: Swept Cylinder



1. KSR-III

4. KSR- III

KSR-III

가

(single layer)

KSR-III

가

KSR-III

가

honeycomb core

가

가

가

가

KSR-III

honeycomb

core

MINIVER

가

가가

honeycomb core

(heat capacity)

가

MINIVER

: 1962 ICAO



2.

Case 1 :

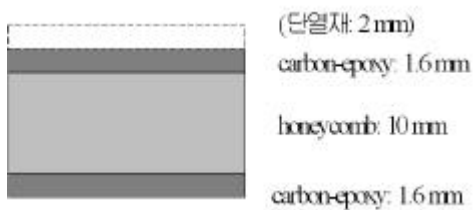
- ( 13.2 mm)
- carbon-epoxy : 1.6 mm
- honeycomb : 10.0 mm
- carbon-epoxy : 1.6 mm

Case 2 : Case 1 2.0 mm

Case 3 : ( )  
carbon-epoxy : 13.2 mm

Case 4 : ( )  
carbon-epoxy : 10.0 mm

3



3.

case 1

, case 2 case 1

2 mm  
. case 2

2 mm  
(optimal value) ,

, KSR-I, II 가  
( carbon-epoxy )

가가 , KSR-III 가

가 가 가

. , ' case 3 + ' case 4

가 carbon-epoxy

5 4 가

carbon-epoxy 가 397  
carbon-epoxy 가 177  
가

Case 2 2 mm

가

carbon-epoxy 176  
honeycomb core

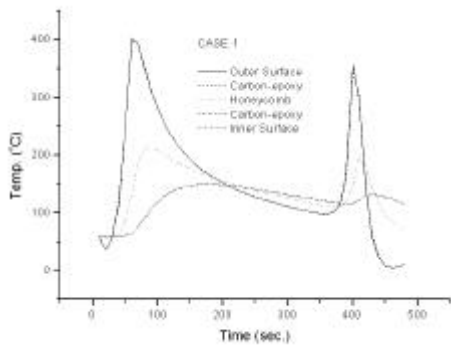
. ( 5, 5 )

5.

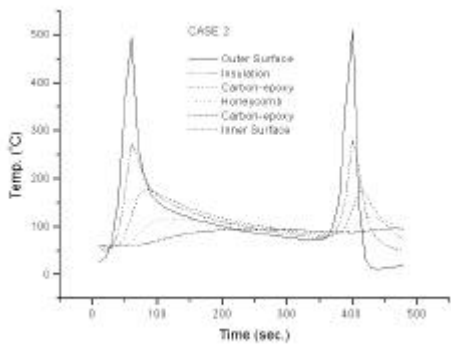
Case	(°C)						(kg/m <sup>3</sup> )
	-	-	carbon-epoxy	honeycomb	carbon-epoxy	-	
1	402	-	397	213	150	150	5.150
2	495	274	176	117	95.2	95.2	5.190
3					151		18.27
4					177		13.84

( : 60 )

carbon-epoxy maximum operation temp.  
: 177



4. Case 1



5. Case 2

60 (margin) 가  
176 가가  
116 가  
가 , 2 mm

case 2  
case 3,  
가  
2.5 가  
가  
가  
가

case 2  
"carbon-epoxy 가 17  
가 176 가  
가"

5.

(maximum operation temp.) (melting point)

가 가

가 250  
가 가

4, 5

60

가 , KSR-III

BMS 10-102 가

KSR-III

KSR-III

honeycomb

honeycomb core

2 mm

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