NASA CONTRACTOR REPORT 166367

Thermal Insulation Blanket Material

R. H. Pusch

Woven Structures

CONTRACT NAS2-11094
June 1982

NASA

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Woven Structures
Division of Hitco
Compton, CA 90220

Prepared for
Ames Research Center
under Contract NAS2-11094

National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

THERMAL INSULATION BLANKET MATERIAL

1.0 INTRODUCTION

The specific objective of this program was to provide NASA with improved advanced flexible reusable surface insulation materials for future Space Shuttle flights. A current flexible ceramic blanket, presently under final development, relies on a quartz thread to hold the "ceramic sandwich" -- like structure together. The need for this thread may be eliminated by weaving a continuous fluted thread core quartz fabric that forms an integrally woven core.

2.0 SCOPE

The program plan was for Woven Structures, a division of HITCO, subsidiary of ARMCO, Inc. to weave three different cell size Hitcore® panels using quartz yarn and to fill the cells of the Hitcore with Q-Felt® insulation. The fabric width was to be 26 inches and two linear yards each of the three cell sizes were to be produced. The three panels were to be the following sizes:

1) 1/2" cell height x 3/4" cell width x 26" wide x 2 yards
2) 1" cell height x 1" cell width x 26" wide x 2 yards
3) 1½" cell height x 1½" cell width x 26" wide x 2 yards

All panels produced were to be heat cleaned at 850° F for a minimum of four hours.

3.0 MATERIALS

The quartz yarn selected for weaving was Alphaquartz® type 300-2/4-QS7 having a starch-oil binder and was obtained on special order from A.A.I. Products, Inc.

The Q-Felt purchased from Johns-Manville Corp. was the six pounds per cubic foot density material obtained in standard sheets ½" x 36" x 60".

4.0 PROCEDURE

4.1 Weaving Development

4.1.1 The initial setup and debugging of the 48 inch C&K loom was done using fiberglass yarn as a means of conserving the loss of expensive quartz yarn. It was during this initial work that it was discovered that the loom had a bent crankshaft, making it impossible to control the cell dimensions. The entire setup was then moved to another loom of the same type and development work resumed. At this time a new fabric roll was also installed.

Hitcore® Trademark for HITCO
Q-Felt® Trademark for Johns-Manville Corp.
Alphaquartz® Trademark for A.A.I. Products, Inc.

4.1.2 The three pattern chains were designed and made up to be used for programming the loom for the three different cell sizes required. The chains were installed and glass Hitcore was woven in ½" x 3/4" x 1" x 1", and 1½" x 1½" cell sizes.

4.1.3 A mechanical problem was encountered when the 1" x 1" cell size glass Hitcore weaving was started. It was found that the loom clutch assembly was slipping under maximum load in one portion of the weaving sequence causing some breakage of warp yarns. This problem was alleviated by adjusting the clutch and installing a two horsepower motor to replace the original one and one half horsepower motor. Additional adjustments to the rollers on the front of the loom, changing the yarn tensioning system, and changing the loom program sequence also were done to minimize yarn breakage.

4.1.4 Three sets of mahogany inspection mandrels were obtained to be used in checking the cell size of all fabric produced. The glass Hitcore produced was then checked and found to be satisfactory in size and weave pattern.

4.1.5 After debugging the loom and making cell size adjustments using fiberglass yarn, the creel was reloaded with quartz yarn. The quartz yarn was tied on to the glass yarn and pulled through the loom. Weaving was now initiated using all quartz yarn and the pattern chain for 1/2" x 3/4" cell size.

4.1.6 When the loom was operated weaving quartz, considerable warp yarn breakage was again encountered. To solve the breakage problem this time, it was only necessary to reduce the tension in the warp sheets weaving the vertical ribs of the core. Following this adjustment, a short length of fabric was woven, checked for cell dimensions, and found to be acceptable.

4.1.7 Production weaving of the quartz Hitcore was then started. Approximately four yards of each cell size Hitcore were woven. The individual pieces of fabric were checked for cell size conformity using the wooden inspection mandrels. Weaving anomolies and cell irregularities were marked so that the production panels could be cut out of minimum defect fabric.

4.2 Q-Felt Insertion Development

4.2.1 The procedure developed for inserting the Q-Felt into the cells of the Hitcore utilized a moistening and freezing technique.

4.2.2 Pieces of one half inch thick 6 pound per cubic foot density Q-Felt were cut, moistened with deionized water, and plied as necessary to make panels 1/2, 1, and 1 1/2 inches thick. The wet Q-Felt was covered with 3 mil mylar plastic sheet and compressed to the required thickness using a fixture having adjustable flat plates. The entire assemblies were put into a freezer operating at 5^{o} F for 15 hours.

4.2.3 After freezing, the panels were cut into strips of appropriate width for each cell size. The 1/2 inch thick panels were cut first using a large band saw that previously had been cleaned inside and out with alcohol.

4.2.4 The quartz Hitcore panel of 1/2 by 3/4 inch cell size was stuffed with frozen strips and put into an oven drying cycle of 300° F for two hours. Following drying, the Hitcore panel was heat cleaned in a cam controlled oven having a hold at 850° for 4 1/2 hours.

4.2.5 After heat cleaning the first panel, it was noticed that a light brown discoloration was present in certain areas of the material.

4.2.6 Some of this discoloration came from water washing off the inside of the band saw and depositing dirt on the Q-Felt.

4.2.7 To alleviate the discoloration problem, the second set of frozen Q-Felt panels were cut on a table saw having a chrome plated blade. This technique was used on all subsequent panel cutting.

4.2.8 Further testing on small samples indicated that the residual discoloration was actually incompletely removed starch-oil sizing that had carbonized. It was found that the combination of the wet Q-Felt and the starch-oil sized quartz when put through the standard drying and heat cleaning cycles resulted in some of the starch-oil sizing being "locked" into the surface of the quartz as carbon which is very difficult to remove.

4.2.9 A solution to the discoloration problem was to heat clean the quartz fabric before filling the cells with frozen Q-Felt and then simply drying the fabric afterwards. This technique resulted in clean white fabric having no contamination.

5.0 MATERIALS SHIPPED

The following materials were supplied to NASA as part of this program:

1) Quartz Hitcore Panel, Q-Felt Filled, 1/2" x 3/4" x 26" x 2 yards
2) Quartz Hitcore Panel, Q-Felt Filled, 1" x 1" x 26" x 2 yards
3) Quartz Hitcore Panel, Q-Felt Filled, 1½" x 1½" x 26" x 2 yards
4) Quartz Hitcore Fabric, 1/2" x 3/4" x 26" x 36", grey goods
5) Quartz Hitcore Fabric, 1" x 1" x 26" x 36", grey goods
6) Quartz Hitcore Fabric, 1½" x 1½" x 26" x 36", grey goods
7) Fiberglass Hitcore Fabric, Style 322, 1/2" x 48" x 36", Volan finish

6.0 APPENDIX

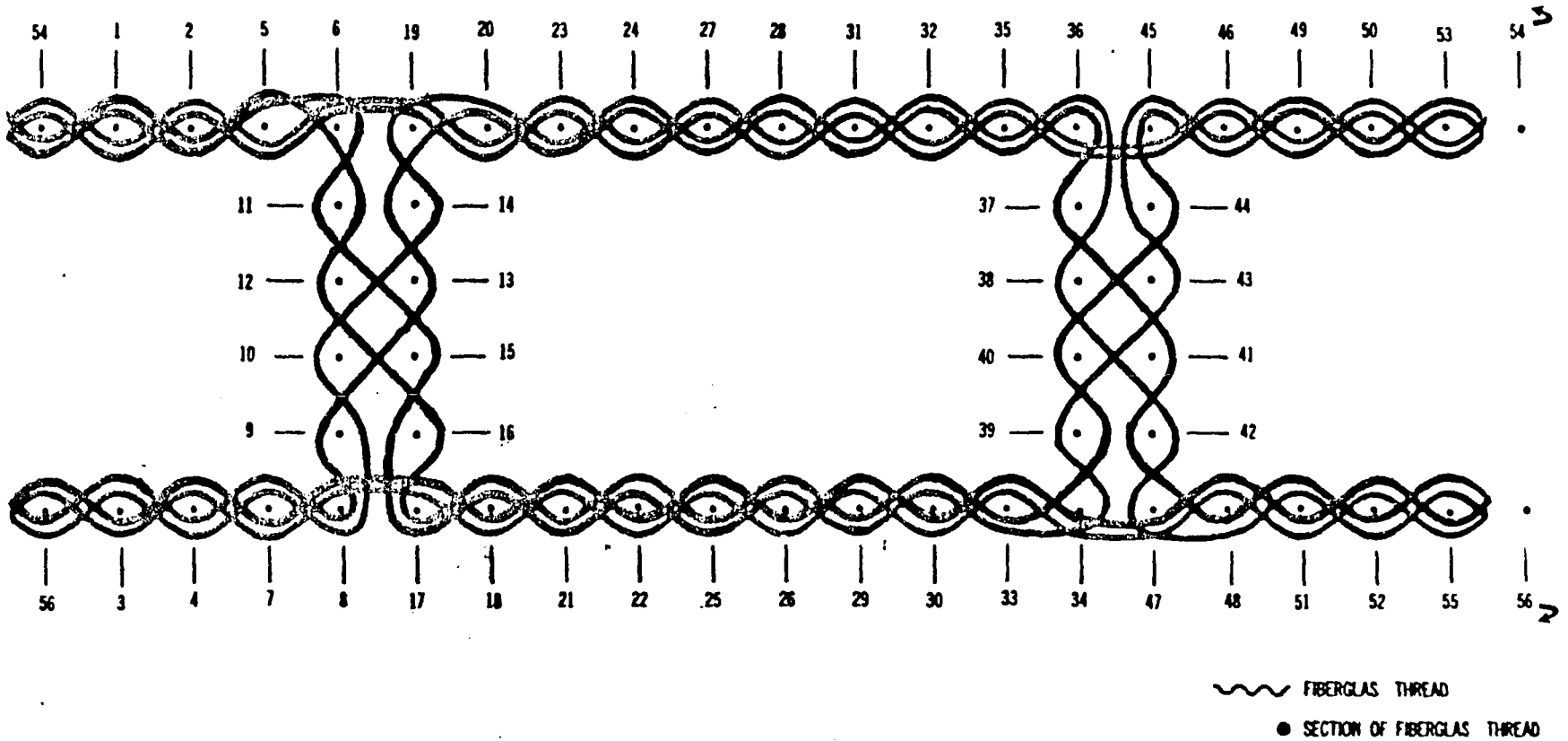
The following attachments are included:

1) A typical diagram of a woven Hitcore fabric.
2) A.A.I. Products, Inc. data sheet, "Properties of Alphaquartz".
3) Alphaquartz yarn certification.
4) Q-Felt certification.

FIBERGLAS FLUTED CORE FABRICS

INTEGRALLY-WOVEN CORE MATERIALS

Woven Structures



Properties of ALPHAQUARTZ

Fiber Properties

Tensile Strength, P.S. I. @ 750°F, Dia. 8.0 microns	126,000
@ 1000°F, Dia. 7.5 microns	133,000
@ 1400°F, Dia. 7.4 microns	99,200

Thermal Properties

Av'g Coeff. of Linear Expansion, 1°C (Temp. range 0-1852°C)	0.54×10^{-6}
Specific Heat, Av'g 0-500°C, cal/gm°C	0.230
Thermal Conductivity, K @ 20°C C.G.S., cal/sec/cm/cm²/°C	0.003
Softening Point	3032°F
Annealing Point	2084°F
Strain Point	1958°F

Mechanical Properties

Specific Gravity	2.2
Hardness Mohs scale	5.6
Poisson Coefficient	0.17
Young's Modulus, p.s.i.	10×10^6

Typical Laminate Properties

Flexural Strength, p.s.i.	77,000
Tensile Strength, p.s.i.	59,000

Electrical Properties

Power Factor, 1 mc at 68°F	0.0001
Loss Factor, 1 mc at 68°F	0.0002
Dielectric Constant, 68°F	3.7
Volume Resistivity, ohm/cm at 390°F	10^{13}

Composition:

SiO_2 > 99.9%; Boron < 50ppm; Alkali Metals (Na, K, Li, calculated as Na equivalent) < 50ppm; Al < 150ppm; Other impurities < 100ppm.

Above figures are for binder-free ALPHAQUARTZ. Coupling agents are normally applied during drawing to improve physical characteristics of laminates. Average pickup - < 5% by weight.

A.A.I. PRODUCTS INC.

A.A.I. Products Inc. Two Amboy Avenue, Woodbridge, New Jersey 07095 (201) 634-5700 Telex #13-8024

A.A.I. PRODUCTS, INC.

TWO AMBOY AVENUE, WOODBRIDGE, N. J. 07095 (201) 634-5700

TELEX NO. 138-024

CERTIFICATION

December 17, 1981

WOVEN STRUCTURES
P.O. #WS5111
ORDER COMPLETE

PRODUCT:	Alphaquartz Yarn
TYPE:	Style 300-2/4-QS7
LOT NO.:	777
NUMBER OF BOXES:	3
NUMBER OF SPOOLS:	27
NET WEIGHT:	61.2 lbs.
SILICA CONTENT:	99.96%
BINDER COMPOSITION:	2.8% Steramine CGL, 5.0% Sopralube ACR 265, 2.0% Solvitose N

This is to certify that the Alphaquartz Yarn 300-2/4-QS7 meets the requirements of Woven Structure's Specification #MS-0101, Revision A, dated September 28, 1977, for the following paragraphs: Para. 2.72 and Para. 2.82.

Victor G. Penotti
Supervisor, Quality Control

Johns-Manville
Sales Corporation

Waterville, Ohio
(419) 878-8111

Mailing Address:
P. O. Box 517
Toledo, Ohio 43693

October 15, 1981

Woven Structures
Div. of Hitco
618 W. Carob Street
Compton, CA 90220

Gentlemen:

This is to certify that J-M's standard inspection procedure has been used in the inspection of the material covered by this order. This inspection indicates that the material tested for J-M Order No. G92 ZK 00709, your Order No. WS 5112 complies with the applicable finished product requirements of Johns-Manville.

Very truly yours,

R. J. Szymanski
Quality Control Manager

Certified in triplicate

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NASA CR-166367		

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15. Supplementary Notes

Technical Monitor: Paul M. Sawko, M/S 234-1, NASA Ames Research Center, Moffett Field, CA 94035 (415) 965-6079, FTS 448-6079

16. Abstract

A study was conducted to provide a tailorable advanced blanket insulation based on a 3-D woven design using an integrally woven core structure. A high purity quartz yarn was selected for weaving and the cells formed were filled with a microquartz felt insulation. Three panels were provided:

1. 1/2" cell height x 3/4" cell width x 26" wide x 2 yards
2. 1" cell height x 1" cell width x 26" wide x 2 yards
3. 1 1/2" cell height x 1 1/2" cell width x 26" wide x 2 yards

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Blanket Insulation Quartz Yard Microquartz Felt	Unclassified - Unlimited SUBJECT Category - 34

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Unclassified	Unclassified	9	

*For sale by the National Technical Information Service, Springfield, Virginia 22161

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