3048 ✓
BDX-613-493 (Rev.)

DEVELOPMENT OF ELASTOMER
CUSHIONS, FY71-4

PDO 6984549, Quarterly Report

G. E. Martinette, Project Leader

Project Team:
G. W. Edman, IV

Published September, 1972

THIS DOCUMENT CONFIRMED AS
UNCLASSIFIED
DIVISION OF CLASSIFICATION
BY Jack H. Kahn /wer
DATE 10/24/72

Prepared for the
United States Atomic Energy Commission
Under Contract Number AT(29-1)-613 USAEC

**Kansas City
Division**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
K7164

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DEVELOPMENT
OF ELASTOMER
CUSHIONS. FY71-4

BDX-613-493 (Rev.)

September, 1972

Project Leader:
G. E. Martinette
Department 835

Project Team:
G. W. Edman, IV

PDO 6984549
Quarterly Report

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Technical Communications

**Kansas City
Division**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

DEVELOPMENT OF ELASTOMER CUSHIONS, FY71-4

BDX-613-493 (Rev.), UNCLASSIFIED, Published September, 1972

Prepared by G. W. Edman, IV, D/835, under PDO 6984549

Studies pertaining to the fabrication of elastomer cushions are being performed on Union Carbide's formulation Y-3333 cellular silicone to determine the following characteristics of this material: the effects of chemical constituents on physical properties; the quantification of frictional shear characteristics; surface cell configuration; the effect of time delay at intermediate processing stages; and the rheological properties. Each study is described and the results to date are reported. Data accumulated are not yet of sufficient quantity to warrant conclusions except for the study of frictional shear, which was completed this quarter. Analysis of these data indicates that a repeatable method for measuring the capability of the material to control movement of adjacent parts in directions perpendicular to the load bearing application has been developed and has proven to be satisfactory.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

THE BENDIX CORPORATION

KANSAS CITY DIVISION

KANSAS CITY, MISSOURI

A prime contractor for the
Atomic Energy Commission
Contract Number AT(29-1)-613 USAEC

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

CONTENTS

Section	Page
SUMMARY	7
DISCUSSION	9
SCOPE AND PURPOSE	9
PRIOR WORK	9
ACTIVITY AND ACCOMPLISHMENTS	9
<u>Chemical Testing</u>	10
<u>Frictional Shear Testing</u>	10
<u>Surface Cell Characterization</u>	10
<u>Process-Interrupt Aging Study</u>	13
<u>Rheological Study</u>	13
FUTURE WORK	13

ILLUSTRATIONS

Figure	Page
1 Typical Scanning Electron Photomicrograph of a Y-3333 Cellular Silicone Cross-Section, 100X Magnification (P-71004)	11
2 Thickness Versus Process-Interrupt Aging Time of Y-3333 Cellular Silicone, 0.060-Inch Nominal Thickness	14
3 Part Weight Versus Process-Interrupt Aging Time of Y-3333 Cellular Silicone, 0.060-Inch Nominal Thickness	15

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

SUMMARY

The objective of this process development order is to optimize elastomer cushion part fabrication by further definition of the variables involved in molding, washing, curing, and testing the material. Effort has been directed toward four testing programs started during the first quarter of fiscal year 1971, and one study, which was planned and initiated during the third quarter of the same year. The particular material under study is Union Carbide's formulation Y-3333 cellular silicone, a relatively new material in elastomer cushion production which is nearing its first use in parts fabrication.

The purpose of the first of the five studies is to determine the chemical consequences of cellular silicone processing techniques and their subsequent effects on physical properties. Included are analyses of the elemental composition, catalyst content, urea content, volatiles and extractables, acidity or basicity, outgassing products, thermomechanical properties, load versus deflection, density, and compression set. Work performed to date includes preparation of samples from eight material lots, development of test methods for analytical analyses, and compilation of physical properties data.

In an attempt to quantify the capability of a cushion to control relative movement of adjacent parts in directions perpendicular to the application of load, the second study was initiated to investigate the frictional shear forces exhibited by the material. Variables considered in this endeavor included percent compression, load, apparent density, and surface conditions. Details of the completed study program were published in Bendix report BDX-613-447, Surface Friction Characteristics of Silicone Rubber Pads, July, 1971. The major result of this study was the development and verification of a standard method for testing frictional shear.

Partially in conjunction with the frictional shear testing, a program was undertaken to characterize the surface cell configuration of Y-3333 cellular silicone. The program consists of a series of optical photomicrographs and scanning electron photomicrographs to be analyzed for percentage cell area, average cell shape and size, average cell spacing, and surface roughness. The initial photomicrographs of each type have been taken and analyzed. The only conclusion from the limited number of photomicrographs taken is that the cell size and cell spacing are uniform. Determination of actual dimensions is being reserved until a more complete sampling has been evaluated.

In an effort to better define the limitations of shelf life, a study was designed to determine the effects of prolonged storage on parts at intermediate processing stages. A sampling is taken of parts whose process was

interrupted, either between molding and washing or between washing and postcuring, for periods up to 24 weeks. Indicators to be used for detection of aging effects are load versus deflection, density, and compression set. All of the material samples have been fully processed and tested. The data for compression set and density, completed at the close of the quarter, have not been analyzed.

Finally, a study was initiated last quarter to determine material rheology and cure characteristics. A study of this type has been under consideration for several years, but the available test equipment was deemed inadequate for the material. Variables under consideration are temperature and pressure in opposition to scorch and cure times. Tests have been performed on a Firestone CEPAR Rheometer, using both filled and unfilled material samples. The results obtained, however, are inconclusive and indicate that some changes in the testing procedure will be required if meaningful data are to be obtained.

There have not been enough data evaluated in any of the four incomplete studies to warrant conclusions at this time. However, information gained in preliminary analyses seems to justify a recommendation to complete each of the studies.

DISCUSSION

SCOPE AND PURPOSE

Operating and testing variables involved in the fabrication and acceptance of cellular silicone parts have never been sufficiently defined to allow confident forecasting of requirements for any individual piecepart. For this reason, the objective of Process Development Order 6984549, Elastomer Cushions, and of all of the studies undertaken in association with the project, is to optimize elastomer cushion part fabrication by further definition of the variables involved in molding, washing, curing, and testing the material. Consistent with the overall objective of the project, each of the five studies will also provide additional knowledge of Y-3333 cellular silicone.

The goal of the chemical testing program is to detect any correlation between physical and chemical properties to determine controls which should be placed on the material specification. The frictional shear determination was initiated to quantify the capability of the material to control movement of adjacent parts in directions perpendicular to the load-bearing application. The characterization of surface cell configuration has the dual purpose of explaining the phenomenon of frictional shear and the determination of processing controls which must be applied to maintain a surface condition commensurate with the desired effect. In an attempt to better define shelf life limitations, the purpose of the process-interrupt aging study is to determine the time dependency of major processing stages beyond molding. Finally, the study of rheological properties was undertaken to ascertain the time limitations involved in compression molding as dictated by the onset of scorch.

PRIOR WORK

The first four of the five studies were started during the first quarter of fiscal year 1971 and the fifth was started last quarter. Activities completed on these projects, up to the beginning of this quarter, include program planning, special fixture design and fabrication, sample fabrication, and data collection.

ACTIVITY AND ACCOMPLISHMENTS

The generation of data for the five study programs continued during this quarter, and the frictional shear testing study was completed. The activity and accomplishments on each of the study programs are summarized.

Chemical Testing

Data collection for the analytical portion of this endeavor, the only remaining activity postponing program completion, has been delayed by other projects in unrelated fields. Consequently, the data which have been generated are still in the raw form and cannot be presented at this time.

Frictional Shear Testing

All activities on this study have been completed, and a detailed description is contained in Bendix report BDX-613-447, Surface Friction Characteristics of Silicone Rubber Pads, July, 1971. The major accomplishments of this effort were the development of a standard method for testing the frictional shear forces exhibited by cushioning materials and the verification of the usefulness of the test method in obtaining repeatable results.

Surface Cell Characterization

The preliminary photomicrographs, further analyzed this quarter, yielded useful results in directing the remainder of the study program. First to be analyzed were the optical photomicrographs taken with reflected light. In these views of the material surface, it appeared as though the cells of the material were uniformly spaced, but they were only an average of 0.011 inch in diameter and open to the surface. This is not as would be expected since the cells are formed by the removal of temporary filler particles which are nearly spherical and average approximately 0.026 inch in diameter.

Optical photomicrographs taken with transmitted light showed that the cells were indeed larger than 0.011 inch in diameter. The 0.011-inch-diameter cells observed in the previous photomicrographs now appeared to be the surface opening of a larger cell. Since a definite cell boundary was not discernible, it could only be concluded that the average cell is larger than 0.020 inch in diameter.

The cells' appearance of being open to the surface still could not be explained, however, since the nearly spherical filler particles would in theory touch the as-molded surface at only one dimensionless point. Scanning electron photomicrographs of the cross-sectioned material were, therefore, taken in an attempt to answer the question of surface opening. Figure 1 is typical of the results obtained.

Analysis of Figure 1 and of other scanning electron photomicrographs indicates that most of the cells are open to the surface only because the very thin skinning, once covering each cell, has been broken. Additionally, these analyses showed that the size of the major cells is an average of approximately 0.025 inch in diameter.

Figure 1. Typical Scanning Electron Photomicrograph of a Y-3333 Cellular Silicone Cross-Section (100X Magnification)

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

Based on the above findings, it was decided that future effort should be directed largely toward use of scanning electron photomicrographs because only this type of analysis would seem to yield the desired information.

Process-Interrupt Aging Study

Testing was completed at the close of the quarter, not allowing adequate time for reduction and analysis of the density and compression set data. The data for thickness and part weight, however, have been analyzed and are presented graphically in Figures 2 and Figure 3, respectively. Neither thickness nor part weight appears to vary enough to be indicative of a time dependence.

Rheological Study

Further effort was directed toward modification of the testing technique to make it possible to use the Firestone CEPAR rheometer in testing filled material. This objective was not fulfilled, but all possibilities have not been eliminated.

FUTURE WORK

It is considered that the data evaluated to date for the four incompleting studies reported above provide sufficient justification for the completion of each study. All future work planned at this juncture consists of further endeavor toward the goals described for completion of the four remaining study programs.

Figure 2. Thickness Versus Process-Interrupt Aging Time of Y-3333 Cellular Silicone, 0.060 Nominal Thickness

Figure 3. Part Weight Versus Process-Interrupt Aging Time of Y-3333 Cellular Silicone, 0.060 Nominal Thickness