QUARTERLY REPORT

CONTRACT NONR 4096(00)

POLYPROPYLENE BALLOON STUDY

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I. INTRODUCTION

This is the fourth quarterly status report submitted on Contract NONR-4096(00) and documents the effort expended during the period from 1 January 1964 through 31 March 1964.

During these three months the following items were accomplished:

1. Blocking tests of Hercules cast polypropylene film.
2. Seal development leading to production techniques.
3. Creep testing of polypropylene sealed with pressure sensitive tape.
4. Fabrication and destructive testing of a polypropylene superpressure cylinder.
5. Design, fabrication and flight test of a 10,000 cubic feet polypropylene balloon.

II. BLOCKING TESTS

Blocking tests in addition to those previously reported were conducted using Hercules 50-gauge polypropylene cast film corona treated both sides These tests were run to determine the relative blocking of cast vs. extruded film. According to Union Carbide technical personnel, blocking is more critical with extruded film.

Samples of Hercules film were cut to size, moistened, accordion folded and placed under 4 psi pressure. Six samples were run, one with inside surfaces together and one with outside surfaces together, using water, a water and starch mixture, and dry starch. Outside refers to outside surface as it is removed

from the roll. The amount of moisture on the samples was greater than that which would be experienced in normal balloon operation. After one week the weight was removed. The moistened sample with inside surfaces together exhibited moderate blocking. The other five samples did not show any blocking.

III. SEAL DEVELOPMENT

Seal development was continued during the first quarter of 1964. Seals were made to determine the optimum sealing temperature of Union Carbide and Hercules film sealed on the modified Doughboy band sealer. With 50-gauge film and GT-301* 1/2 x 1/2 x 1 tape, seals were made using sealing temperatures of 240, 250, 260, 270, 280 and 290 F. The best seals were obtained with Union Carbide film sealed at 270 F. At lower temperatures the tape peeled away readily; at higher temperatures the tape exhibited excessive shrinkage.

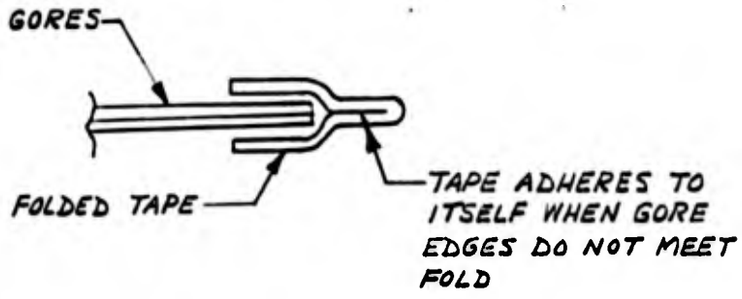
The Hercules film demonstrated that the best appearing seals occur when the tape is sealed on the inside surface (see definition of "inside" under Blocking Tests). The peel strength increased after a day, apparently the result of more complete curing of the adhesive.

When using the band sealer it was necessary for the tape to cover any areas of the polypropylene that might otherwise be exposed to the band. The rough edges on the band tended to damage the polypropylene. This was remedied by installation of a new band.

An attempt to develop production sealing techniques was

* G. T. Schjeldahl Company Registered Trademark, U. S. Patent Office

undertaken in mid-January using the band sealer with a tape folding attachment. The tape folder centered the fold within ± 1/16 inch of true position. With the gores stacked on the table it is necessary to control the location of the edge of the gore accurately with respect to the tape position. The gore edge did not position itself all the way back to the fold in the tape and consequently the tape adhered to itself. The tape spindle was repositioned to partially eliminate this.



When the tape adheres to itself, transverse stress across the seal causes the tape to tear apart, leaving holes which could be stress risers to initiate tearing. Transverse stress can be eliminated if the balloon has sufficient circumferential fullness when fully inflated and gusty winds are not present at launch to cause the material to flap, therefore this may be only a minor problem.

Since time would not permit further sealing studies, the small flight test balloon and tether test balloon were sealed using the Echo type sealer which gave a strong uniform seal

with superior peel strength. The band sealer does not produce seals with high peel strength, apparently the result of insufficient pressure being applied to the seal area during heating of the tape. In addition, the gores are precisely positioned on the Echo type sealer while on the band sealer they are not.

In order to improve sealing speeds without sacrificing seal quality, we propose to investigate certain band sealer modifications during the manufacturing methods study. (GTS Proposal No. 76030 dated 24 February 1964 to ONR). First, the heating blocks would be replaced by a pair of heating wheels. This allows greater pressure to be applied during sealing. An increase in pressure on the blocks causes the bands to seize with consequent burning of the polypropylene. However, increased pressure using wheels should not cause the bands to lock because of the small contact area between the wheels and bands. The bands would still be used to carry the material through the sealer. The fan on the sealer will continue to be used, as it performs the important function of cooling the material and preventing it from adhering to the rollers as it comes out of the sealer.

IV. SEAL CREEP TESTS

Seal creep tests were conducted using 50 gauge polypropylene butt sealed with GT-301, 1/2 x 1/2 x 1 tape on the Doughboy band sealer and with Permacel K50 one inch wide pressure sensitive tape. The K50 was tested to determine its usefulness as a cold patch for repair.

The GT-301 seals were allowed to cure for one hour, then cut into inch wide strips, sprayed with toolmakers blueing and suspended with weights at room temperature. The sample with a 2.5-pound weight (5000 psi stress) showed no evidence of creep after 24 hours. The sample with a 4-pound weight (8000 psi stress) showed raising of the seal at the outer edges after two hours, however no further creep was experienced after that time up to 24 hours.

Three samples of 50-gauge polypropylene one inch wide were butt sealed on the corona treated side with K50 pressure sensitive tape. The samples were then sprayed with toolmaker's blueing and weights of one, two and three pounds suspended from them. This resulted in seal stresses of 2000, 4000 and 6000 psi respectively. After 8 minutes the 6000 psi sample began to creep, and after one hour the 4000 psi sample showed evidence of creep. After 17 hours the test was terminated with creep recorded as follows:

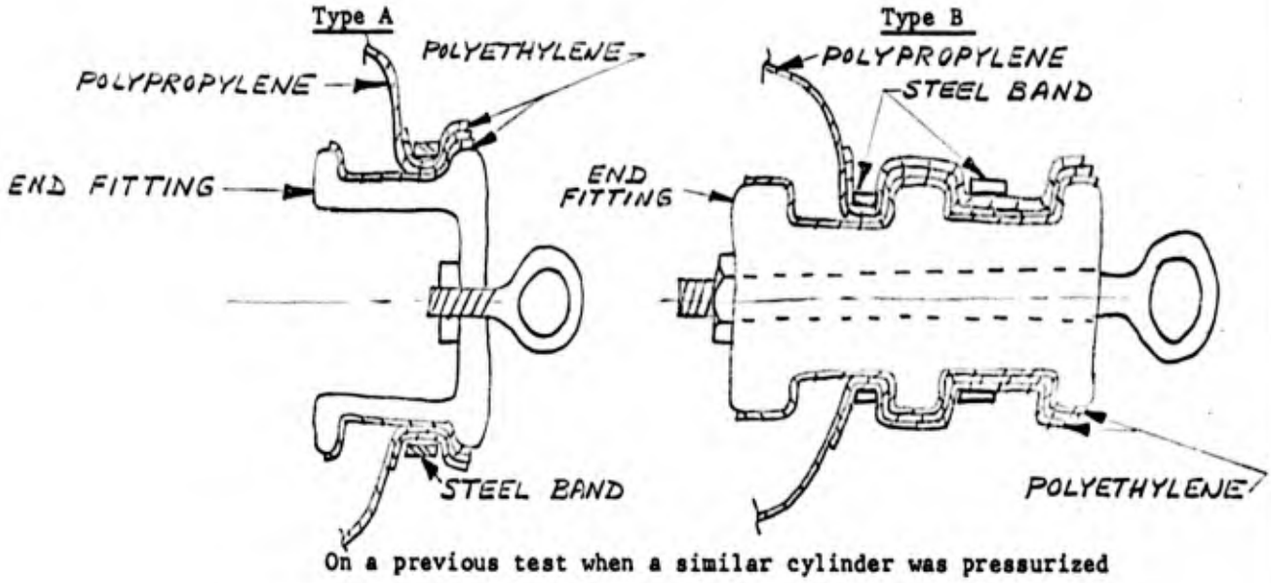
Stress (psi)	Creep at Butt Joint (inches)
2000	.05
4000	.20
6000	.25

Three more identical samples were made using K50 tape and stressed for 27 hours. Results were as follows:

Stress (psi)	Creep at Butt Joint (inches)
2000	.08
4000	.30
6000	.32

V. SUPERPRESSURE CYLINDER TESTS

A cylinder consisting of 4 gores of 5C-gauge polypropylene 52 inches wide by 20 feet long was fabricated using two types of banded end fitting as follows:



On a previous test when a similar cylinder was pressurized using a Type A fitting and 1/2-inch wide steel band, the material slid the band to the far end of the fitting and then the polypropylene was cut on the band, causing destruction of the cylinder. This problem was overcome by using 3/4-inch wide band. With the wider band, no visual evidence of material slippage was present. In both cases the fitting was lined with polyethylene tape.

No material slippage occurred at any time during the test using the polyethylene tape lined Type B fitting with 3/4-inch wide steel band.

The cylinder burst at 4 inches water pressure which was equal to 11,080 psi circumferential stress.

VI INITIAL FLIGHT TEST

A small flight test cylinder balloon of 50 gauge biaxially oriented ~~Union Carbide~~ polypropylene film was designed, built and flight tested.

Design features of the balloon are as follows:

Altitude: 71,350 feet for 37 pounds gross weight.

Diameter: 30.3 feet

Sigma (shape parameter): 0.15

Length of gore: 43.5 feet

No. of gores: 28 (42 inches wide)

Area: 4150 ft^2

Volume: 10,200 ft^3

Inflation Tube: 25 feet long x 10 inch lay flat entering balloon wall 8 feet from top fitting.

Valving duct: 82 inches long x 26 inch lay flat located 132 inches from base.

End fittings: Banded type

Balloon Weight: 13.4 lb.

The balloon gores were butt sealed on the Echo sealer using GT-301, 1/2 x 1/2 x 1 tape and a sealing temperature of 270 F.

The payload consisted of a GMD tracking beacon with a rod thermistor for monitoring ambient temperature and was suspended from a parachute with the mechanical timer and squib-

actuated line cutters.

System weights and lift were as follows:

Balloon and accessories	13.4 lb.
Payload including parachute	5.9
Gross weight	19.3
Free Lift (10.4%)	2.0
Gross lift	21.3 lb.

The balloon was launched in clear weather with light ground winds. Average ascent rate was 670 feet per minute to ceiling of 82,500 feet. After 34 minutes at altitude the termination device released the parachute and payload.

The balloon was handled during layout, inflation and launch in the same manner in which other common balloon films are handled. The operation was a success in all of its phases.

VII. FUTURE PLANS

A tethered test using a 100,000 cubic foot balloon will be conducted early in the second quarter of 1964. Manufacturing methods improvement to provide higher sealing speeds, faster gore dispensing and more efficient production techniques is planned when the amendment to the existing contract is received. This will be followed by fabrication and flight test of a 5,000 pound payload polypropylene balloon near the end of the second quarter of 1964.

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