THE DEVELOPMENT OF A FREEZE-TOLERANT
SOLAR WATER HEATER USING CROSSLINKED
POLYETHYLENE AS A MATERIAL OF CONSTRUCTION

Progress Report
for Period January 5, 1977 - March 15, 1977

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MASTER

March, 1977

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Progress to Date - March 15, 1977

Fifteen 10 ft. coils of crosslinked tubing have been subjected to repeated freezing and thawing. The composition of the crosslinked polyethylene and the stress in the wall of the tubing (i.e. "hoop stress") are parameters which are being studied to find a crosslinked polyethylene composition which will be strong and resilient enough to withstand repeated freezing and thawing without necessitating excessively thick walls.

The results at this time are shown on the accompanying table.

The two XLPE formulations used in coils #10-15 appear sufficiently promising to be used in the construction of the collectors which will be performance tested at Los Alamos and, I hope, service tested in a subsequent ERDA contract.

Tubes having the standard wall thickness-diameter ratio of plastic tubing (i.e. $\frac{1}{128}$) when subjected to the standard domestic hot water pressure of 40 psig would be subjected to a hoop stress of only 136 psi. The temperature drop across the .048" wall of .375" O.D. tube would under usual collector conditions be only a couple of degrees.

Therefore, enough 3/8" O.D. .048" wall tubing made from the formulation used in coils 12, 13, and 14, has been produced for fabricating the absorber surface of one collector.

The low-iron glass for both collectors has just been received from ASG Industries.

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Work to be done Within the Next Two Months

One collector will be assembled using the tubing made from the XLPE formulation used in coils #12, 13, and 14. Additional tubing made from the XLPE formulation used in coils #10, 11, and 15, will be produced and fabricated into an absorber surface for the other collector.

One or both of these collectors will then be delivered to Los Alamos for performance testing.

John M. Bradley

RECAPITULATION OF FREEZE -THAW TESTS OF MARCH 11, 1977

Coil #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Polyethylene Density gm/cc	.927	.96	.96	.96	.96	.96	.96	.96	.96	.96	.96	.933	.933	.933	.96
Polyethylene Melt Index	2.17	3	3	3	3	3	3	3	3	3	3	2.33	2.33	2.33	.96
Loading of GPF in parts/100 parts of resin	20	40	40	20	40	40	40	40	40	20	20	40	40	40	20
Loading of crosslinking agent in parts/100 parts of resin	2.5	2.5	2.5	2.5	4	2.5	2.5	1.5	4.0	1.5	1.5	1.5	1.5	1.5	1.5
Type of crosslinking agent	←———— Lupersol 130 —————→										→ Varox —————→ Lupersol 130				
Average initial tube O.D. inches	.390	.274	.282	.389	.397	.264	.271	.385	.385	.333	.367	.384	.3405	.362	.359
Minimum wall thickness inches	.049	.016	.012	.021	.030	.020	.018	.046	.043	.023	.023	.040	.035	.0353	.025
Hydrostatic test pressure psig	30	52	53	40	40	30	40	56	80	52	82	56	115	94	131
Calculated hoop stress psi	104	419	597	350	245	183	281	206	318	350	613	241	501	411	875
Freeze-thaw cycles to failure	-	4	6	-	-	-	16	-	-	-	-	-	13	12	-
Freeze-thaw cycles without failure	100			17*	7*	39		54	47	49	44	44			5
Approximate percentage permanent distention after the above number of freeze-thaw cycles	0	0	(-3)	1	1	3	2	0	0	2	5	3	10	4	5

*Tubes 4 and 5 add an excessive number of pinhole leaks resulting from small bubbles in the tube wall caused by improper crosslinking of the extruded tube. Therefore, the test of these tubes was discontinued even though no macro failure was caused by the strains of freezing.

The Development of a Freeze-Tolerant Solar Water Heater using Crosslinked Polyethylene as Material of Construction.

COMPARISON OF TASK ACCOMPLISHMENTS WITH PLANNED MILESTONES

- Originally planned.
- Actually occurred
- Projected completion.