NOTE

Inverse Relaxation in Compression of Solid Polymer Block

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If an extended viscoelastic specimen is allowed to recover a part of the deformation given to it, such that tension in it has not become zero, the stress in it tends to increase. This phenomenon is termed as "inverse relaxation" (IR). The occurrence of IR in textile fibers like cotton, viscose, polyester, ramie and wool,[1] spun yarns,[2] and fabrics[3] have been reported in the literature. In these studies, the materials were strained axially (tensile testing). However, there is no data available to indicate whether IR occurs in case of viscoelastic materials when they are compressed. The present note sums up the results obtained from a preliminary study conducted on polyurethane foam of density 33.3 kg/m^3 when it is under the influence of compressive forces.

Instron tensile tester with compression cell was used. A foam piece with dimensions 50 × 50 × 50 mm was compressed to a certain predetermined level and retracted to various levels. The rate of compression was 5 mm/min. Compressive pressure was applied over the area 50 × 50 mm. A typical compressive pressure-time curve is as shown in Figure 1. After compressing the material to a certain level represented by OA in time T_1 the compressive pressure (P_1) was noted down. Then the material was decompressed to a level B in a time T_1 to T_2 and the compressive pressure (P_2) was measured immediately. The material was left in this condition for some time, say up to T_3 until the compressive pressure stabilized corresponding to the point C (P_3). As in the case of samples tested earlier for axial stress,[1–3] the IR index for compressive pressure was calculated using the formula $[(P_3 - P_2)/P_1] \cdot 100$. In the present experiment $T_3 - T_2$ was kept as 10 min. The results for two compression levels with various levels of retraction are given in Tables I and II.

It is quite evident from the data presented in the tables, for initial levels of decompression, the IR index is negative, indicating that the specimen exhibits pressure/stress relaxation. As decompression level is further increased, the IR index becomes less and less negative, and later becomes positive, which indicates the onset of inverse relaxation. The IR index goes on increasing, reaches a maximum, and then starts decreasing. Ultimately, at a particular level of decompression the IR index becomes zero. This behavior of the solid material under compression is similar to the one exhibited by the textile fibers, yarns, and fabrics loaded axially. IR index values depend upon the compression level as well as decompression level.

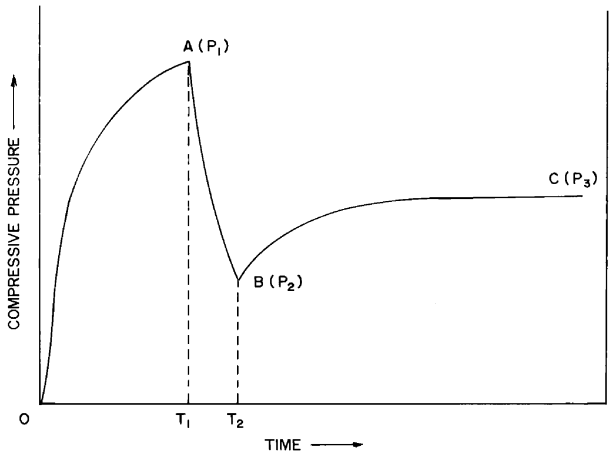

Figure 1 Compressive pressure vs time curve in a typical inverse relaxation experiment.

The study clearly indicates that viscoelastic materials exhibit the phenomenon of inverse relaxation under compressive forces also. Further detailed study is in progress.

REFERENCES

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Table I Inverse Relaxation for Polyurethane Foam at 10% Compression Level

Decompression Level (%)	Actual Compression (%)	Pressure P_1 (k Pa)	Pressure P_2 (k Pa)	Pressure P_3 (k Pa)	IR Index
0.0	10.0	23.52	—	16.46	−30.00
0.4	9.6	23.52	16.46	15.68	−3.32
0.8	9.2	23.52	13.33	14.50	4.98
1.6	8.4	23.52	11.37	12.74	5.82
2.4	7.6	23.52	9.76	11.17	6.00
3.2	6.8	23.52	8.04	9.76	7.31
4.0	6.0	23.52	6.23	8.15	8.16
4.8	5.2	23.52	4.70	6.74	8.67
5.6	4.4	23.52	3.14	5.17	8.63
6.4	3.6	23.52	1.49	3.65	9.18
7.2	2.8	23.52	0.20	2.16	8.33
8.0	2.0	23.52	0.08	0.78	2.98
8.8	1.2	23.52	0.00	0.00	0.00

Table II Inverse Relaxation for Polyurethane Foam at 8% Compression Level

Decompression Level (%)	Actual Compression (%)	Pressure P_1 (k Pa)	Pressure P_2 (k Pa)	Pressure P_3 (k Pa)	IR Index
0.0	8.0	19.80	—	13.32	−32.70
0.4	7.6	19.80	13.68	12.66	−5.15
1.2	6.8	19.80	9.88	10.66	3.94
2.4	5.6	19.80	6.66	8.15	7.53
3.2	4.8	19.80	5.10	6.55	7.32
4.0	4.0	19.80	3.53	5.06	7.73
4.6	3.4	19.80	1.76	3.61	9.34
5.2	2.8	19.80	1.18	2.74	7.88
5.8	2.2	19.80	0.20	1.37	5.91
6.2	1.8	19.80	0.16	0.59	2.18
6.8	1.2	19.80	0.00	0.00	0.00