Vectran Rope Stretch
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Introduction:

The elongation of the vectran ropes supporting the acrylic vessel (AV), as the AV was filled and since filling, has been measured. The elongation or stretch was found to be a function of both load and time under load. The elongation under load was as predicted from measurements by Yale Cordage but the elongation or creep with time was unexpected. For clarity, the slow elongation with time is referred to as creep in this note.

Measurements by Yale Cordage:

Yale Cordage manufactured the support ropes from Vectran fibre or filament supplied by Hoescht Celanese. Each rope was subjected to 10 pretensioning cycles from 0 to 15000 lbs. After the pretensioning cycles the elongation of the rope was measured as a function of load. Their results are tabulated below.

Rope Tension	Load Cell	Rope Stretch	Vert. Defl.
lbs	lbs	%	In.
1000	2000	0.31	1.75
2000	4000	0.37	2.088
3000	6000	0.42	2.371
4000	8000	0.46	2.596
5000	10000	0.5	2.822
10000	20000	0.67	3.782
15000	30000	0.84	4.741

The rope length was 1128.85" and because the support rope is in the shape of a U, the rope tension is 50% of the total load supported by a rope and the vertical deflection (or distance the AV is expected to move) is 50% of the total stretch in the rope.

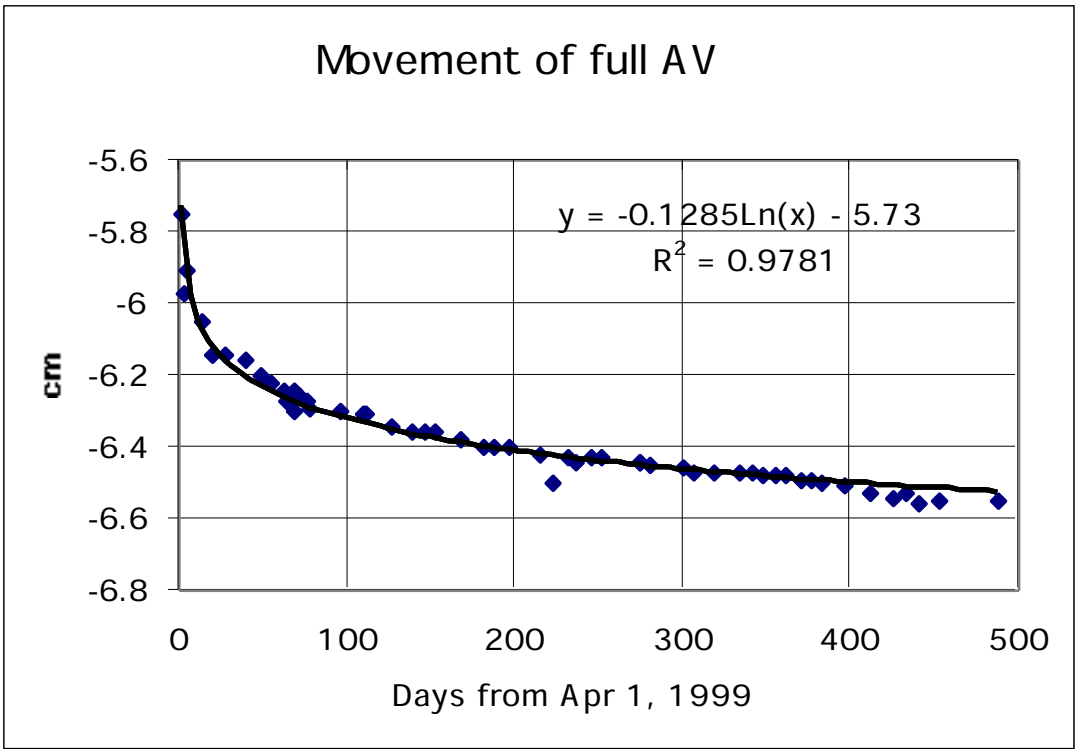
AV equator measurements:

During AV construction four vectran strings were attached to the AV equator at 90 deg intervals. The other ends past through the deck and are attached to extensiometers so that small vertical movements of the vessel relative to the deck can be recorded. These strings enable us to continuously monitor the position of the AV equator and, when compared with similar equipment measuring the position of the AV neck flange, enable us to monitor several of the most probable AV shape changes of concern to the AV designers. In addition these strings enabled us to monitor rope elongation during the filling of the AV and to subsequently monitor rope creep, not expected from the short term measurements by Yale Cordage and not, heretofore, measured by Hoescht Celanese or, to our knowledge, by any other rope manufacture.

The filling of the AV with D2O began in Sept '98 and ended in Apr '99 during that time the total load on the vectran ropes varied from 88000 lbs to 50000 lbs (midway through

the fill) to 230000 lbs at the end of the fill. The load depended on the relative levels of D2O and H2O, which were controlled to minimize pressure differences across the acrylic shell. During the filling the short tem rope elongation as a function of load was consistent with the predictions from the Yale Cordage measurements but in addition a slower elongation component or creep was also observed. This creep was a concern to us because it was not expected and we did not know if it would stop with time.

Since Apr 1999 the AV weight has been constant with each load cell registering about 23000 lbs ± 1000 lbs, the rope tension would therefore be 11500 lbs. From Apr 1999 to Aug 2000 the AV has move down about 0.5 cm, as shown in the figure below where the average of four strings is plotted as a function of time. Fortunately this creep has stopped. The magnitude of the effect is 0.04%.



This creep could be due to the vectran stretching or the braided rope settling into its final position. Since there are no other reports of vectran slowing stretching under load the later explanation is the most likely. Shrinkage of the vectran measuring strings would give a similar result but this explanation is unlikely because the neck of the AV, which is measured by very short strings, has move down by the same function as the equator.