Engineering Property - Hardness

Hardness, as applied to elastomers, is defined as the relative resistance of a surface to indention by an indenter of specified dimension under a specified load. The most commonly used measuring instrument is a durometer. Shown in Figure 1 is a pocket-size instrument. Numerical hardness values are derived from the depth of penetration. The harder the sample, the further it will push back the indenter point and the higher the readings as shown in Figure 2.

On the durometer A scale, 0 is very soft, and 100 is infinitely hard. Values are usually read immediately after firm contact has been established. The hardness range of elastomers is so broad that a single durometer cannot indicate practical measurable differences of hardness. For this reason durometers are available in more than one scale model, (e.g., A and D scale durometers). The A scale durometer is widely used throughout the rubber industry. The durometer D model, which has a stiffer spring and a more pointed indenter, is used to measure the hardness of hard rubbers.

FIGURE 1 POCKET-SIZE DUROMETER, TYPE A

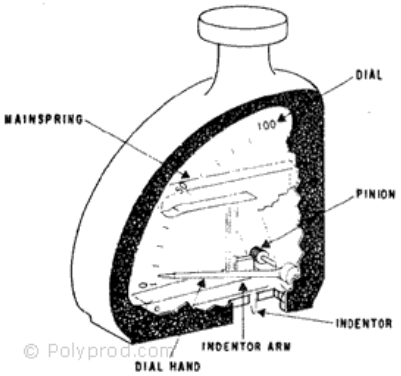

FIGURE 2 SCHEMATIC DRAWING POCKET-SIZE DUROMETER

Mechanical limitations of durometers and the way people use them cause hardness measurements to be inconsistent. It is not uncommon to find a difference of 5 points in individual hardness readings of an elastomer specimen. Table-top durometers can measure hardness more accurately, but they are not as convenient and are not used routinely.

Frequently, hardness is assumed to correlate with stiffness (modulus), but this is not always true. Variations of a few points in hardness can show a marked difference in compression-deflection.

A statistical determination has been made of the relationship between hardness and 100% modulus of Poly-Pro Urethanes measured with durometers on the A and D scales. As expected as shown in Table II, the A scale is more reliable for predicting the modulus of the softer stocks; the D scale should be used with the harder stocks.

The values in Table II are graphically shown below

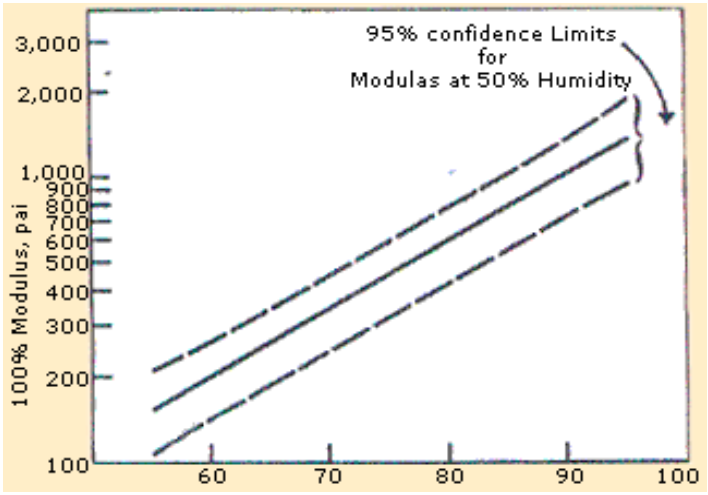

FIGURE 3 HARDNESS – DUROMETER A

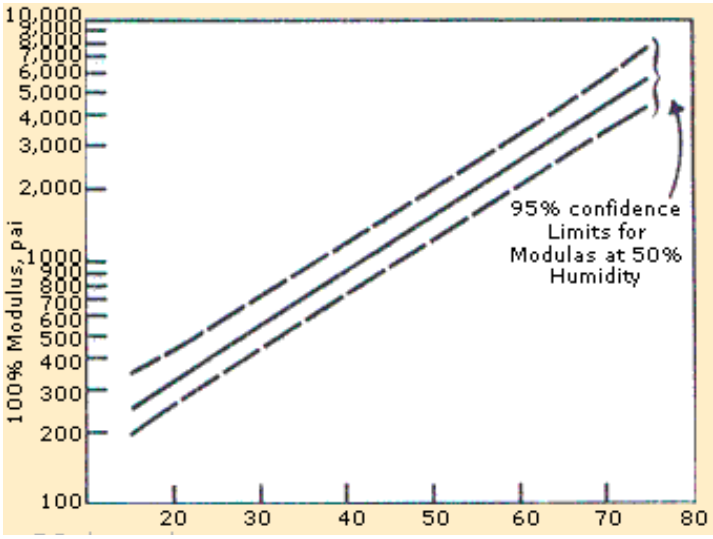

FIGURE 4

Typical hardness values for P.P.C Urethanes are:

PPC Compound Number	Urethane Durometer A	Hardness Durometer D
P80	78-80	-
P90	88-93	40
P95	88-93	40
P560	45-50	5000
P575	-	70-7

Engineering Property - Hardness

Table II

Hardness A	95% Confidence limits	Avg 100% Modulus psi	Hardness D	95% Confidence limits
55	105-205	150	-	-
60	140-265	200	10	175-275
64	180-330	250	14	195-330
68	210-400	300	18	240-400
73	295-530	400	23	315-520
77	365-650	500	27	390-630
80	430-795	600	31	480-760
83	500-910	700	34	560-880
86	580-1060	800	36	630-1000
88	645-1200	900	38	700-1120
90	700-1350	1000	40	760-1250
92	800-1550	1150	43	900-1400
1	1	2000	55	1650-2500
1	1	2500	59	2000-3800
1	1	3000	63	2400-3800
1	1	4000	69	3200-5100
1	1	5000	73	3900-6400

Table III

Durometer A	Durometer D
50	-
60	-
70	18
75	25
80	30
85	35
90	40
95	48

The reliability of predicting modulus from either A or D scale is approximately +33%, for 95% confidence limits. In the low modulus range of less than 500 psi, predictability is 25%.

The A scale should be used with moduli of 500 psi and under. The D scale is more useful for predicting moduli of more than 1000 psi. Either scale may be used for the Intermediate areas as in Table II.

One hundred per cent modulus can be predicted to within +115 at a level of 400 psi, ranging up to +315 at 1150 psi using the A scale; using the D scale predictability ranges from + 100 at 400 psi to + 1200 to 5000 psi.

A linear relationship between durometer A and D does not exist. Approximate equivalent readings for durometer A and durometer D are shown in Table III. Because of differences in indenter tip shape difference between A and D readings can vary widely for different materials.

Hardness above 95 on the A scale should not be specified because the upper accuracy limit of the instrument is being approached. Accuracy at the lower end of the D scale is also limiting and values below 25D are questionable.

Most Urethane compositions lie between durometer 58A and 75D as shown in Figure 5. No other type of rubber offers unique properties over this hardnesses can be made by blending polymers. Softer polymers can be made by incorporation of plasticizers, changing curing agents, or by making cellular products.

Hardness Scale