Engineering Property - Flexing

When subjected to flexing, rubber products frequently fail due to the development and propagation of cracks. The cracks reduce other properties, which in turn reduce the service life of the rubber. Cracks can grow through mechanical means or by oxidative and ozone attack.

ASTM D-430, Method B, is a test designed to produce cracking by bending. The time or numbers of flexes to crack initiation are used as the measure of performance. It employs a DeMattia flexing machine which flexes a 6" x 1" x1/4" specimen having a 0.094" round grove molded transversely in the center of the strip. This machine operates at 300 cycles per minute, See Figure 1.

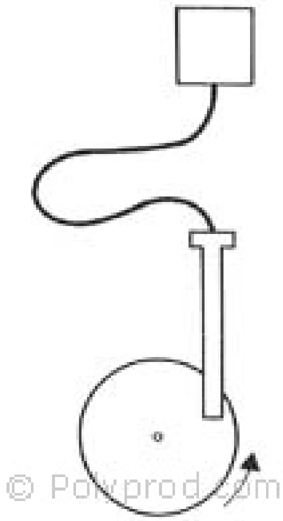

FIGURE 1 DE MATTIA FLEXER

Bends and Straightens Specimen, or Alternately Stretches and Relaxes It.

An adaptation of the bend flex method of ASTM D-430 is ASTM D-813 which requires the deliberate cutting of the bottom of the grooved specimen to initiate crack. The number of flexing cycles needed to attain a specified crack length is then observed.

ASTM D-1052 (Ross Flexer) is another method of determining the resistance of elastomers to cut growth from repeated bending. The equipment is illustrated in Figure 2. The flexed area to the test specimen bends freely over a rod 3/8" In diameter, through an angel of 90°. One end of the test specimen is griped by a holder. The other end is placed between two rollers which permit free bending movement of the test specimen during each cycle. This machine runs at 100 cycles per minute.

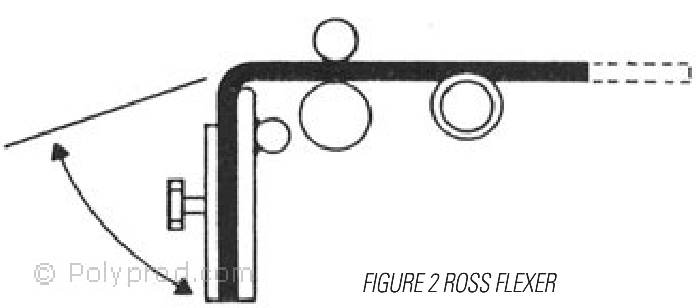

FIGURE 2 ROSS FLEXER

To obtain the ultimate in flex life with urethanes, careful attention to stoichiometry and polymer hardness must be considered. Urethanes may be specially compounded by adjustment of curing agent level to 100-100% theory (see Figures 3,4, and 5 on next page) provide best flex resistance.

Softer vulcanizates like Die-Thane DT-35 urethane rubber with MBCA curing agent have excellent flex life. In the Ross notched test, no cut growth occurred during 420,000 flexes (70 hrs.) at a rate of 100 cycles/minute. The more vigorous DeMattia test, run at 300 cycles/minute, caused failure in 24 hours using notched specimens; but un notched samples ran for 100 hours (1,800,000 flexes) with only slight cracking occurring.

Design of the part to reduce localized concentration of the stress or heat built-up will improve flex life. When an elastomeric part is flexed, very high stresses are developed in thick cross sections. Under repeated flexing, any cut in the surface of the part will grow larger because of the high local stresses concentrated at the cut. As with any elastomer, the rate of cut growth under flexing may be reduced (Figure 6) by decreasing the thickness of the part.

Unlike other elastomers, Die-Thane can be utilized practically in very thin sections because of its exceptional strength and toughness.

Internal Heat Build-Up

As mentioned in the section on resilience, heat build-but in urethane parts, resulting from internal friction under high frequency flexing, exceeds that of many conventional elastomers and is the usual cause of premature failure of urethane parts operating under flexing or high speed rotary motion under load. Because of the low thermal conductivity of urethane elastomers, heat developed by internal friction cannot be readily dissipated. Heat build-up is, therefore, a very important consideration when designing with urethanes. Its adverse effects can be minimized by using thin cross sections from which heat is more easily dissipated. The high strength and load bearing capacity of urethane elastomers makes possible the use of sections which are thin enough to dissipate heat at the same rate at which it is developed so the piece is not harmed.

Engineering Property - Flexing

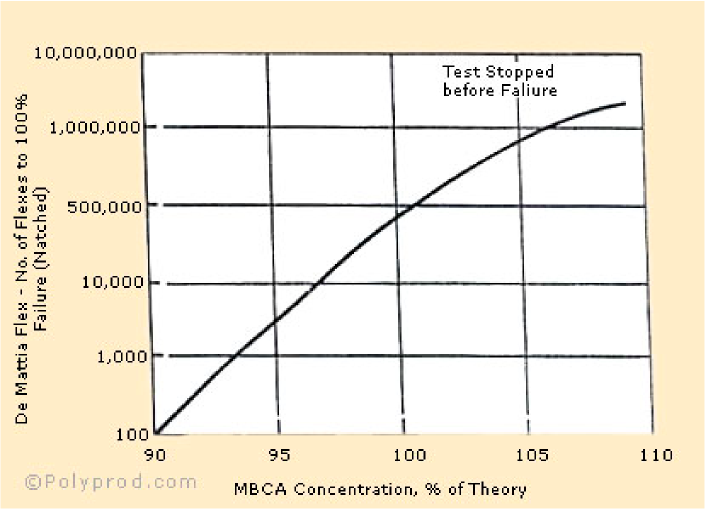

Figure 3 Die-Thane DT-35 Flex Life

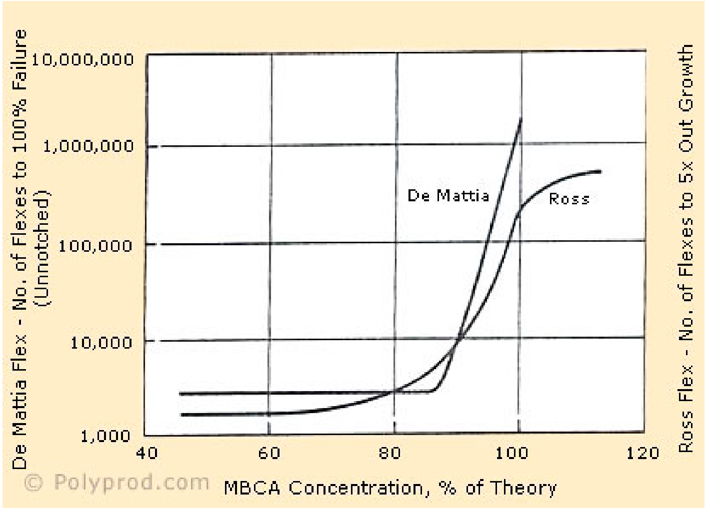

Figure 4 Die-Thane DT-25 Flex Life

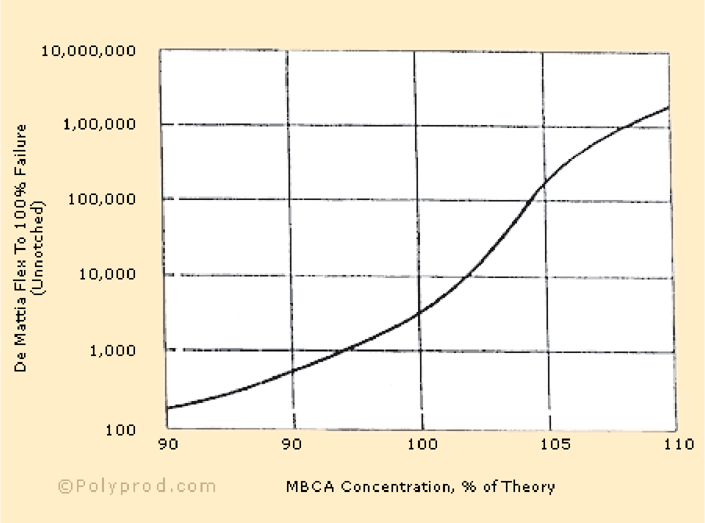

Figure 5 Die-Thane DT-15 Flex Life

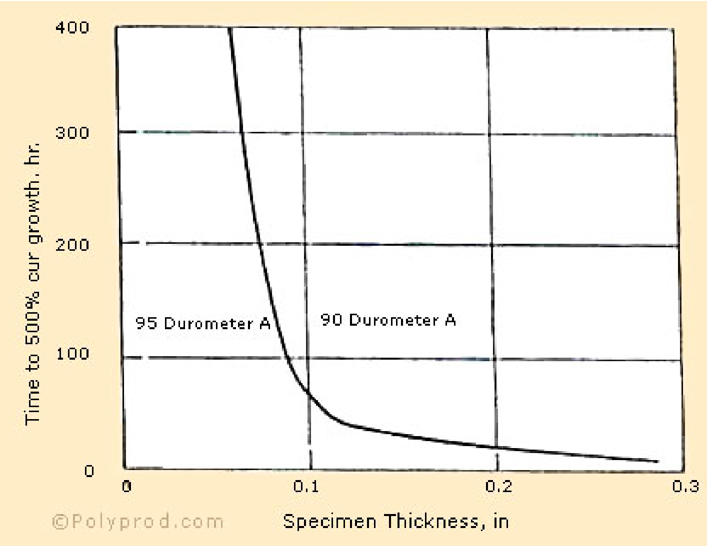

FIGURE 6 THICKNESS EFFECT ON CUT GROWTH

An example in which thinner sections actually increased the service life of a urethane elastomer part is offered by experience with industrial truck wheels made of Die-Thane urethane rubber. Early test wheels were made to the same dimensions normally used with conventional elastomers. In service, abrasion resistance was excellent but many premature failures occurred as a result of internal fracture and reduction in adhesive bond strength at the hub. Both types of failure were traced to excessive heat build up under very high loads. The problem was solved by increasing the hub size and reducing the thickness of elastomer in the tire. This change provided a thinner tire section, which dissipated internal heat more effectively. It also increased the shape factor of the area of over which the load was distributed, thus decreasing the deflection for a given load. With the new design, urethane fork truck wheels are giving outstanding performance.