GLOSSARY OF FLEXIBLE POLYURETHANE FOAM PHYSICAL PROPERTY TERMS

1. **Density** - Density is weight per unit volume, $\frac{\text{weight}}{\text{length x width x height (volume)}}$ and is expressed as lbs/ft^3 (pcf).

   Density is usually measured in grams/cm^3 and multiplied by 62.4 to convert to lbs/ft^3 (pcf).

   Density can be obtained from any sample size. Density is not related to pore size, i.e., coarse pore and fine pore foams can have equal densities.

   Density is not a measure of firmness, stiffness, or load bearing capacity. That is defined by Indentation Force Deflection (IFD) or Compression Force Deflection (CFD).

2. **Indentation Force Deflection (IFD)** - IFD (previously ILD) is one test method to determine load bearing capacity (firmness or stiffness), and is expressed in pounds force per 50 in.^{2} at a given percent deflection of the foam.

   For example: P215-50, FHA grade carpet cushion foam has a target IFD of 50 lbs/50 in^2 at a deflection depth of 25% of the original thickness of the sample after a rest period of one minute, 25%R.

   To obtain the 25%R value, a 50 in.^{2} circular indenter platen is driven into a 15" x 15" x 4" foam sample, stopping when it reaches a deflection of 1", 25% of the 4-inch thickness. The testing device records the force in pounds required to hold this foam indented after one minute. The higher the force reading, the higher the load bearing capacity of the foam. This result can be reported in metric and the sample size can be varied.

   Sag Factor (Modulus) is the ratio of the 65%R IFD to the 25%R IFD values and is expressed in real numbers with one decimal. Sag factor gives an indication of cushioning quality. A high value indicates a resistance to "bottoming out."

   Recovery Ratio is the ratio of 25%R IFD released to 25%R IYD initial when measuring IFD values at 25% deflection, 65% deflection, and then released back to 25% deflection. Recovery ratio is expressed as a percentage.

   Guide Factor is the ratio of 25% IFD to density and is expressed in whole numbers. Guide factor is useful in determining the relative firmness of foams with different densities. It is also used to compare the economy of foams. The higher the guide factor, the more economical the foam because you get a firmer foam with a lower density.

3. **Compression Load Deflection (CLD)** - CLD is also a measure of firmness and is expressed in pounds per square inch (psi), at a given percentage deflection.

   The sample size is 2" x 2" x 1" thick. The entire sample is compressed under the 50 in^2 indenter platen in this test. The procedure is the same as IFD. Record 25%R & 65%R values. It is common practice on foam specifications is to specify only the 25%R-value.

   Both IFD & CFD can be tested at 50%R or any other deflection point based on customer / supplier agreement.

4. **% Compression Set** - % compression set is a measure of the permanent deformation of a foam after it has been compressed between two metal plates for a controlled time period and temperature condition. The standard conditions are 22 hours at 70°C (158°F) The foam is compressed to a thickness given as a percentage of its original thickness, usually 50%. Compression set is expressed as the percentage of its original thickness that remained "set". For example: If a 2" x 2" x 1" sample measured 1.00 inch before compression and 0.95 inch after the test, it is reported to have a compression set value of 5%, i.e., it did not recover 5% of its original thickness.

FOAMEX INNOVATIONS

5. **Tensile Strength** — Tensile strength is a measure of the amount of force required to break a 1/2 square inch area of foam as it is pulled apart. Tensile strength is expressed in pounds per square inch (psi). The tensile sample is die cut to a dumbbell shaped, 6" x l" x 0.5" thick.

6. **Elongation** — Elongation is a measure of the extent to which the foam can be stretched before it breaks and is expressed as a percentage of its original length. Elongation is measured at the same time, as tensile strength is determined; therefore, the sample size is the same.

7. **Tear** — Tear strength is a measure of the force required to continue a tear in foam after a split has been started and is expressed in pounds per linear inch (pli)

   The sample size is 6" x l" x l" thick.

   Tear strength is an important property when the foam will be sewed or stapled in an application.

8. **Permeability** — is the measure of the volume of air per minute that can be pulled through a sample of foam and is expressed in cubic feet per minute.

   The sample size must be at least 4" x 4" to fit over the opening of the Frazier permeability device.

   The thickness varies with the product. When possible, the permeability is tested on the application thickness.

   FOAMEX measures permeability parallel to the foam rise.

9. **Impact Resilience (Ball Rebound)** — is a measure of elasticity, bounce, or springiness of foam and is expressed as a % of return, or % resilience.

   The sample size is 4" x 4" x 2"

   To obtain % resilience a 16.3 gram, 5/8 inch, steel ball is dropped 18 inches onto the foam through a clear plastic tube with every 5% return calibration marked. Three drops are executed and the averages of the three readings are equal to the % of the return of the ball to its original height.

1. **Clickability** — is the rating of a foam's ability to recover from a die cutting operation. Foams are rated as having a good, fair, or poor click property. Click is tested on a one-inch piece of foam by die-cutting a tensile specimen and observing the initial recovery and then the recovery after one minute. What is observed is the sharpness of the edges of the tensile part and the one-inch foam sheet it was cut from. Also, the height recovery after the compression of the die cutter is noted.

11. **Weldability** — is the opposite of clickability. If foam has a poor click rating it is said to weld, i.e., the top and bottom edges of the die cut part stick together.

12. **Thickness** — is the measurement of the distance between the top and bottom surfaces of a sheet of foam and is expressed in mils or inches. For example, 1/8 of an inch equals 0.125 inch or 125 mils; therefore, one inch is equal to 1,000 mils.

    Foam thicknesses are measured or gauged by micrometers. Pin, circular plate, hydraulic micrometers are used for measuring thickness on foam. It is necessary to have as little force placed on the foam surface by the micrometer as possible. It is advisable to place a metal plate underneath the foam sample for a stable base.

Foam is measured in board feet. A board foot of foam is equal to a 12"x12"xl" piece of foam and this is equal to 1/12 of a cubic foot of foam. This is the commonly used measure in the foam industry.

FOAMEX INNOVATIONS

13. **Bond Strength** — is a measure of the force needed to separate two substrates that are laminated together and are expressed in ounces.

    The sample size is 8” x l” x thickness of the laminate.

14. **Steam Autoclave Aging** — is a test treating the foam sample in a steam autoclave and retesting specific physical properties to detect appreciable deterioration of the foam after hot and humid conditions.

    There are two sets of conditions that ASTM D 3574 specifies:

    1. 3 hours at 105 ± 3°C., and
    2. 5 hours at 125 ± 5°C.

    Condition 1 is usually used for polyester foams and condition 2 is for polyether foams.

1. **Dry Heat Aging** — is a test treating the foam sample in an air-circulating oven and retesting specific physical properties to detect appreciable deterioration of the foam in hot but dry conditions. This aging test is performed for 22 hours at 140°+ 1.2°C.

16. **Fatigue** is a measurement of the loss in load bearing capability and is expressed as a percentage load loss.

    Three fatigue tests are:

    1. Static Fatigue: Measure the 25% and 65% IFD values. Deflect to 75% if the original thickness and keep deflected for 22 hours. Relax the foam for 30 minutes. Then retest IFD at 25% and 65% deflection points and calculate force loss.

    2. Roller Shear Fatigue: A stainless steel roller is used to dynamically fatigue a sample of foam for 8,000 or 20,000 cycles in 5 hours or 12 hours respectively. IFD values are also compared before and after fatiguing and a percent loss of load bearing capability is calculated.

    3. Constant Force Pounding Fatigue: A flat horizontal indenter foot is used to fatigue a foam sample for 8,000 cycles in 2 hours, or 80,000 cycles in 19 hours.

    IFD values at 40% deflection are compared before and after fatiguing and the percent load loss is calculated.