FOAM SPECIFICATIONS EXPLAINED

A standard Ultralon Products (NZ) Limited Specification Sheet lists the following physical properties for our foams:

- Density
- Hardness
- Tensile Strength
- Tear Strength
- Elongation @ Break
- Compression Set
- Compressive Strength
- Water Absorption
- Thermal Conductivity

The following information has been collated as a guide to what these Specifications mean, and how they are derived.

DISCLAIMER:
Because we have no control over the many different conditions under which this information and our products may be used, we do not guarantee the suitability of our products in any given situation. Users of our products should make their own tests to determine the suitability of each product for their particular purposes. The products sold are without warranty, either express or implied, and the buyer assumes all responsibility for the loss or damage arising from the handling and use of our products, whether done in accordance with directions or not.

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Specifications for EVA (Ethylene Vinyl Acetate) FOAMS

		Low- Density					High- Density							
Property - test method	**Units**	**EVA30**	**EVA45**	**EVA60**	**EVA75**	**EVA90**	**EVA105**	**EVA120**	**EVA150**	**EVA190**	**EVA220**	**EVA260**	**EVA350**	**EVA400**
Density JIS K6767-1976	Kg/m3	28-33	42-48	55-65	70-80	85-90	100-115	115-130	140-155	180-200	210-235	250-280	330-370	400+
Sheet size	mm	2000x 1000	2000x 1000	2000x 1000	1900x 940	1840x 920	1300x 1150	1250x 1110	1170x 1050	1140x 1020	1080x 970	1020x 900	920x 820	1150x 850
Thickness +/- 0.5mm	mm	3-40	3-40	3-36	3-32	3-30	3-30	3-30	3-33	3-38	3-34	3-33	3-30	3-22
Hardness* (JIS C)	Degrees	15-20	20-25	25-30	30-35	35-40	35-45	40-50	45-55	50-58	58-65	65-75	75-85	75+
Tensile strength JIS K6767-1976	KPa	450	700	800	900	1000	1200	1300	1400	1800	2000	2300	3000	----------
Tear strength JIS K6767-1976	Kn/m	2.50	4.00	4.50	4.50	5.00	5.00	6.00	7.00	10.00	11.0	12.0	18.0	----------
Elongation @ break JIS K6767-1976	%	200-250	250-300	250-300	250-300	250-300	120-170	120-170	120-170	150-200	150-200	170-220	250-300	----------
Compression set** JIS K6767-1976	%	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Compressive strength(25%) ASTM D 3575-91	KPa	30	40	60	70	75	130	160	195	250	310	405	950	1070
Water absorption JIS K6767-1976	g/cm3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Thermal conductivity ASTM C 518-76	W/m. C	0.040	0.042	0.043	0.044	0.045	0.046	0.047	0.050	0.052	0.055	0.058	0.064	---------
Service temperature	C	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/+60	-70/+60	-70/+60	-70/+60	-70/+60	-70/+60

- *Hardness is read after 2 seconds
- ** Compression set @ 25% deflection – 22 hrs @23 C + 24 hrs recovery
- This data represents typical laboratory results only, and does not represent a guarantee of performance in any application.
- Tolerances on sheet sizes: Low-density foams +/- 0.5%, High-density foams +/- 2%

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Specifications for PE (Polyethylene) Foams

		Low- Density					High- Density			
Property - test method	**Units**	**PE30**	**PE45**	**PE60**	**PE75**	**PE90**	**PE120**	**PE140**	**PE180**	**PE250**
Density JIS K6767-1976	Kg/m3	28-33	42-48	55-65	70-80	85-90	110-130	130-150	170-190	230-290
Sheet size	mm	2000x 1000	2000x 1000	2000x 1000	1900x 940	1840x 920	1250x 1110	1150x 1050	1120x 1020	1000x 890
Thickness +/- 0.5mm	mm	3-40	3-40	3-36	3-32	3-30	3-43	3-40	3-37	3-33
Hardness* (JIS C)	Degrees	22-27	27-32	35-40	45-50	50-55	55-65	60-70	65-75	70-80
Tensile strength JIS K6767-1976	KPa	350	500	600	700	900	1400	1500	1800	2000
Tear strength JIS K6767-1976	Kn/m	2.50	4.00	4.50	5.00	6.00	7.70	9.00	10.50	12.0
Elongation @ break JIS K6767-1976	%	150-200	150-200	150-200	120-170	120-170	140-190	140-190	140-190	120-170
Compression set** JIS K6767-1976	%	<5	<5	<5	<5	<5	<5	<5	<5	<5
Compressive strength(25%) ASTM D 3575-91	KPa	45	60	110	120	130	210	400	500	
Water absorption JIS K6767-1976	g/cm3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Thermal conductivity ASTM C 518-76	W/m. C	0.040	0.042	0.043	0.044	0.045	0.047	0.050	0.058	0.059
Service temperature	C	-70/ +70	-70/ +70	-70/ +70	-70/ +70	-70/ +70	-70/ +70	-70/ +70	-70/ +70	-70/+70

- *Hardness is read after 2 seconds
- ** Compression set @ 25% deflection – 22 hrs @23 C + 24 hrs recovery
- This data represents typical laboratory results only, and does not represent a guarantee of performance in any application.
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Specifications for Ultralon Specialty Foams

		Buoyancy	Performance Foam			Flexalon Foam			Ultrastop Foam			
Property - test method	**Units**		**Soft**	**Medium**	**Firm**	**45kg**	**70kg**	**90kg**	**150kg**	**190kg**	**260kg**	**300kg**
Density JIS K6767-1976	Kg/m3	42-48	28-34	42-49	63-70	42-48	65-75	85-95	140-160	180-200	250-270	290-310
Sheet size	mm	2000x 1000	2000x 1000	2000x 1000	2000x 1000	2000x 1000	2000x 1000	1950x 950	1150x 1050	1080x 980	950x 860	900x 800
Thickness +/- 0.5mm	mm	3-40	3-40	3-40	3-36	3-40	3-40	3-32	3-25	3-26	3-28	3-26
Hardness* (JIS C)	Degrees	15-20	19-24	23-30	31-39	12	16	21	25-30	28-33	35-40	40-45
Tensile strength JIS K6767-1976	KPa	400	402	605	703	733	1014	1100	500	570	830	1040
Tear strength JIS K6767-1976	Kn/m	2.5	2.5	4.0	4.5	3.3	4.4	5.0	3.0	4.0	5.0	5.0
Elongation @ break JIS K6767-1976	%	250-300	165-220	180-240	190-250	260-300	240-280	250-300	250-280	300-320	320-340	320-340
Compression set** JIS K6767-1976	%	<5	<5	<5	<5	<5	<5	<5	13	12	9	8
Compressive strength(25%) ASTM D 3575-91	KPa	25-30	40	53	92	45	55	60	48	52	83	115
Water absorption JIS K6767-1976	g/cm3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Thermal conductivity ASTM C 518-76	W/m. C	0.04	0.040	0.042	0.043	0.044	0.046	0.047	0.044	0.046	0.047	0.048
Service temperature	C	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/ +60	-70/+60	-70/+60	-70/+60	-70/+60

- *Hardness is read after 2 seconds
- ** Compression set @ 25% deflection – 22 hrs @23 C + 24 hrs recovery
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- Tolerances on sheet sizes: Low-density foams +/- 0.5%, High-density foams +/- 2%

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DENSITY

Unit of measure	kg/m^3
Test method	JIS K6767-1976

Density is mass *m* per unit volume *V*. For the common case of a homogeneous substance, it is expressed as:

$$\rho = \frac{m}{V}$$

where, in SI units:

ρ (rho) is the density of the substance, measured in kg/m^3

m is the mass of the substance, measured in *kg*

V is the volume of the substance, measured in m^3

Example

In the case of a 40mm thick sheet of PE30 @ 2m x 1m, we have the following:

Using a set of scales, the sheet weighs 2.4kg.

Measuring the sheet we get a volume of 2m x 1m x 0.040m = $0.08m^3$

From $\rho = \frac{m}{V}$, we get Density = $2.4kg/0.08m^3$ = $30kg/m^3$

Alternative units

An alternative unit that is commonly used to measure density is lb/ft^3.

The relationship between that and kg/m^3 is 1 lb/ft^3 = 16 kg/m^3.

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HARDNESS

Unit of measure	JIS C - degrees
Test method	JIS K6767-1976

The instrument we use to measure "hardness" in our foams is an Asker Hardness Tester, Type 'C' (JIS 'C'). This durometer has a ball-bearing probe that is pressed against the material, and is more suitable for measuring foams than the traditional Shore 'A' hardness gauge, which is used predominantly in the rubber industry. The Shore 'A' gauge uses a sprung-loaded pin, which has the tendency to puncture the foam, thereby giving a false reading. The ball-bearing of the JIS 'C' gauge spreads the load and allows deflection without puncturing the foam.

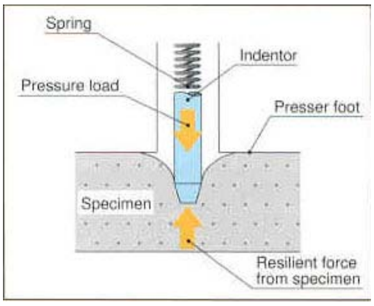
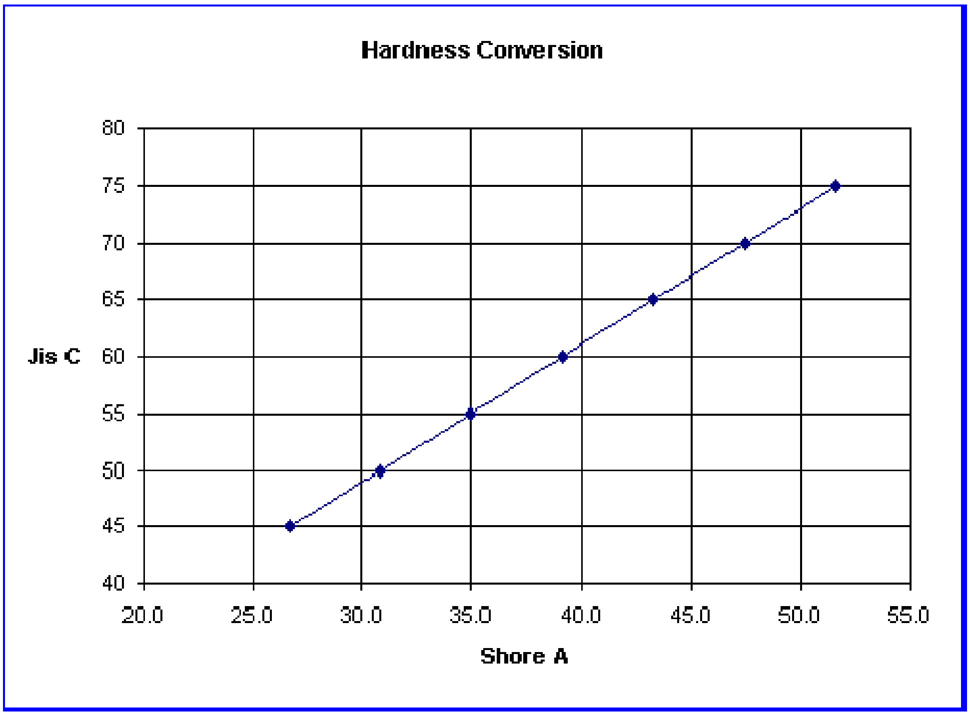


diagram of a typical Shore 'A' gauge

Hardness Conversion Guide



Jis C	45	50	55	60	65	70	75
Shore A	26.7	30.8	35.0	39.2	43.3	47.5	51.7

Conversion

Shore 'A' to JIS 'C' — (X° Shore 'A' x 1.2) + 13 = Y° JIS 'C'

Eg. — (35° Shore 'A' x 1.2) + 13 = 55° JIS 'C'

JIS 'C' to Shore 'A' — (W° JIS 'C' – 13) / 1.2 = Z° Shore 'A'

Eg. — (65° JIS 'C' – 13) / 1.2 = 43° Shore 'A'

Temperature

Because temperature has an effect on hardness, these figures are standardised at 20 degrees Celsius.

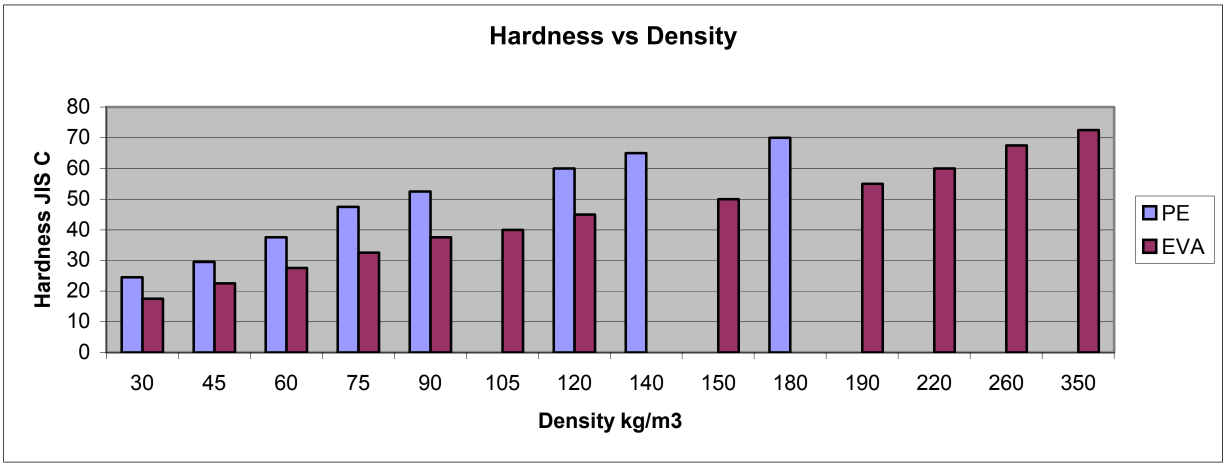
For a hardness measured at temperatures other than the standard 20 degrees, an approximate guide is that for a decrease of 1.5 degrees Celsius, the hardness will increase by 1 degree JIS C.

Other

Hardness and density are not necessarily related. It is possible to compare two foams of the same density, but because they have different resin bases, or are made using different manufacturing methods, the hardness may be different. An example of this is our PE120, which has a hardness range of 55-65 JIS C, compared to our EVA120, which has a hardness range of only 40-50 JIS C. As a general rule however, for the same group of foams produced under the same manufacturing method, as the density increases, so does the hardness.

In particular, because our high-density foams (105kg/m^3+) are made in the same mould sizes, as the density increases so does the hardness, but the sheet size reduces. Eg.

Material	**Density**	**Hardness - JIS C**	**Sheet size - mm**
EVA120	120kg/m^3	40-50	1250 x 1110
EVA220	220kg/m^3	55-65	1070 x 950
EVA260	260kg/m^3	60-75	1000 x 890
EVA350	350kg/m^3	65-80	920 x 820



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TENSILE STRENGTH

Unit of measure	kPa
Test method	JIS K6767-1976

Tensile strength σ_{UTS}, or S_U measures the force required to pull a piece of foam to the point where it breaks.

Tensile strength is measured in units of force per unit area. In the SI system, the units are newtons per square metre (N/m^2) or pascals (Pa), with prefixes as appropriate. The non-metric units are pounds-force per square inch (lbf/in^2 or PSI).

The calculation for Tensile Strength is done by stretching a dumbbell shaped piece of foam of a particular shape, and measuring the maximum force applied until it breaks.

Calculation of *Tensile Strength (T),*

$$T=F/(Wt)$$

Where, F = maximum load until test piece breaks (N)
W = width of test piece (m)
t = thickness of test piece

For example, calculate the Tensile Strength of EVA45:

Using our testing equipment we have a piece of foam that is 10mm thick and 10mm wide, and requires a force of 70N to break it.

From above, T=F/(Wt)

Where, F = 70N
W = 0.01m
t = 0.01m

therefore $T = 70/(0.01 \times 0.01)$
$= 700kPa$

Thus, the Tensile Strength of EVA45 is 700kPa.

TEAR STRENGTH

Unit of measure	Kn/m
Test method	JIS K6767-1976

Tear Strength is determined by applying a tensile force to a specially shaped piece of foam with a 90 degree notch in it, and measuring the maximum load at the time of break.

The high level of cross-linking in Ultralon foams (70-80%) makes them more tear-resistant than many others. This cross-linking means that the polymer chains are formed together much like a net, so the foam is very strong in both directions. Due to the method of manufacture, some other foams are stronger in one direction than the other, but this is not the case with Ultralon foams, which have much greater uniform strength, a fine cell structure, and consistent physical properties.

ELONGATION @ BREAK

Unit of measure	%
Test method	JIS K6767-1976

Elongation @ Break is the elongation of the foam recorded at the moment of rupture of the specimen, often expressed as a percentage of the original length. It corresponds to the breaking or maximum load. In layman's terms it is the amount the foam can stretch before it snaps. A "brittle" foam will have a lower figure than a foam that is more like warm chewing gum.

This test is done in conjunction with the Tensile Strength test, using the same dumbbell shaped piece of foam. The ends are pulled apart, and the amount of stretch is measured at the time of breaking.

Calculation of *Elongation @ Break (E),*

$$E = (l_1 - l_0) / l_0 \times 100$$

For example, calculate the Elongation @ Break of EVA45:

Using our dumbbell shaped test piece we measure a length of 0.040m prior to testing and mark this on the sample, thus giving us $l_0 = 0.040m$.

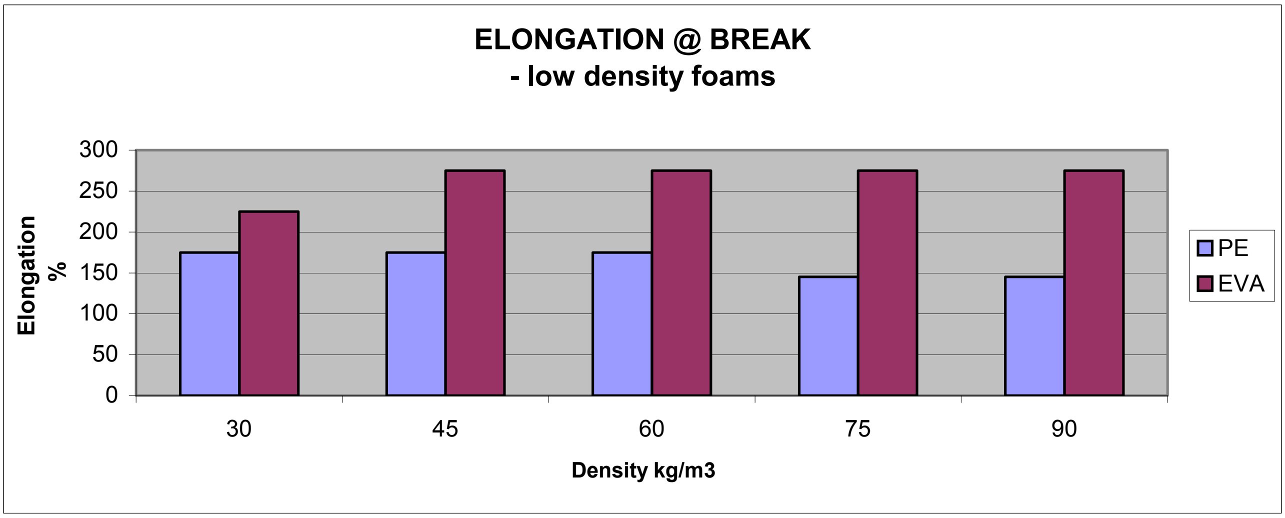
The Tensile Strength test is then performed, and the sample length had stretched to 0.150m at the time of breaking, thus giving $l_1 = 0.150m$.

From above, $E = (l_1 - l_0) / l_0 \times 100$

Where, $l_0 = 0.040m$
$l_1 = 0.150m$

Therefore $E = (0.150 - 0.040) / 0.040 \times 100$
$= 275\%$

Thus, the Elongation @ Break of EVA45 is 275%.



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COMPRESSION SET

Unit of measure	%
Test method	JIS K6767-1976

Compression set testing is used to determine the ability of foam materials to maintain elastic properties after prolonged compressive stress. The test measures the somewhat permanent deformation of the specimen after it has been exposed to compressive stress for a set time period. This test is particularly useful for applications in which foams would be in a constant pressure/release state. A small value indicates that the foam has a strong ability to recover when compressed for a long period of time.

A test piece is subjected to compressive strain corresponding to 25% of the thickness, for 24 hours. Afterwards, the test piece is kept for a further 24 hours at standard conditions, and the thickness is measured again. The compression set rate C_s (%) is indicated by the following equation:

$$Cs = \frac{t_0 - t_2}{t_0 - t_1} \times 100$$

where t_0 = prior thickness of a test piece (m)
t_1 = spacer thickness (m)
t_2 = thickness (m) of the test piece 24hrs after removal

Standard Ultralon foams have Compression Set figures of <5%, making them ideal for orthotic and footwear applications.

COMPRESSIVE STRENGTH (25%)

Unit of measure	KPa
Test method	ASTM D 3575-91

The Compressive Strength figure is the amount of force required to produce a 25% compression in the foam.

It is calculated as follows, using foam at least 25mm thick:

CD = F/A

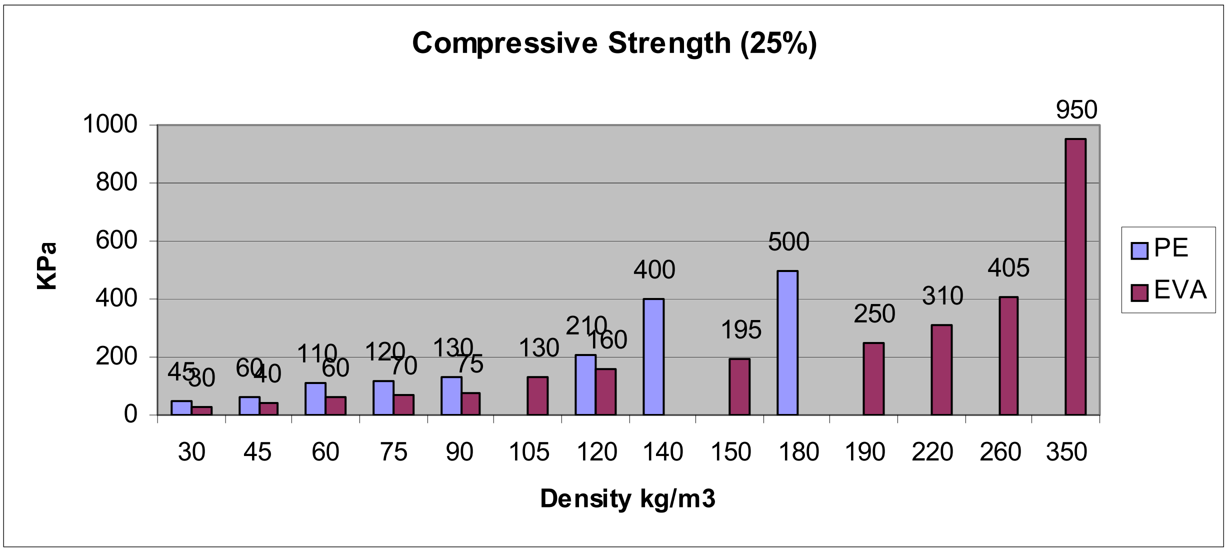
Where: *CD = compression deflection force, per unit area of specimen.*
F = force required to compress the specimen 25%.
A = specimen compression contact area.

For example, using EVA45 at 100mm x 100mm x 25mm, we find the force required to compress it by 25% is 400N, thus we have:

CD = F/A
And, F = 400N
A = 0.010m^2

Therefore, CD = 400N/0.01m^2
= 40Kpa

As a general rule, we would not recommend compressing Ultralon foam beyond 30% compression. If a required compression is around this figure, we would suggest you discuss the application with an Ultralon Products Technical Representative, or if possible, test the foam for suitability in the application.



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WATER ABSORPTION

Unit of measure	g/cm^3
Test method	JIS K6767-1976

Ultralon foams are closed-cell, so generally don't absorb water unless they are crushed beyond their compressive limit. The amount of water absorbed is $0.002 g/cm^3$, which is negligible. This figure was obtained by immersing the foam in water for 24hrs, and then calculating the water absorbed over this time by determining the change in mass of the foam.

Ultralon foams are used in applications such as lifejackets, floatation pontoons on boats, and marine fenders & cushions, where their strength and flotation properties are critical.

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THERMAL CONDUCTIVITY

Unit of measure	W/m.°C
Test method	ASTM C 518-76

Conduction takes place when a temperature gradient exists in a solid (or stationary fluid) medium. Energy is transferred from the more energetic to the less energetic molecules when neighboring molecules collide. Conductive heat flow occurs in the direction of decreasing temperature because higher temperature is associated with higher molecular energy.

The equation used to express heat transfer by conduction is known as Fourier's Law and is expressed as:

$$q = k\,A\,dT / s$$

where

q = heat transferred per unit time (W, Btu/hr)

A = heat transfer area (m^2, ft^2)

k = ***thermal conductivity of the material*** *(W/m.K or W/m.^{o}C, Btu/(hr ^{o}F ft^2/ft))*

dT = Temperature difference across the material (K or ^{o}C, ^{o}F)

s = material thickness (m, ft)

Example

An example of this could be, wanting to know the amount of heat transferred through a foam insulation panel. If the panel is PE30 (k=0.040*W/m.^{o}C*) and measures 2800mm x 1200mm x 50mm, with refrigerated goods @ -20°C on one side of the panel and an air temperature of 20°C on the other side, then we have the following:

$$q = k\,A\,dT / s$$
$$= 0.040 \times (2.8 \times 1.2) \times (20 - {}^{-}20) / 0.050$$
$$= 107.52W$$

The lower the figure for Thermal Conductivity, the better the material is at insulating.

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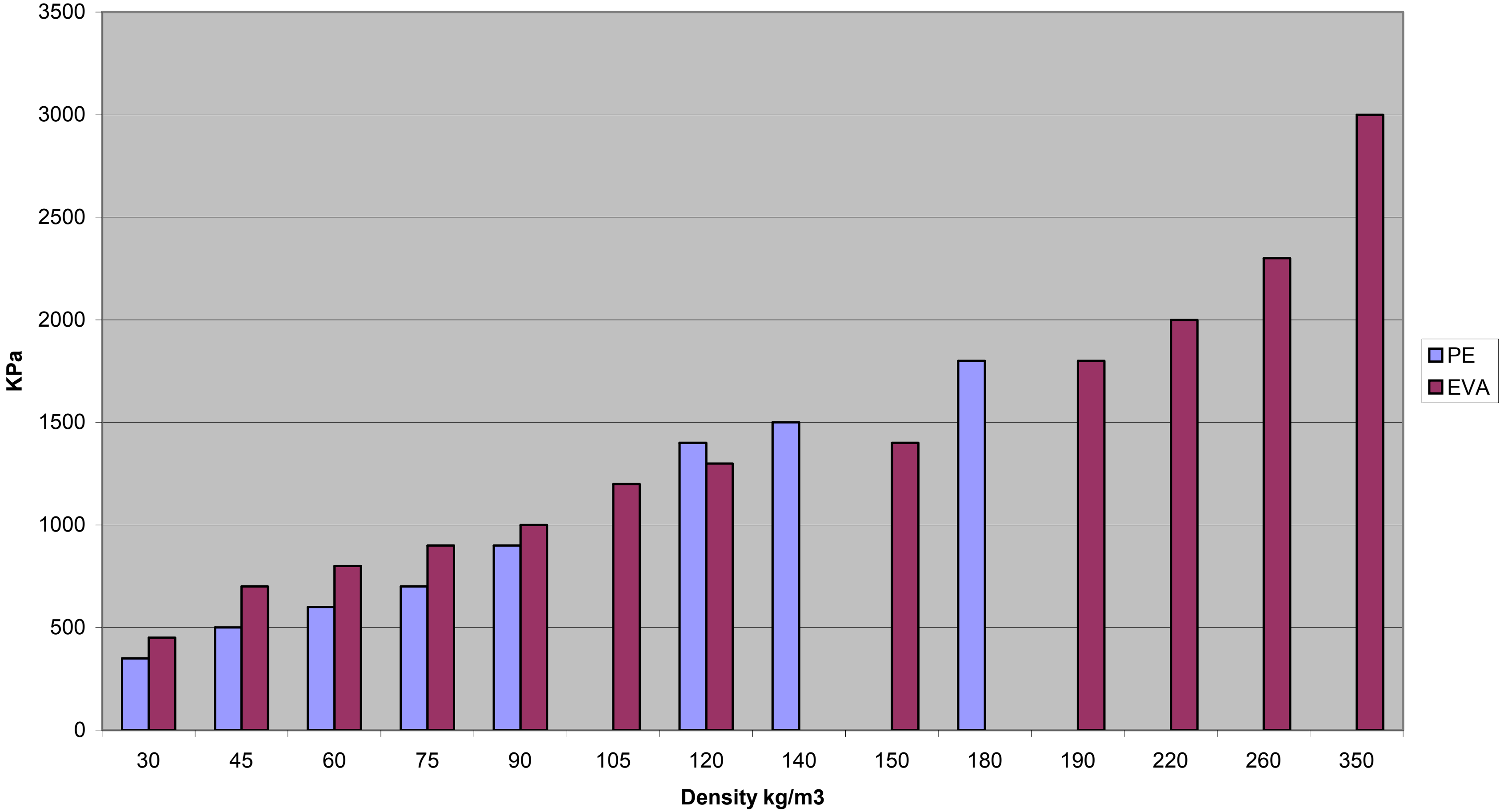
Tensile Strength



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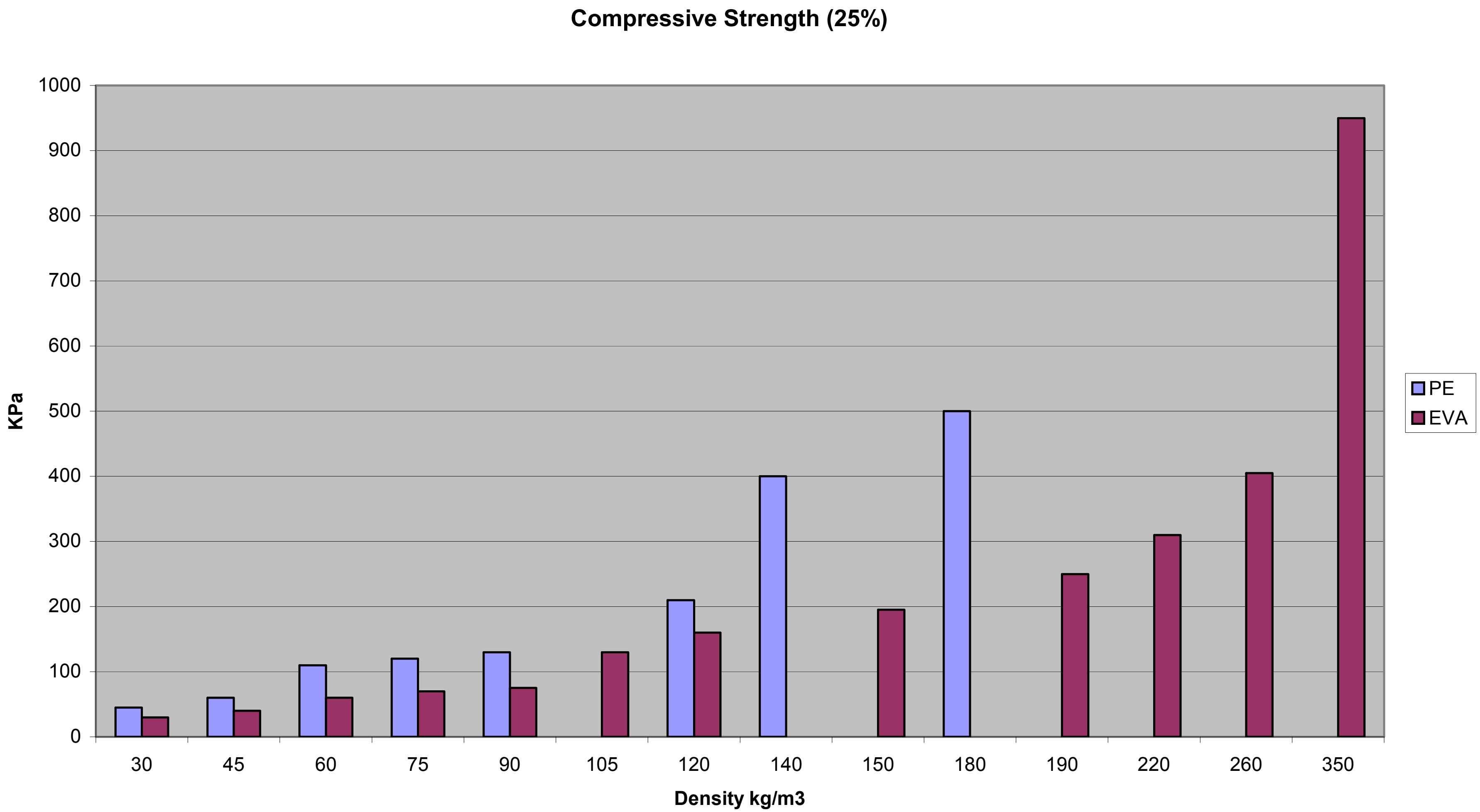

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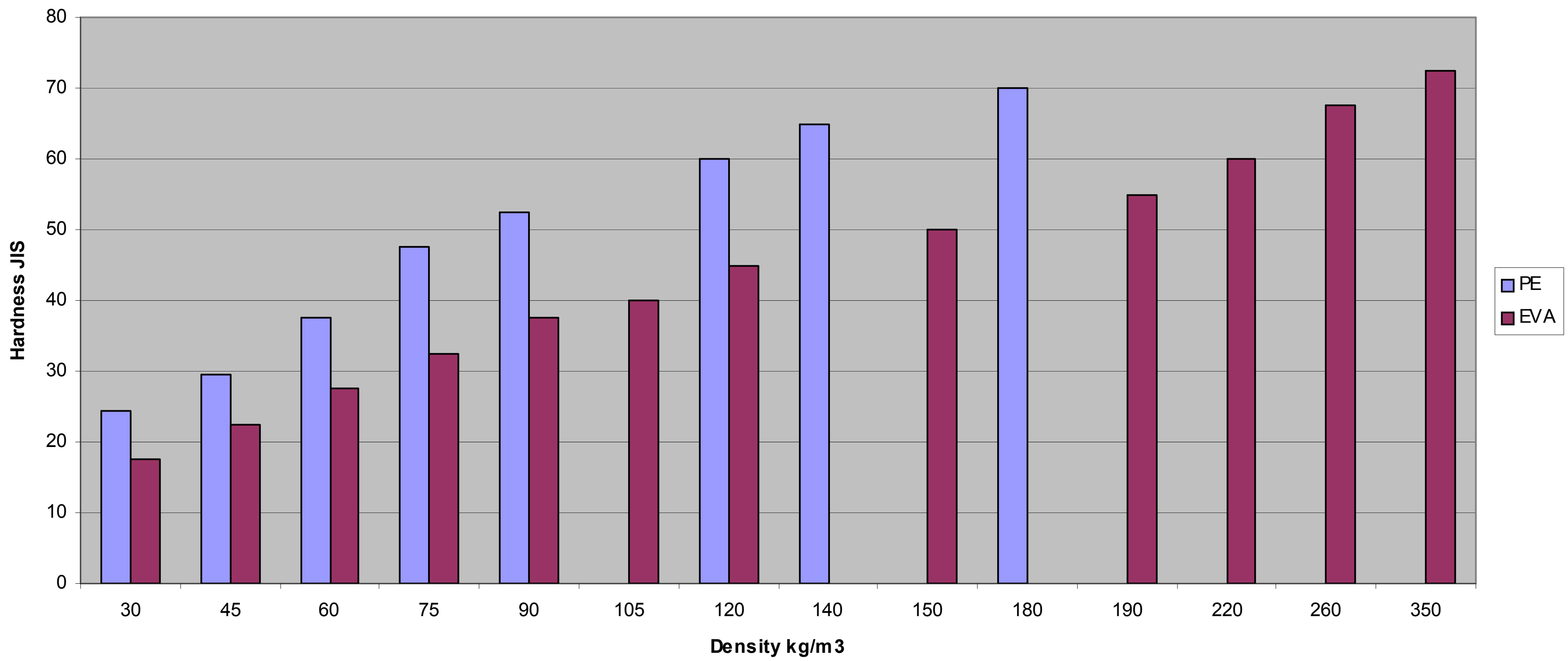
Hardness vs Density



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