

## Why choose SILON TA 1117 HD for oil and gas applications?

TA 1117 HD is one of the most appropriate PEX-b material grades for oil and gas applications because of its unique combination of relatively high density and tensile strength for PEX and a high degree of cross-linking. TA 1117 HD, having been engineered for use in applications in the oil and gas sector, may not be the optimum product for use in other applications because of some of the very properties that make it the best product for oil and gas use.

### Cross-linking and Chemical Resistance:

The degree of cross-linking or gel content (these terms mean the same thing) is measured by grinding a sample of cross-linked PEX and performing an extraction with boiling xylene to dissolve out all un-cross-linked polyethylene and soluble additives. Boiling xylene is such an aggressive solvent that it will dissolve even the best grades of HDPE almost immediately when immersed.

Understanding how gel content is measured, the higher the gel content the more chemically resistant the PEX. The average gel content of cross-linked TA 1117 HD when measured during regular quality control testing is 74.6%. This is not the maximum, as the ultimate degree of cross-linking can approach 77% as the product reaches complete cure. In contrast Silon TA 1108 HD has a routine gel content of 71.5% with an ultimate gel content of 74% and Padanaplast Pexidan L/T pipe grade material has a gel content of 68% with an ultimate gel content of over 70% (\*).

### Elevated Temperature Performance:

These differences may appear small however differences in gel content will result in significant differences in performance under extreme conditions. Hot set testing demonstrates the effect gel content on PEX under such an extreme condition. In this test cross-linked PEX tensile specimens are heated to 392°F (200°C) with a constant tensile load and the elongation is measured. The average hot set elongation of cross-linked TA 1117 HD is 19%, the average hot set elongation of the TA 1108 HD is 25%, and the hot set elongation of the Pexidan L/T is about 30% (\*).

Hot set tests give a clear indication of the performance difference at elevated temperatures, since these tests are carried out at a temperature well above the point when the PEX becomes completely amorphous and a very much rubberlike material. In this amorphous state the hot set elongation properties is related to the abrasion resistance behaviour of the material.

## Swell and Abrasion Resistance:

It is well known that the degree of swelling of PEX or any plastic exposed to a solvent is related to the degree of cross-linking (†). Abrasion resistance also improves with increased cross-linking. What this means to an oil and gas pipe application user of PEX, is that when exposed to an aggressive fluid such as crude oil at elevated temperatures, the low gel content pipes will swell more and suffer more abrasion damage. Swelling of a plastic liner inside a steel pipe will result in the effective inside diameter of the pipe decreasing which may amplify abrasion as flow velocities are forced higher.

	Maximum Gel Content (%)	Hot Set Elongation (%)	Specific Gravity	Tensile Yield Strength (psi)
TA 1117 HD	77	19	0.947	3200
TA 1108 HD	74	25	0.944	2850
Pexidan L/T	70	30	0.946	2900

(\*) Data regarding Padanaplast Pexidan L/T is taken from the Panadanplast Technical Data Sheet for the product and confirmed by testing at Silon Compounds Ltd. Data for TA 1108 HD and TA 1117 HD is an average of production quality control results measured at Silon Compounds Ltd.

(†) ASTM D2765 describes methods of determining gel content as well as a method of determining swell ratio.

## Tensile Yield Strength and Density:

The specific gravity and tensile strength properties of HDPE and PEX are important considerations as well, though they should be considered along with the degree of cross-linking. The specific gravity of a polymer gives an indication of the crystallinity of the polymer. Typically the more crystalline a polymer is, the higher its tensile strength and tensile modulus.

Tensile yield strength determines the burst strength of a pipe. Silon TA 1117 HD has better tensile strength than Padanaplast Pexidan L/T, having very nearly the same specific gravities of 0.947 and 0.946(\*), and tensile yield strengths of 3200psi (21.9MPa) and 2900 psi (20MPa)(\*) respectively. This is only at room temperature. Tensile properties of plastics are related to the temperature making cross-linking necessary. As the temperature of the plastic rises the

crystalline regions of the polymer matrix begin to dissolve and the tensile properties decline. At this point the cross-links become much more important.

The consensus is that cross-linking of PEX takes predominantly takes place in the amorphous regions of the polymer matrix. In this way cross-linking improves the materials creep and heat resistance. What sets TA 1117 HD apart from other grades of PEX is that it has a high degree of cross-linking while still maintaining a high specific gravity. It is difficult to obtain a high degree of cross-linking while maintaining a higher specific gravity in PEX. Normally there is a performance trade off between these two properties. TA 1117 HD however is a material with little compromise between density and cross-linking.

### **Adhesion Properties:**

TA 1117 HD is expected to have superior adhesion properties. This is because potable water application products have a greater need to be aesthetically appealing (shiny) when converted into tubing. The aesthetics of TA 1117 HD are not as great a concern, so as a result surface finish is rougher, which in turn results in better performance of composite pipes where bonding between the PEX and fibre reinforced epoxy is desired.

### **Conclusion:**

There are many good materials in the market when they are used for the applications that they were engineered for. TA 1117 HD is engineered for oil and gas applications while TA 1108 HD and Pexidan L/T are engineered for potable water tubing applications. They have differing high melt flow rates and are easily processed into the products they are designed for. Because TA 1117 HD may be exposed to higher maximum temperatures there is more need for high gel content. TA 1108 and Pexidan do not require the same abrasion and solvent resistance that TA 1117 HD has. TA 1117 HD makes superior large diameter pipes while these other materials are designed for glossier thin walled tubing products.

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