Connections
ICO EUROPE

February 2007

Inside this issue:

Our feature article this month talks about how PE rotomoulded tanks behave under long term stress. We discuss subjects such as creep, design and test methodology.

ICO Europe – strong results this year and looking for expansion

Derek Bristow – President ICO Europe – extends his warm wishes to all customers and business partners for 2007. The ICO share value reflects the solid trading results for ICO's global operations.

ICO tank grade review

ICO Europe has a wide range of resins used in tanks, each one is supplied as a high quality powder in natural, black or colours. Here is a brief summary of the major grades.

ICORENE® 3940 – our highly popular easy to use high quality UV8 0.939g/cc grade
ICORENE® 1339 – our ultra stiff 0.943 density grade retains great stiffness and improved creep performance. Useful for down-gauging wall thickness.
ICORENE® 1613 – a well balanced 0.938 density powder with great flow and ESCR
ICORENE® 1741 – super tough 0.940 density grade for tanks that need extra impact resistance and superior moulding properties
ICORENE® 1502 – X link PE with a stiffness of a 0.940 linear PE but offers much greater ESCR, flex fatigue resistance and fire – melting properties. Now with improved moulding window with lower odor.

Quote: ICO C2.1 for more information

New tank colours for Europe

ICO Europe is introducing a new range of colours specifically designed and tested for use in large or small outdoor water tanks. These materials feature the following unique advantages: full opacity at 4mm thickness to eliminate light and therefore algae growth, UV15 long term protection to sunlight damage, food approved colouration and all this with full retention of physical properties. The first colours are available in stock (from Italy) as a powder in our famous high quality ICORENE 3940 grade. Available in other grades such as our ICORENE 1339 tank grade -ICO will make to order.

Quote: ICO C2.2 for colour range

Glow in the dark released in Europe

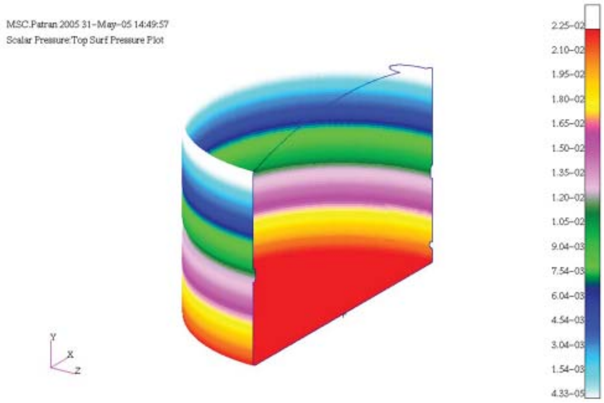
Testing of the highly successful glow in the dark grade has begun in Europe. Customers have identified some novel applications in addition to the more typical uses in buoys, floats, docks, markers, posts and road barriers. The ICO EU grade is known as ICORENE X1902, glow time (pale green) is up to 12 hours. Quote: ICO C2.3 for more information

New ICO translucent polymers

In the Washington DC ARM show- Nov 2006 ICO Polymers announced the release of a new line of translucent polymers. The first grade ref for Europe is ICORENE PPT040/RM. Initially these were designed as replacements for difficult to use PC polymers in applications such as non clear lighting fixtures. They are now being used in rotomoulded furniture and point of sale display products. Quote: ICO C2.4 for more information

PE tank materials selection, creep and design lifetime

The following article should help ICO customers who manufacture large tanks understand some of the complex issues around predicting wall thickness, product lifetime and the behavior of PE materials designed to last many years. The PE material in these circumstances is under constant load (or "stress") from the weight of the water or liquid inside the tank and therefore will gradually "creep" (bulge) at the base of the tank depending on factors such as the design, average wall thickness, temperature and the weight of the tank contents. In addition to the creep behavior, PE products under constant stress will eventually reach a point where failure occurs (this is often called the creep rupture lifetime). This means that tanks holding liquids have a certain expected lifetime which is not infinite.



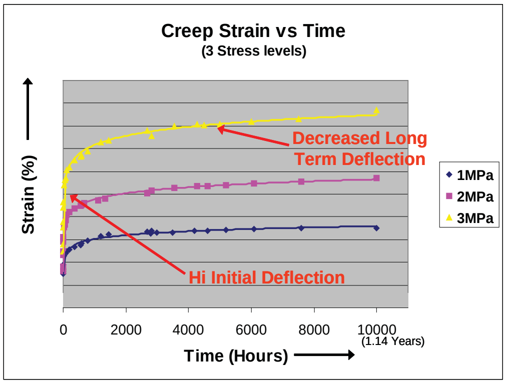
The creep rupture time is dependent on the stress applied to the plastic, people talk about "design stress", they are basically referring to the approximated stress the plastic walls experiences in any particular design of tank.

The way that this "design stress" is used in an FEA (Finite Element Analysis) program is trivial - it simply allows you to work out the wall thickness (usually) of the part from a standard formula so that the pressure inside the tank will cause it to fail in (say) 15 years. For a cylindrical tank, this equation will be something like:

Design stress = (Pressure x radius)/(2 x wall thickness)

So knowing the pressure in the tank (from the volume of liquid and its density) and the radius of the tank (usually dictated by the storage volume), you can rearrange this equation to calculate the desired wall thickness of the moulding based on the "Design Stress".

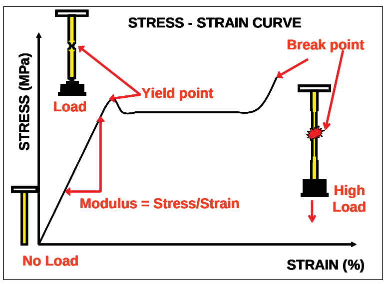
ICO has a broad range of materials available to the moulder. Only some of them are suitable for use in large tanks. For good long term properties in a tank grade what is needed is a balance between stiffness and good physical properties. For typical situations this tends to encourage moulders to use higher density resins such as 0.938 – 0.944 g/cc density with lower than usual MFI. To perform well in tanks the material needs to be moulded carefully with few pinholes or porosity which if present can lead to stress concentrations. Similarly dry blending pigments can create points of stress that create premature failure – shortening the lifetime of the tank.



(Figure 2)

The Significance of Creep in Designing with Plastic

Material selection for plastic parts is usually based on information found on datasheets which includes tensile strength, elongation, flexural modulus and perhaps impact properties from ARM, IZOD or Charpy test procedures. All of this information is derived from Stress-Strain relationships under various time periods from milliseconds to minutes and can be useful in looking at differences between resins but does it really provide much data for designing products with long term performance requirements?

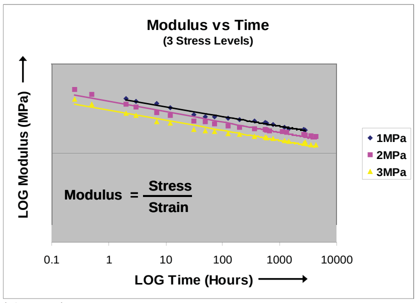


(Figure 1)

The low temperature ARM impact test is commonly used in rotational moulding for the assessment of plastics. The test takes a few milliseconds to complete and is useful in differentiating between inherently brittle or ductile grades as well as how the material processes under a particular set of moulding conditions. It doesn't however provide any information on how a part will perform over many years in the field although a product made from a plastic that moulds well, will generally outlast a part with high levels of porosity or an inherently brittle nature.

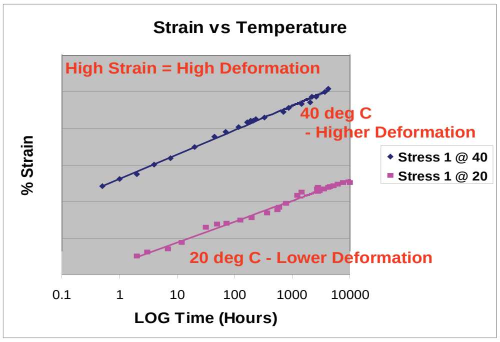
Similarly, testing of flexural or tensile modulus (indication of stiffness) and strength of a plastic takes only a few minutes and values may provide guidelines for upper limits of performance (Figure 1). Few people would however design tanks with for example 900% elongation combined with a tensile stress at yield of 17MPa which are representative of standard values found on a datasheet. Normally a part is subjected to significantly lower applied stress (commonly below 2MPa) over time periods of years rather than minutes and elongation values are often expected to be below about 5%. Mechanical properties on datasheets provide some guidance in grade selection and comparisons but limited information for performance under common operating conditions.

A different test procedure is therefore needed to better approximate conditions experienced in actual use and this is where Tensile Creep testing is useful. Even when a relatively small load is constantly applied to a plastic part, the plastic creeps or stretches over time. In creep testing, much like the standard tensile test, test samples are subjected to a load and the strain measured over time at a set temperature.



(Figure 3)

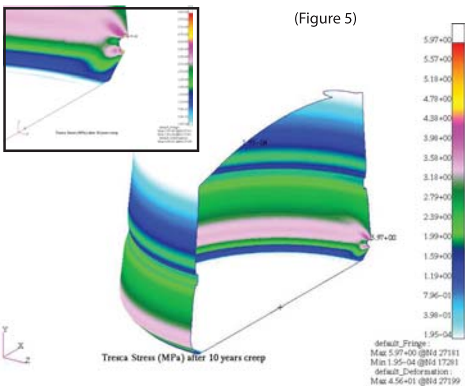
The stress is kept constant and is more representative of maximum values expected to be experienced by the part, i.e. they are much lower than the yield value in the normal tensile test. Initially the strain rate is relatively high and this slows after a few days or weeks but does not stop (Figure 2). The modulus of a plastic is calculated using stress/strain (where % strain = the amount that the sample stretches divided by the original sample length). The modulus of plastic will decrease as the part stretches, if subjected to a load over time (Figure 3). In laboratory testing, this process is accelerated by testing many samples of the same polymer at various stress levels and temperatures, from which a general relationship can be found and subsequently used to predict long term performance of the polymer is obtained. As the temperature is increased, the plastic becomes softer and weaker and stretches more when the same stress is applied as shown in Figure 4. Because of the lower stress levels used in creep testing, the tests take months or even years to complete and are extremely expensive. Creep data is thus often not available for plastic such as Polyethylene, which is not generally used for structural applications.



(Figure 4)

Using the formulae obtained from tensile creep testing, it is possible to predict how the properties of the plastic will change over time for specific conditions and this information is utilized in design software packages making use of Finite Element Analysis (FEA). These formulae could include relationships between:

1. Stress and Strain with Temperature
2. Stress, Strain and Modulus over Time
3. Stress and Strain with Density



(Figure 5)

The FE analysis can predict how parts will behave over long time periods and highlight areas of high stress due to design or loading conditions. FE analysis is purely a computer simulation tool and it needs to be remembered that the accuracy of results are only as good as the information provided i.e. material properties, along with loading and environmental conditions such as support methods. Because of the complexity of FEA modelling, suitably qualified and experienced people are required to set up the program and equally as important, to validate the results obtained. In the FEA example (Figure 5), Tresca stress intensities predicted after 10 years are shown as different colours (light blue is low and red is high stress) and one can clearly see that the tank bulges near the base as expected. Tanks often fail at the outlet and the predicted high stress intensity in this region due to the hole in the tank wall provides some insight as to why this happens. The rib in the tank wall provides some rigidity to the tank wall but also changes the stress intensities within the tank. This highlights the fact that features such as outlets, ribs and overall design can have a significant effect on inherent stress in the final part along with long term performance. What is not generally considered in analysis are what effect incorrect plumbing or tank installation, inserts, imperfections such as bubbles or contaminants in the tank walls, density variations and built in stress due to heating and cooling effects in the moulding process, will have on the stress in the final product. With additional input, the influence of some of these factors on the stress intensity in the product can be checked as well.

This issue of "Connections" main feature article is written by ICO's Bloys Rijkmans.

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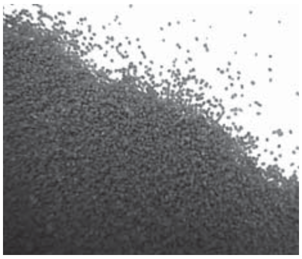
New optimized foam PE grade from ICO UK

ICO UK has developed an improved compounded PE foam grade featuring improved cell formation, greater blowing reliability and a blow ratio of 8x. The grade called ICORENE 5445 has been tested and used very successfully in three layer foam sandwich structures in boats and large sea kayaks.

Quote: ICO C2.5 for more information

Micropellet black now available from stock



ICO UK has announced the stock availability of ICORENE 1613 Bk85, a black micropellet 0.938 density grade. Production of micropellets in various colours and ICO grades has been ongoing in the UK since 1998 on a make to order basis. Says Graham Savage, ICO UK MD: "Unexpectedly high demand for this black grade in recent times have encouraged us to put some into stock"

Micropellets in rotomoulding exhibit very fast dry flow fluidity making them very different to process in comparison to powders. One of the other unique features is their higher than normal bulk density making them useful to moulders that have difficult tools with compact tight-for-space features.

Quote: ICO C2.6 for more information

ICO global news

Acetal Global distribution arrangement with Aardvark polymers

ICO Polymers North America has signed a distribution agreement with the specialist engineering polymer supplier Aardvark Polymers. This supply agreement will provide ICO customers globally to the range of Acetal products designed for Rotomoulding. Acetal is particularly useful in fuel and high temperature applications.

Quote: ICO C2.7 for more information

Creep testing program

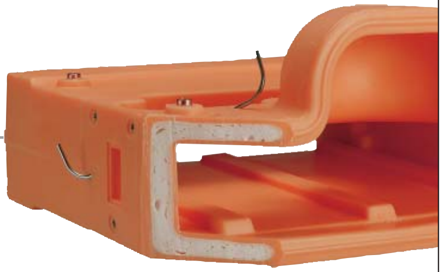
ICO Courtenay is working closely with Impact Laboratories in the UK to provide long term creep data for the ICO tank colour range. As part of this in depth study the relationship between PE mid term properties in full notch creep testing is being looked at. Results are expected in 2008.

Quote: ICO C2.8 for more information

Contacts

ICO Europe: Derek Bristow
dbristow@icopolymers.com
ICO Italy: Fabio Rossini
frossini@icopolymers.com
ICO France: Olivier Vilcot
ovilcot@icopolymers.com
ICO UK: Graham Savage
gsavage@icopolymers.com

ICO Holland: Helga Dekempeneer
hdekempeneer@icopolymers.com
EU R&D Centre: Arnaud Robert
arobert@icopolymers.com
tel +044 1427676767
General Enquiries:
John Steele
jsteele@icopolymers.com tel: +441832730608



Coming up next issue
Focus on PE Foam