GLOBAL SOLUTIONS

The newsletter from DSM Composite Resins > May 2004 > No. 2

TANKS, PIPES AND RELINING

Reliability of FRP pipes! How quickly can we find the answer?

Currently, to achieve a prediction concerning the maximum service pressure of FRP pipes, the chemical and oil industries require a regression curve according to ASTM D2992.

To determine such a curve, test specimens have to be statically or cyclically pressurised with water, applied stress versus failure time is then plotted in a log-log graph. By extrapolating the long-term hydrostatic pressure (LTHP) and lower confidence limit (LCL) in bar, a design life of 20 years can be obtained. But lifetime prediction based on a regression curve is very time consuming and expensive. At least 18 failure points are needed, with minimum one point, at a failure time of more than 10.000 hours. Considering all the limitations of the existing test procedure, the introduction of a reliable, faster and cheaper test method could be a revolutionary development for the total FRP pipe industry. This issue of Global solutions describes such an alternative test method – Ultimate Elastic Wall Stress (UEWS).

IN THIS ISSUE

DSM Geleen site by night.

Ultimate Elastic Wall Stress (UEWS) The time-saving test

The UEWS method is based on the concept that failure of glass-reinforced resin structures starts with debonding at the glass/resin interface. Once this debonding phenomenon starts, less surface area will be available for proper stress distribution, which, in turn, causes stress concentrations and hence further debonding.

The macroscopic effect of this will be creep: increasing deformation at constant load, and in most cases also an increasing permanent deformation when the load is released. Such a degradation mechanism is intolerable over the longer term. With the new test these conditions can be accurately predicted.

For more information on UEWS see inside.

Focusing on Tanks, Pipes and Relining

As a leading supplier of performance materials, DSM is committed to reinforcing its position in chemically resistant resins. Over the coming years DSM will further grow in this segment by providing the industry with resins and expertise to withstand the extreme conditions of today's process industries. Being Europe´s largest resins supplier, our Atlac resins form part of DSM´s comprehensive portfolio, which covers over 500 types of resins. DSM´s own chemical installations worldwide also rely on the chemical resistance and strength of Atlac and Synolite resins for use in various tanks, scrubbers, pipelines and sewers. DSM is committed to the composite industry. Today and tomorrow!

Jan Lodewijk Lindemulder
Business Manager Tanks Pipes & Relining

Case study

UEWS at DSM
Method used to qualify FRP pipes.

At the production site of DSM in Geleen, there are many factories producing various different chemicals for the life science, performance materials and fine chemicals business clusters. To ensure that all these operations run in an efficient and safe way without being affected by corrosion, pipelines are offen constructed from FRP. To safeguard the quality of FRP filament wound pipes - especially when operating at (high) pressures - one of the testing criteria used is UEWS.

Supporting this rapid test method, DSM Technopartners built their own test equipment to qualify pipes from different suppliers based on different resins. "By using the UEWS test, we are sure that proposed pipes are in accordance with the DSM requirements" says Paul Theeuwen, material engineer. "Also, because the test is very fast [one day for one pipe], this method can easily be used to check the quality and consistency over a prolonged period. The evaluation of new pipe structures or resin types is also much easier and faster when using UEWS".

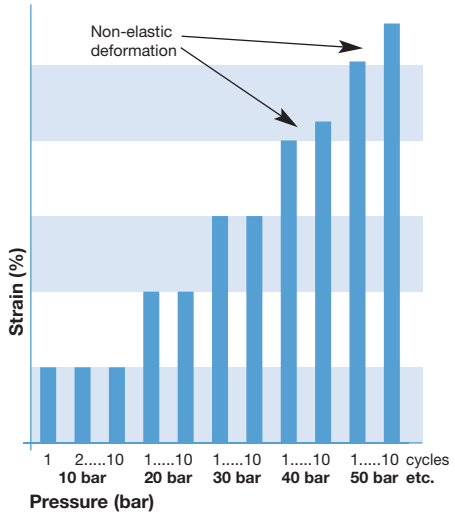
"Recently, we compared pipes based on Atlac E-Nova FW 1045 and FW 2045, the new vinyl ester urethane grades from DSM Composite resin, with pipes based on Atlac 590 [epoxy novolac vinyl ester], which are currently in use. All tested pipes appeared to fulfil the requirements, which makes it easier to switch to new products without taking any risks. UEWS enables us to install pipes based on the latest, best available, technology. We have instant access to the best products on the market without any delay due to time consuming and costly approval testing".

UEWS test in progress.

UEWS testing
An explanation of the procedure

The UEWS test is a rapid way of predicting long term quality and consistency. We look at what's involved in the testing process.

The occurrence of increasing deformations at constant load can be seen as a borderline between permissible and non-permissible deformations or stresses. This borderline is called the Ultimate Elastic Wall Stress (UEWS) - a point that can be determined by a relatively simple procedure.



Pressure versus time during UEWS test.

TEST PROCEDURE

A specimen (pipe - standard containing water at 65°C) is loaded in a prescribed time- versus-pressure schedule. This schedule consists of cycle groups. Each cycle group consists of ten one minute cycles at pressure and one minute cycle at no pressure. The first Cyclic Test Pressure (CTP) shall be 10% of the pressure corresponding with expected UEWS ($P_{UEWS,exp}$). After each cycle group the CTP is increased with 10% of the $P_{UEWS,exp}$. During the test the strain is measured with strain gauges. The strain between the first and tenth pressure cycle is compared. When the strain increases as a result of the cyclic load at constant pressure, a non-elastic deformation occurs. At that moment, in principle, the UEWS point has been passed. From the highest pressure before which a non-elastic deformation results, the UEWS is calculated using the following formula:

$UEWS = P_{UEWS}(D_J + T_r)/2T_r$

Where: UEWS = Ultimate Elastic Wall Stress (N/mm^2)

P_{UEWS} = internal pressure corresponding with UEWS (MPa)

D_J = internal diameter at the location of the strain gauge (mm)

T_r = reinforced wall thickeness at the location of the strain gauge (mm)

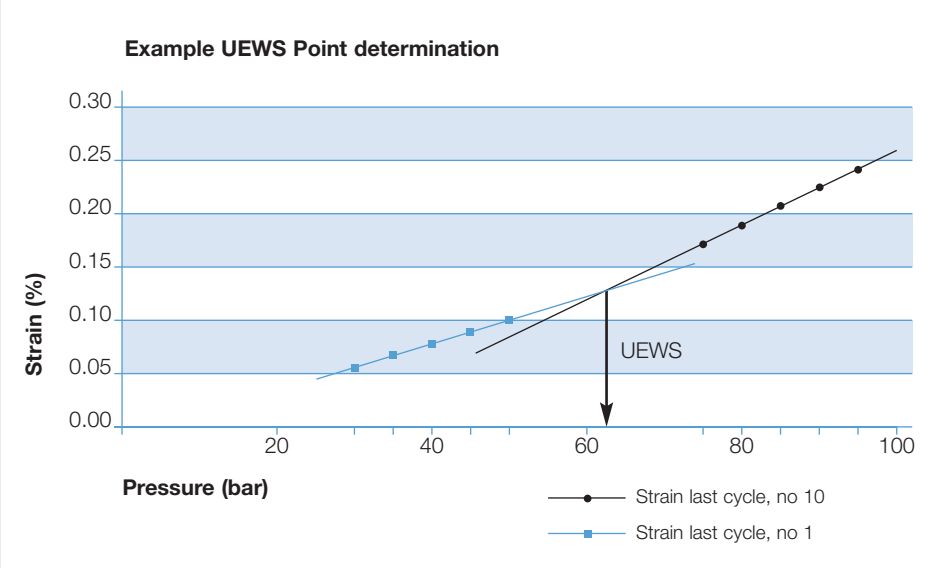
Advantages of the UEWS test

We can conclude that the UEWS test will benefit not just raw material suppliers, but the entire value chain.

SUMMARY OF BENEFITS

By far the biggest advantage of the UEWS test compared with long term testing according ASTM D9229 is the speed of testing, one test can easily be completed within just one day. To obain a reliable test results at least 3 (preferably 5) tests should be performed.

What's more, the required equipment is straightforward and although a high level of accuracy is required, test performance and evaluation of the results is relatively simple. All these benefits result in much lower costs and time savings.



Determination of UEWS point.

Unfortunately, the actual method is not applicable to all types of pipes - for example sand filled and radial filament wound pipes and elbow parts - due to different reinforcement orientation, which requires different positioning of the strain gauches. Acceptance within the industry is still low. A study, directly comparing both test methods would help to investigate the correlation between UEWS and ASTM D9229.

DSM Composite Resins is prepared to support such a study, offering it's experience and testing facilities.

If a correlation can be proven, there would be no grounds for not recognising the validity of UEWS test results. This would be a great benefit to the industry, especially as the introduction of new materials and evaluation of new pipe structures would be much easier.

Not only does the UEWS test benefit the raw material (resin and glass) suppliers, but also the total industry - because it clears the way for adopting the latest developments much sooner.

KEMA believes in UEWS

Being the project executor of the joint industry project "Durability of fibre reinforced constructions", which was completed one year ago, KEMA PowerGenerations & Sustainables is fully convinced about the potential for the UEWS test method.

The objective of this project was to determine a short-term test procedure to estimate the maximum design pressure of pipes. Three short-term test methods were evaluated: Proportional Elastic Limit (PEL), Low Speed Loading (LSL) and Ultimate Elastic Wall Strength (UEWS).

According to Esther Kokmeijer of KEMA, leader of this particular project: "Even though a high level of accuracy is required in its execution, the UEWS is the preferred test - thanks largely to the simplicity of the test procedure and equipment. Together with the PEL test, the UEWS test can be performed within one day, which is a great benefit. Moreover the test can be used for different kind of pipes. The conclusion of the study was that, so far, no solid conclusion could be drawn on the correlation between the UEWS and the durability requirements of ASTM 2992. Therefore it is necessary to perform a regression analysis according to ASTM 2992, on linerless pipes as used for the investigations . To give a follow-up to the project would be a challenging job. Finding a good correlation between ASTM 2992 and UEWS could prove a major step forwards for the industry.

Esther Kokmeijer
Kema PowerGenerations & Sustainables

News

Jan-Lodewijk Lindemulder

Jan Lodewijk Lindemulder, 35, started at DSM in 1995 after graduating Mechanical Engineering at Twente University. After working for seven years at Dyneema, DSM´s ultra strong fiber, he started as Sales Manager Benelux for DSM Composite Resins.
Today, Jan Lodewijk´s responsibility as business manager is to control and develop the market segment of Tanks, Pipes and Relining. Home life revolves around wife Yvonne and one-year-old son Olivier. Jan-Lodewijk also enjoys diving, sailing and music: playing piano and synthesizers.

LATEST DEVELOPMENTS:
Atlac 490-05C ready for the future

The formulation of Atlac 490-05C, DSM Composite Resins' pre-accelerated terephthalic acid based unsaturated polyester, has recently been optimized.

Now this resin is free of monomeric amines and therefore much more friendly to work with. The resin combines high temperature resistance and good chemical resistance to acids, water, salt solutions and organic solvents. These characteristics make Atlac 490-05C suitable for all types of chemical process equipment and storage vessels. The solvent resistance of Atlac 490 makes it an excellent choice for GRP tanks, pipes and linings for handling liquid hydrocarbons.

Low peak system introduced in Atlac E-Nova FW 2245

To meet requests from the market place, Atlac E-Nova FW 2245 now contains a new low peak exotherm system to get better shrinkage control, expecially in thick laminates and during application at tropical condidtions. Thanks to this new system, Atlac E-Nova FW 2245 is now even easier to work with - complementing the other good processability properties of the resin, like improved wetting and adhesion to glass and carbon fibres, combined with standard way of thixotropation.

Atlac E-Nova FW 2245 belongs to the 2000 family of epoxy vinyl ester resins based on E-Nova technology. These grades are distinguished by high temperature resistance and good corrosion resistance, especially in contact with solvents.

Atlac E-Nova resins have been modified and tailored to give the right blend of properties that each market sector demands. Atlac E-Nova FW 2245 has been specifically developed to give filament winders improved performance - which is also beneficial to all other open moulding applications. Please visit our selector guide at our website.

EVENTS

CONF. MECHANICS OF COMPOSITE MAT.	May 16-20, 2004, Riga, Latvia	cirule@pmi.lv
REINFORCED PLASTICS 2004	May 25-27, 2004, Budapest, Hungary	maroska@muki.hu
EUROP. CONF.ON COMPOSITE MAT.	May 31 and June3, 2004, Rhodes, Greece	eccm11@iceht.forth.gr
COMPOSITES AFRICA 2004	24 & 25 August 2004, Caesars Gauteng, SA	www.compositesafrica.co.za
PACE 2004	8 & 9 September, 2004, Cologne, Germany	sgarrington@rapra.net
7TH INTERNATIONAL AVK-TV CONFERENCE	28-29 Sep, 2004, Baden-Baden, Germany	ursula.zarbock@avk-tv.de

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