Mechanical behaviour of polypropylene

Science, Physics

Mechanical Behaviour of Polypropylene of the Introduction Many industries manufacturing plastic materials and related products do not follow the standards commonly used by the industries manufacturing steal and metals because the two differ in many respects. For instance, the design and the life span of the products from two industries is one of the differences. Besides, the load exerted on the materials is non-linear and time dependent. The range at which the material recovers the strain is ten times higher in metal than the plastics because the latter have high sensitivity to the stress concentration (Lewis and Weidmann, 1999a; Lewis and Weidmann, 1999b). These differences mean that the materials react differently with agents from the environment. Therefore, manufacturer must be in a position to appreciating these differences to avoid the production of plastic materials and products with premature failures commonly referred to as nasty and cheap.

The rational design

The plastic containers adopt the pseudo-elastic design methodology, which involves substitution of appropriate Poisson’s ratio and values of Modulus (that depend on temperature and appropriate time). The substitution involves using elastic standardised strain solutions, which depends on the geometry of the part and the load configuration. The method is appropriate for experimenting and investigating the design failures for polypropylene tanks. Some of the successful approach involve analysing the stress to the 4th order of the linear differentiation (Lewis and Weidmann, 1999a; Lewis and Weidmann, 1999b). The equation takes into consideration the transition between the vertical and the horizontal dimensions as well as the thickness.

The manifestations of these transitions are accounted when the wall of the tank increases through radial expansion. The phenomenon can be described as stress concentration.

Elements of design

The method involve assessing the strength parameters based on general values like stability (buckling, kinking), deformation (excessive bends), and strain or stress. Most failed tanks will fail at the welded construction at the joint level. Therefore, the best approach is to adopt a limiting stress criteria, which will aim to provide conservative alternatives to the problem (Lewis and Weidmann, 1999a; Lewis and Weidmann, 1999b).

Causes of tank failure

The design of the tank is very important. The hydrostatic pressure increases linearly and proportionally with the tank's height. This means that the most appropriate strategy of resisting the pressure is by increasing the tank thickness. The same principle is applicable when constructing the walls of the dam. Failed tanks did not have these principles applied in their design hence the main cause of failure associated with poor design of thickness because the thickness of the walls was uniform. Such designs only take into account the protection of horizontal welds instead of balancing both the vertical and the horizontal welds and preventing the development f tension. The failed tanks exposes the lower panels to immense stress (hoop stress), which accumulates more easily in the weak areas (weld zones) leading to failure (Lewis and Weidmann, 1999a; Lewis and Weidmann, 1999b).

Conclusion

When designers under estimate the dimensions of the tank (the thickness of a plastic tank), it leads to increased hoop stress to about thrice the recommended values by the DVS 2205), hence leading to failures. Design stress is one of the factors that cause tank failure, hence the need to increase the resistance of the tank. DVS 2205 recommends that designs should consider increasing the thickness of the tank toward the base to ensure that tanks have better strength to increase the fatigue resistance and reduce failure for environments that use plastic materials for bulk storing (Lewis and Weidmann, 1999a; Lewis and Weidmann, 1999b).

References

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