Plastic Components for Turbochargers

Seeking to achieve further reductions in weight and cost is also accelerating substitution of aluminium with plastic components in the turbocharging system. The first functional compressor housing prototypes, following successful testing, show such potential. Production of complex compressor wheels made of plastic will follow at a later stage. The article by Mann+Hummel highlights, among other things, the challenging demands made on both materials and production technology.
1 Introduction

In the gasoline engine market, turbocharging is increasingly used to improve the basic engine performance as well as for downsizing. Therefore, it has recently been integrated into some high-volume applications. For high volume vehicles, special attention is focused on reducing weight and CO₂ emissions. Thermodynamics, playing an important role here, it is thus essential to identify further potential for cost and weight reduction in the charging components, for example substituting aluminium with plastic on the compressor side.

Mann+Hummel, experienced in supplying air intake systems, has in recent years carried out extensive investigations in that area. For a 3.0-l Biturbo-Engine, a near-series prototype of compressor housing made of the high-performance thermoplastic material PPS has been developed.

Successfully accomplished results in the engine endurance test, the burst containment test and on the turbocharger test bench showed that it is possible to fulfil the requirements of a compressor housing using high-performance plastics.

It has also been investigated whether it would be possible to make the compressor wheel in plastic. The plastic wheel injection moulded out of PEEK provides a cost benefit, a shorter speed-up time of the turbocharger and benefits in fulfilling the very challenging burst containment test.

2 Requirements

The three fundamental requirements for plastic compressor housing are component stability under all conditions, burst containment safety and very high dimensional accuracy. In gasoline engines the pressure and temperature in the compressor is lower than in diesel applications. Nevertheless, pressure pulsation and high temperature lead to high stresses in the joints, which should be welded for cost reasons. Therefore, structural reinforcement measures, such as ribs, are necessary to avoid ‘expansion’ of the compressor housing. This would lead to a decrease in efficiency of the compressor. Reinforcement of the part is also essential to meet the burst containment requirements. In this test, the compressor wheel is modified in order to fail at the predefined (excessive) rotational speed. The test is deemed successful when the metal parts are contained within the housing. In order to reduce the kinetic energy of the burst wheel, it is important that as much energy as possible can already be adsorbed in the inner region of the housing.

The requirements for the applied material Polyphenyl Sulphide (PPS) are two-fold: First a very high dimensional stability under all load conditions is necessary and second a ductile material behaviour should dissipate kinetic energy and improve the strength of the weld joints.

3 Plastic Compressor Housing

The geometry of compressor housing is mainly determined by the design of the volute, in which the compressed air is conducted from the diffuser gap to the charge air duct. It is above all the shape of the flow cross-section in the volute which determines the complexity of the design of the complete compressor housing. For a simple design, the aluminium compressor housing can be produced by an inexpensive die-casting process. Volute cross-sections with at least one undercut require the more complex chill casting method.

As well, for a compressor housing made of plastic, the complexity of the de-