

Successful recycling of PTFE - for a sustainable future

As a member of the NEUMAN & ESSER GROUP, STASSKOL GmbH offers high-performance plastics for a wide range of applications, including tailor-made sealing materials for use in reciprocating compressors. These materials require very good mechanical properties and high wear resistance.

The recycling of such PTFE-based materials presents a challenge. A sintering process is used to process these special compounds, which can be carried out as cold compression molding (CCM) or hot compression molding (HCM). In CCM, the preform is sintered in the furnace without pressure, while in HCM the material is subjected to simultaneous pressure and temperature.

Small grain sizes are required

The sintering process of PTFE requires the material or the mixture to be grinded almost to the original grain size of about 20 to 40 μm . In tests carried out by STASSKOL, the chips of two materials were collected separately for this purpose. The materials in question were SK202, a CCM-PTFE with glass fibers, amorphous carbon black and graphite as well as SK801, an HCM-PTFE with carbon fibers and a thermoplastic filler.

For the selected materials, both PTFE processing methods are represented because the recycling challenge is greater for cold compression than for hot compression. Compression at low temperatures makes the size of the powder particles play a special role. In addition, materials with a significant proportion of carbon and glass fibers were deliberately selected because the change in fiber length distribution is of particular importance in the recycling process.

The grinding process is crucial

The technological challenge in the recycling of PTFE materials lies in the grinding process, since very fine particle sizes in the range of around 50 μm must be achieved. For this purpose, an impact classifier mill type ICM 15 from NEUMAN & ESSER Process Solutions was used (Fig. 1). With the aid of the parameters grinding speed (m/sec), mass flow (kg/h) and speed of the classifier wheel (m/sec), the process can be regulated with this mill type so that the desired particle size is achieved. In addition, the degree of filling of the grinding chamber has a major influence on the result.

In the tests carried out, with a constant circulation speed of the impact chuck of 128 m/sec and a constant circulation speed of the classifier wheel of 10 m/sec, the mass flow was varied to determine the influence on the particle size.

For both materials (SK202 and SK801), the reduction of the mass flow leads to a small reduction of the grain size. Grain sizes in the range of approx. 50 μm could be achieved in all grinding tests. Therefore, the high throughput of the ground material was selected for the further tests and the ground recycling material was added to the virgin material in different concentrations by a powder mixer.

Optimized properties through recycling

The mixtures of recycling material and virgin material were processed into test semi-finished products at standard processing conditions (CCM for SK202 and HCM for SK801). Based on these test semi-finished products, the mechanical properties, material hardness and tribological properties (friction and wear) were determined.

The wear resistance was determined by means of a reciprocating tribometer (Fig. 2) - a STASSKOL in-house design - using the respective process gas in which the corresponding seal material is used. These are nitrogen for SK202 and hydrogen for SK801.

The investigation of SK202 shows that at 10, 20 and 30 wt.-% recycled material, the properties of the pure virgin material are even exceeded. Both the Young's modulus and the elongation at break are above the values of the virgin material, and the low wear rate and the lower coefficient of friction show that the wear properties have also improved because of adding the recycled material. At 40 wt.-%, the wear properties remain at a very good level, but the density and mechanical properties deteriorate.

In the case of SK801 produced by hot compression, there is only a slight decrease in hardness, Young's modulus, and tensile strength at 100% recycled content compared with virgin material. In particular, the wear properties under Hydrogen atmosphere benefit from the recycling process. The wear rate is thus reduced and the coefficient of friction more than halved. Therefore, further tests with additional concentrations of recycled material were not necessary.

Conclusion

In conclusion, the tests showed that it is possible to recycle PTFE sealing materials, and that this even improves the properties of the materials. This brings an advantage for the customer, and it is an important milestone for the sustainability of our products.