Ceramics – Compounding of Feed Stock with PTW16XL and Sample Production with HAAKE MiniJet

Rheology Application Notes

Keywords:

- Ceramics
- Twin Screw Extruder
- Injection Moulding

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Abstract

Powder Injection Moulding is a useful Process as a large number of complex products are produced with short cycle times. Base Products is fine ceramics or metal powder blended with Binder to form a flowable feedstock for injection moulding. These two steps are investigated on a small scale using laboratory equipment.

Fig. 1: Instrument setup, RD16, PTW16/25, split feed with two metering feeders, die plate and conveyor belt.

Introduction

In test runs with small laboratory compounders we can prove feasibility of binder-powder compound. Binder systems are based on waxes, or Polymers LDPE, PP, POM are used. Compared to Masterbatch compounds the focus is on highest degree of filling of the powder, still obtaining a feed stock which can be used in a moulding process. The „green" parts undergo a heat treatment (sintering). End products are e.g. catalyst beads, turbine blades.
Usually laboratory development will check for maximum degree of filling and compatibility or performance of the binder or polymer. Moreover trials for e.g. Powder metal alloys easily can be performed, in order the change the composition with various components. The HAAKE MiniJet enables quick tests on processability. The samples could be sintered and used for mechanical testing.

Materials and Methods

A polyethylene wax based binder was blended with Zirconium oxide.

For the HAAKE PolyLab OS an RD16, a PTW16/25 XL parallel twin screw extruder and two HAAKE metering feeder (binder, ceramic powder) was used (Fig. 1) to homogenize the raw materials:

- *Feed method: split feed with two feeders first zone.*
- *Strand die 2.5mm and conveyor belt was for take off*

In case of air bubbles, atmospheric venting is advised.
Product was cooled on the conveyor belt, easily cut to pellets and manually fed to the MiniJet.

Fig. 1 shows the split feed with two metering feeders coupled by an adaptor. Split feed is essential as wax (brittle flakes) and the ceramic (fine powder) segregates when fed trough the same hopper.

A setup of the system with the feed of the wax in the first zone and the powder via the secondary feed port is shown in Fig. 2. For powder compounds with Polymer grades with high Tg (melting Temperatures) this way of feeding is advised to prevent higher wear on the barrel. As the pellets have higher melting point the lubrication is less compared to waxes. Also when looking on the high output feeding with separate ports is advised.
Before starting the test with the volumetric feeders pretests for the output curve of the metering feeders were

Fig. 2: Separate Feed of wax and powder.

the extruder by running the wax first, then subsequently adding the powder. Stable extrusion was achieved by the summarized set up:

Set values:

- *Speed: 200rpm*
- *TS1 (Feed): 30°C*
- *TS2: 120°C*
- *TS3: 160°C*
- *TS4: 160°C*
- *TS5: 160°C*
- *T Die : 160°C*

Measured values:

- *Torque: 50 Nm*
- *Pressure Die: 7 bar*
- *T (Melt): 170 °C*

For the MiniJet (Fig. 3) the strand was broken to pellets and manually fed. The set values are as shown in the display of the MiniJet (Fig 4) resulting in e.g. a tensile bar (Fig. 5).

Results and Discussion

Compounding worked without problems. The desired output of 6 kg/hr was reached with the given composition (85/15 % wt/wt). Neither the compounder nor feeding system was pushed to the limit. Fig. 6 shows the wax and powder, and the compound (disk, pellet, strand, tensile bar, sheet). Extruded strands were brittle and easy to break manually. Sheet extrusion was possible, but disks moulded in the MiniJet showed higher surface quality. Injection moulding by the MiniJet was easy as well with the parameters shown in Fig. 4.

Summary

The HAAKE PolyLab system is the ideal instrument for quick development. The compounding itself could be done with the PRISM Eurolab with similar parameters. With the modular PolyLab further test with a small internal mixer can be performed e.g. to evaluate minimum binder ratio or using single screw extruders to measure the viscosity of the feedstock.

Fig. 3: HAAKE MiniJet

Fig. 4: Parameter for MiniJet

Fig. 5: Tensile bar in MiniJet Mould

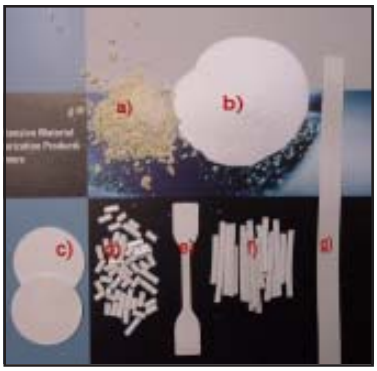

Fig. 6: Raw material (a,b) and Product samples (c-g):

a) wax (PE)
b) ceramic powder (ZrO_2)
c) disks
d) pellets
e) tensile bar
f) strands
g) sheet

Literature

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