

Dispersive Mixing Technology by Optimizing Screw Tip Clearance

1. Outline

Plastics materials are modified by compounding fillers or alloying polymers to improve end products properties for higher value added. The compounding quality is depending on the dispersion status and molecular size of a secondary ingredient, the modifier, in the base polymer, and therefore, customers require the extruders of excellent dispersion performance. The results of our tests using our Twin Screw Extruder (TEX) prove that the dispersion performance is significantly affected by the tip clearance, which consists of screw flight tip, and cylinder bore. That is to say, it is very important to optimize the tip clearance in the kneading section in order to achieve excellent dispersion performance.

We report here how the tip clearance affects dispersion performance, polymer temperature and specific energy of Twin Screw Extruder, TEX.

2. Test results

1) Dispersion Performance vs. Tip Clearance

We evaluated the dispersion performance at three levels of tip clearance in the kneading section ; standard, twice and three times standard. The following Fig. 1 shows the test flow. Fig. 2 shows the dispersion performance at each tip clearance. And Photo 1 shows the condition of compound material observed through the vent opening after the kneading section. The test results show that there exists an optimum tip clearance to achieve ideal dispersion performance. If tip clearance is too small, local heat-up and high shear speed reduce the polymer viscosity and that causes insufficient shear stress. If tip clearance is too large, shear speed at tip clearance becomes too low and that reduces shear stress to the compound material.

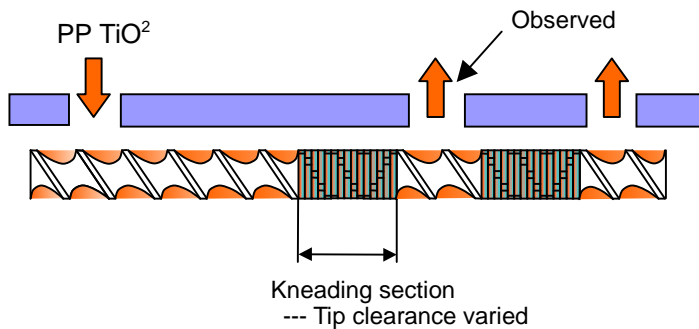


Fig. 1 Test flow

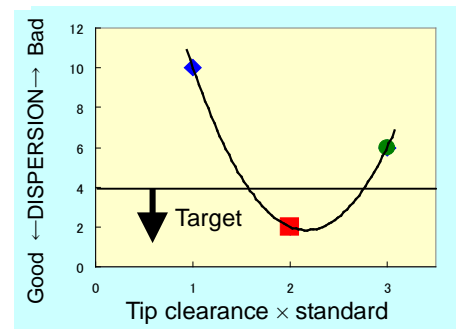


Fig. 2 Dispersion of TiO₂ in PP+60%TiO₂

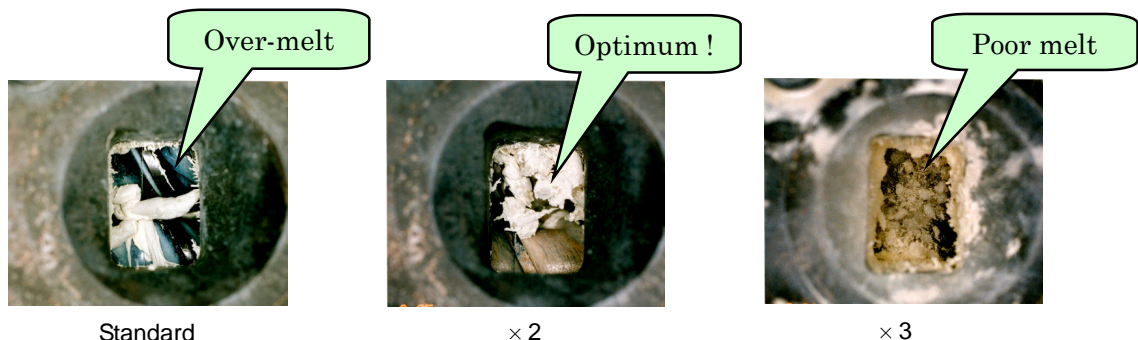


Photo 1 Observation of material condition through the vent opening (PP+60%TiO₂)

2) Polymer Temperature & Specific Energy vs. Tip Clearance

Tip clearance greatly affects polymer temperature and specific energy. The larger tip clearance, the lower shear speed at tip clearance. Lower shear speed enables the compounding at lower temperature with less local heating and leads to an ideal energy-saving compounding.

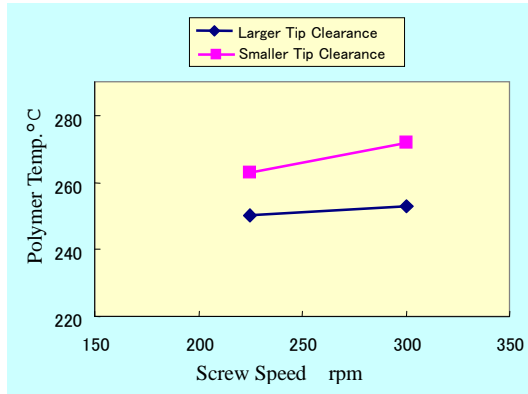


Fig. 3 Polymer Temp. vs. Tip Clearance

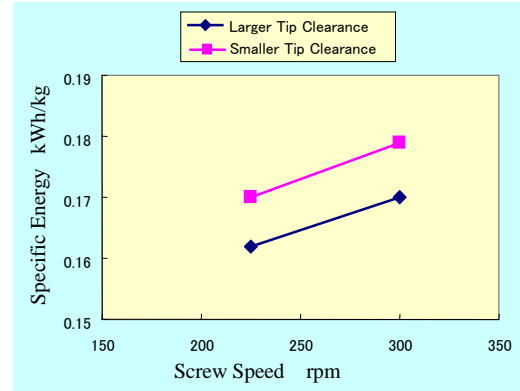


Fig. 4 Specific Energy vs. Tip Clearance

3. Special Kneading Cylinder “NIC”

We have been of the opinion that compounding in a screw extruder is performed by both screw and cylinder. To achieve better dispersion performance by improving tip clearance, we developed the special kneading cylinder “NIC” with a unique channel structure on cylinder bore that is another constituent of tip clearance. NIC cylinders enable us to achieve more improved dispersion performance, energy-saving operation, and higher processing rate of twin screw extruders.

Good results have been achieved with NIC cylinders installed on a lot of twin screw extruders mainly for polymer blending, polymer alloying, filler compounding and masterbatch (carbon black, titanium dioxide, etc.).

< Advantages of NIC >

- 1) Excellent kneading performance
- 2) Kneading at lower temperature
- 3) Energy saving
- 4) Good coloration performance
- 5) Higher processing capacity

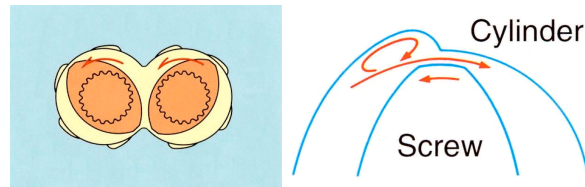


Fig. 5 Special kneading cylinder “NIC”

4. Afterword

It is very important to optimize the tip clearance in order to improve the product quality because of its significant effects to dispersion performance in TEX. Performance evaluation is required to find an optimum tip clearance for each case as it depends on the compounded materials and the application. We are available to perform various evaluation tests to meet your needs by means of pilot extruders in our Plastics Machinery Developing Center / Hiroshima, Japan preparing various kinds of screw elements and NIC cylinders.

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