

CONDUCTIVE COMPOUNDS



CABOT

creating what matters

Delta P Test for Fiber Performance



Cabot Delta P Test Characterizes Carbon Black Performance in Fine-Denier Synthetic Fibers

The performance of a carbon black in synthetic fiber is a function of the physical cleanliness of the black and the quality of its dispersion. Dispersion is, in turn, influenced by carbon black morphology and by the compounding process. The pressure rise (Delta P) test measures the sum of these effects.

The traditional Delta P test involves extruding a given amount of carbon-black-filled resin through a 325-mesh (44-micron) screen and measuring the rise in pressure. In many applications where fiber diameter exceeds 6 denier, this test is adequate. But for smaller diameter fibers, this traditional test is not discriminative enough, since these fibers are sensitive to carbon-black-born contaminants that can easily pass through the screen.

In addition, the traditional Delta P test, which measures the overall increase in pressure (P3), fails to differentiate between the pressure rise caused by compound viscosity and higher extrusion pressure caused by the carbon-black-born contaminants.

Cabot uses a modified Delta P test that is more accurate in characterizing the suitability of carbon blacks for the preparation of masterbatches used in fine-denier fiber applications.

■ Delta P test description

Compounding Equipment

1. For PET or PP: a 30-mm co-rotating twin-screw extruder (i.e. Werner & Pfleiderer) with a vacuum vent and an L/D ratio of 38:1. The screw was of Werner & Pfleiderer design, containing one-third kneading blocks. The exact screw profile is available from Cabot Technical Service in Billerica upon request.
2. For PP only: an adapted internal mixer can be used for the compounding step (example: Banbury®).

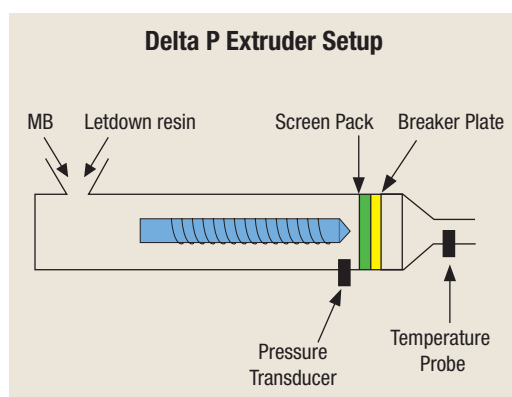
Delta P Test Equipment

Extruder configuration: 25-mm single-screw extruder (i.e. Killion) with data acquisition package and computer analysis. Equipment should be optimized to deliver consistent pressure:

- Minimum screw diameter of 19 mm (0.75 in.)
- 3:1 compression ratio
- RPM controlled to $\pm 1\%$
- Heater controlled to $\pm 3^\circ\text{C}$ or better

Breaker plate: while many different breaker plate configurations (7 – 57 holes) are used in the laboratory to generate data, a 7-hole configuration allows greater sensitivity. It should be noted that data from a 7-hole configuration may not correlate completely with data from a different configuration.

Screen pack: the 165 x 1400 mesh screen was part of a screen pack with the following configuration: 100/(165x1400)/150/60/40 (mesh). The nominal opening of this screen is 10 microns; the absolute opening (the largest particle that will pass through) is 17 microns. This screen configuration allows a significantly better prediction of performance than is possible with a 325-mesh screen.



■ Cabot Delta P test method overview

A minimum of 100 g of carbon black, as representative of the bulk sample as possible, is required. Less than 100 g of carbon black is either not a representative sample or does not make sufficient masterbatch for sensitive pressure rise measurements. Carbon black is compounded with a typical loading of 30% for PET and 35% for PP. The following steps 1-3 refer to the Typical Delta P Curve graph at right.

1. Extrude neat resin for a minimum of 5 min. to establish a baseline pressure (P1).
2. Introduce sufficient masterbatch and neat resin to give a 10% carbon black loading in the extrudate. Extrude all the masterbatch through the screen pack.
3. Purge with neat resin for a minimum of 5 min. to establish new pressure baseline (P2).

Delta P is defined as $(P2 - P1) \div (\text{grams of carbon black})$ and expressed in bar per grams of carbon black (bar/g CB).

[1 bar = 14.5 psi]

■ Cabot Delta P test method for use with PET

The PET in this study, supplied by American Hoechst Corp., was a fiber-grade polyester (IV = 0.64, TiO₂ = 0.03%). The carbon black was dried before compounding in an oven at 125°C overnight. The PET resin was dried in a dehumidifying dryer/hopper (i.e. Novatec) at 160°C until the moisture level was below 100 ppm. Concentrates with 30% carbon black loading in PET were compounded in a 30-mm twin-screw extruder with the following parameters:

- Screw speed of 350 rpm
- Throughput of 10 kg/hr
- Extruder temperature settings:
260/280/280/280/ 280/280/260°C for heater zones 1-7
- Torque: approximately 85%
- Die temperature settings for die zones 1-5: 266/268/271/288/288°C
- Polymer melt temperature: 325-335°C

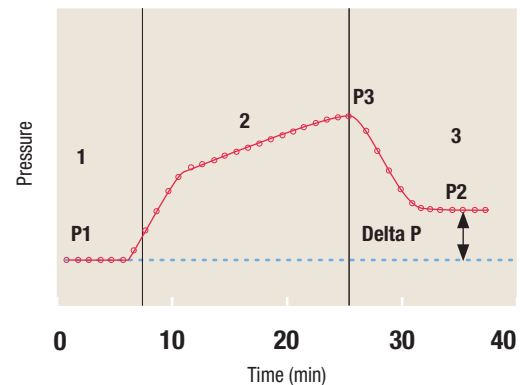
To determine the carbon black loading in the PET concentrates, the PET in the concentrate was dissolved into m-cresol at a temperature just below its boiling point. After filtration, the carbon black loading was determined from the remaining carbon black on the filter.

In the typical Delta P in PET test, 400 g of 30% carbon-black-loaded PET concentrate were mixed with 800 g of polystyrene and added to the extruder. Polystyrene was used as letdown resin in the test rather than PET because it does not require drying. Cabot has performed sufficient control experiments to show that results using polystyrene as letdown resin are directly correlatable to results using PET as letdown resin. The polystyrene was Styron® 666 D resin (melt flow rate = 8 g/10 min.). The actual pressure rise test was measured as explained in the overview section above.

■ Cabot Delta P evaluation on PP concentrates

In a typical Delta P evaluation in polypropylene, the PP concentrates were prepared on an internal mixer. 285 g of 35% carbon black loaded PP masterbatch were then mixed with 715 g of PP resin and extruded as described in the overview section. The resin used both for the carbon black concentrate preparation and the letdown was a polypropylene homopolymer with melt flow rate = 35 g/10 min.

A Typical Delta P Curve



® Banbury is a Registered Trademark of Farrel.

® Styron is a Registered Trademark of Dow Chemical.

Addresses

North America

Cabot Corporation
Business and Technical Center
157 Concord Road
Billerica, MA 01821-7001
USA
Tel: +1 978 663 3455
Tel: +1 978 670 6298 (*Technical Service*)
Fax: +1 978 670 6149 (*Technical Service*)
Tel: 800 526 7591 (*Customer Service*)

Latin America

Rua do Paraíso, 148 - 5th floor
Paraíso CEP 04103-000 São Paulo SP
BRASIL
Tel: +55 11 2144 6400
Fax: +55 11 3253 0051
Tel: 0800-195959 (*Customer Service*)

Middle East/Africa

Cabot Specialty Chem. Inc.
Jebel Ali Free Zone
LOB 15, Office 424
Dubai
UNITED ARAB EMIRATES
Tel: +971 4 8871 800
Fax: +971 4 8871 801

Europe

Cabot
Interleuvenlaan, 15 i
B - 3001 Leuven
BELGIUM
Tel: +32 16 39 24 00
Fax: +32 16 39 24 44

Pacific/Asia

Cabot Specialty Chemicals, Inc.
Level 21, MNI Tower 2
11, Jalan Pinang
50450 Kuala Lumpur
MALAYSIA
Tel: +60 3 2164 8352
Fax: +60 3 2162 0253

Notice and Disclaimer. The data and conclusions contained herein are based on work believed to be reliable; however, Cabot cannot and does not guarantee that similar results and/or conclusions will be obtained by others. This information is provided as a convenience and for informational purposes only. No guarantee or warranty as to this information, or any product to which it relates, is given or implied. CABOT DISCLAIMS ALL WARRANTIES EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AS TO (i) SUCH INFORMATION, (ii) ANY PRODUCT OR (iii) INTELLECTUAL PROPERTY INFRINGEMENT. In no event is Cabot responsible for, and Cabot does not accept and hereby disclaims liability for, any damages whatsoever in connection with the use of or reliance on this information or any product to which it relates

© Cabot Corporation, MA, U.S.A. All rights reserved 2006.



CABOT

creating what matters

www.cabot-corp.com/plastics

CABELEEC® is a registered trademark of Cabot Corporation.