Application Note
LR-62

Nanocomposites – Examples on Compounding of Nanoclay Blends in Twin screw extruders

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Key Words:

- Montmorillonite
- Nanoclay
- Nanocomposites
- Twin screw extruder

Abstract

This report describes practical examples of nanoclay – polymer compounds processed successful in the Karlsruhe PI Demo center during 2006.
Nanoclay was compounded with commercially available resins such as PP, PA and ABS. Test setup and instrument parameters are given as a guide line.

Introduction

Nanomaterials enter the consumer market. The focus shifts from science to standard applications. For polymer based Nanocomposites the research is often driven by the automotive industry searching alternatives to bulk materials. Especially nanoclay-polymer blends are known to improve material characteristics such as flame resistance, barrier properties or toughness. Decreasing prices, high availability, readymade Masterbatch, vast research work, make nanoclay-compounds perfect systems to start development [1] or assess a machines performance.

Test arrangements

Test 1
Instrument: Rheodrive 16 with Torque sensor, Rheomex PTW16/40OS XL parallel twin screw extruder
Feeder (Polymer): Metering MF
Feeder (filler): micro twin screw feeder MT2 zone 3, 3 mm die plate
Pelletizer FLP16, waterbath.

Materials: 96% PP Moplen HP561, 2% PB closite 20A, 2% MA-g-PP
Output 2 kg/h, speed variable
Temperature [°C]: 200,210, 210, 200, 200, 195, 190, 190, 190, 190 (die)

Test 2
Instrument: Rheodrive 16 with Torque sensor, Rheomex PTW24-40HC parallel twin screw extruder
Feeder polymer: gravimetric twin screw feeder DS 20,
Feeder filler: micro twin screw feeder MT1, with side feed, 2*2mm die plate, pelletizer, waterbath.

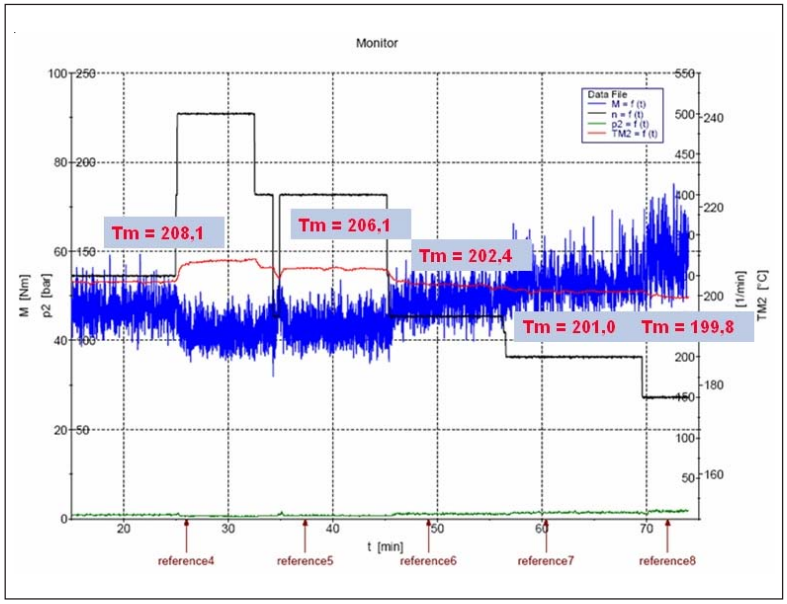
Materials: 95% PP Moplen 501H, 5% Dellite 72, Output 6 – 32 kg/h, speed: 800 rpm
Temperature [°C]: 180, 200, 200, 200, 210, 210, 220, 220, 230, 230 (die)

Test 3
Instrument: Rheodrive 16 with sensor, Rheomex PTW24-40HC parallel twin screw extruder
Feeder polymer: gravimetric twin screw feeder DS 20
Feeder filler: micro twin screw feeder MT1, all via 1. feed port, 2*2mm die plate,pelletizer, waterbath

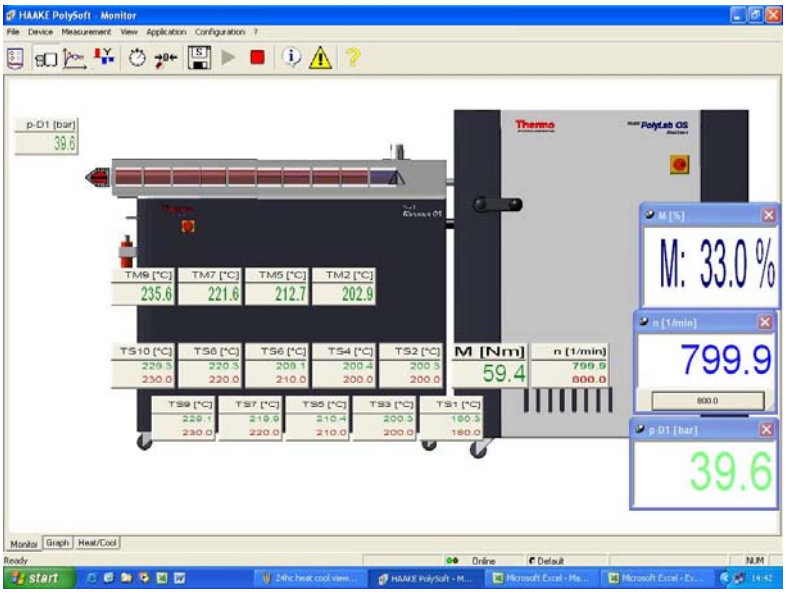
Materials: 97,5% Ultramid PA 6/66, 2.5% Dellite 72,Output 8 kg/h, speed: 640 rpm
Temperature [°C]: 270, 270, 270, 270, 280, 280, 280, 280, 280, 280, (die)

Results and Discussion

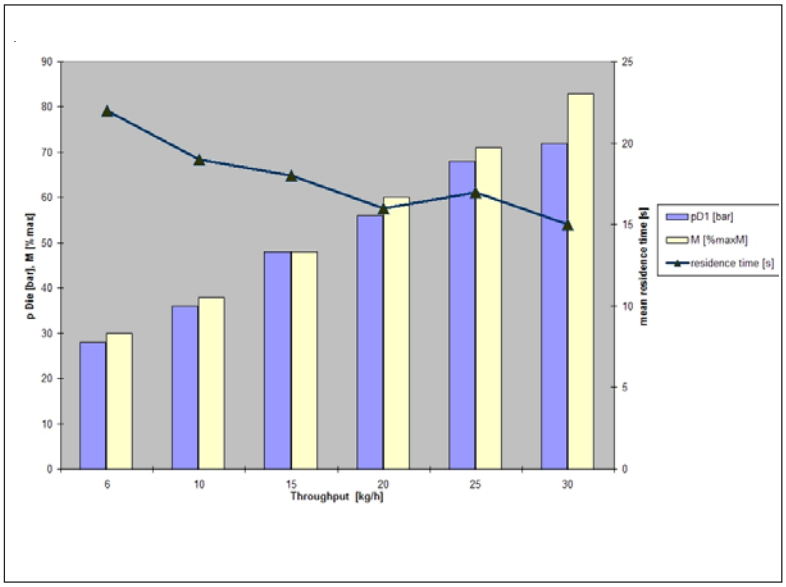
Test 1: PP, low output, optimizing melt temperature
Melt temperature plays an important role in determining the maximum throughput of an extrusion line. In this example a very sensitive additive was used to improve the processability of nano clay in a fibre grade (high MI) Polypropylene. Though a setup, ensuring a melt temperature of well below 210 °C was easily found we determined in a trial the minimum melt temperature. Reference samples have been produced after stable conditions were reached. During a test run of 60 min the speed was reduced stepwise from 500 to 150 rpm, reaching 200 °C for minimum melt temperature.



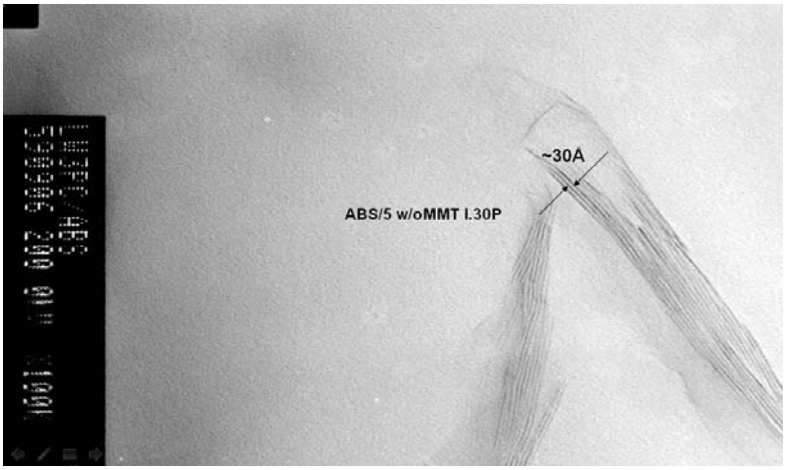
PTW16-40 OS optimizing melt temperature



PP-Dellite compound, 30 kg/h at 75% of maximum torque.



Processing data for Rheomex PTW24/40 HC PP + Nanoclay



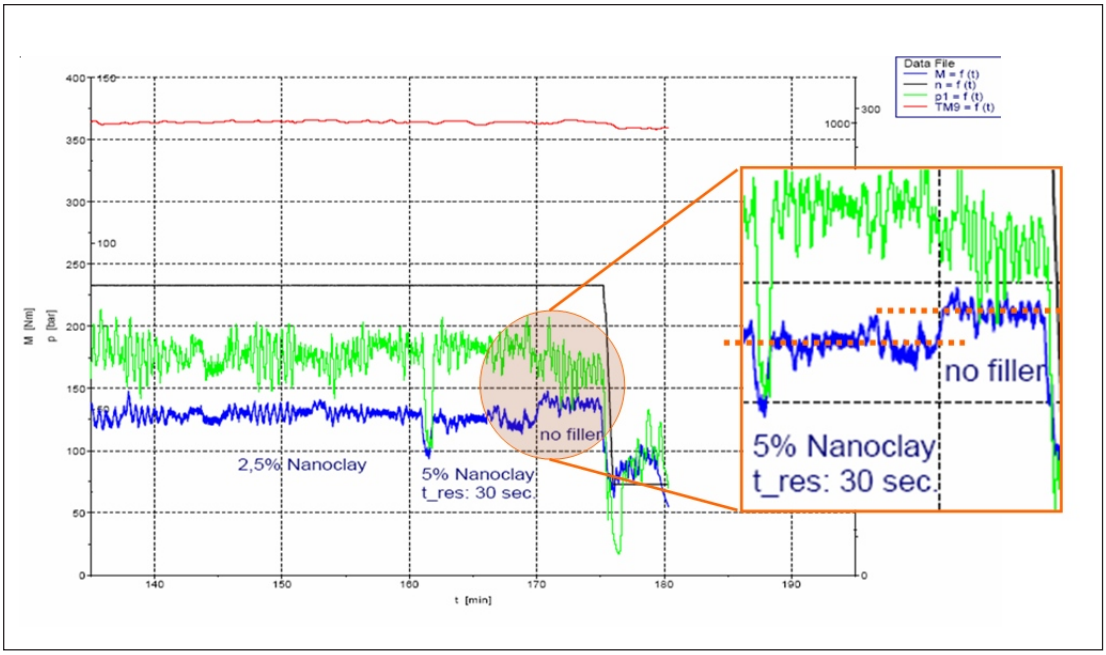
Compounding MMT/ABS with PTW24 and RS600 OS

Test 2: PP high speed, high output
Trials on PP compounding with Dellite (MMT) using high screw speed (800 rpm), Throughput up to 30 kg/hr, yet the limitation was given by the feeding system. The chart plots throughput versus die pressure, torque.

Our customer CRP, Italy is researching on new materials in the field of optics for automotive application. During pre trials and later with a similar installed unit (PolyLab System with Rheomix 600 and Rheomex PTW24/40) various blends were produced using standard screw geometry and side feeder for the nano clay. Dr. Martinelli from CRP comments the results on ABS with 5% montmorillonite (MMT) as follows:

- *"The results are good because an intra space gallery of 3 nanometres is an evidence that good intercalation has been achieved; prior to compounding the space was 2 nanometres. And also there are some areas where it is possible to see that exfoliation has happened."*
- *"This result was achieved with a commercial MMT, functionalised for PA, not for ABS (producers are now less available to optimise their products for little amounts). So this is evidence, in my opinion the compounding is good because we reached the best result possible with the materials available in the market."*

Test 3: PA and Nanoclay with Rheomex PTW24/40 OS
Compounding of a batch of 20 kg with 2,5% filler was a more standard application. Since achieving a high output was not requested feeding of the nano clay and pellets was through the main feed (zone 1). Typical output was 8 kg/h, further more one batch with 5% filler was produced. To compare possible degradation of the PA at the end of the test a sample of the processed base polymer was taken. An interesting effect is the increased torque in the absence of the organo-modified nano clay. With our Standard System we were able to compound high performance materials as the Ultramid C40, a high viscous PA 6/66.



PA and Nanoclay with PTW24-40 OS

Summary

In all tests a standard screw setup was used and performed well. Especially if not high throughput is demanded, the PolyLab OS is an ideal system [2] for quick testing and sample production. Special attention must be paid to the feeding system. With throughputs of 5 kg/h and 2.5 % filler, gravimetric micro twin feeders are recommended.
By adding a melt pump or changing the twin screw sensor to internal mixers, single screw extruders quickly, the PolyLab system offers far more than just compounding.

Literatur

[1] ***The Dynamic Viscoelasticity of Polyethylene Based Montmorillonite Intercalated nanocomposites***
Hong Mei YANG, Qiang ZHENG Department of Polymer Science and Engineering, Zhejiang University Hangzhou*
Chinese Chemical Letters Vol. 15, No. 1, pp 74– 76 , 2004

[2] ***Flexibility in Polymer Research***
Ansgar Frendel, Matthias Jaehrling, Kunststoffe plast Europe 6/2005 pp1-3, 2005

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