LMI Melt Flow Rate Test
Applications & Calculation

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Melt Flow Rate Test Applications

LMI Melt Flow Rate Tester

Method A

Method B

Method A to B Conversion

Operation Points

Other Applications (Shear thinning behavior, intrinsic viscosity, and thermal stability)
Melt Flow Rate Test Applications & Benefits

Standardized measure of flow characteristic of polymer melts at a single point specific condition

Quality control / lot to lot consistency

Minimizing waste

ASTM D1238
ISO 1133

http://westextrusion.com
https://www.slideshare.net
https://home.plasticsnews.com
http://www.freedigitalphotos.net
LMI Melt Flow Rate Tester

- **Weight**: ±0.5%
- **Thermometer**: ±0.1 °C
- **Piston**: D: 9.474 mm
- **Capillary die**: D: 2.095 mm, L/D:3.818
Standardized Testing Condition

ASTM D1238 / ISO 1133 to specify:
- Testing conditions (temperature and weight)
- Testing time
- Sample mass
- Piston travel
- Die dimensions
- Precision
Method A

Manual Operation

- Mass measurement of extrudate collected over time
- Cut-n-weigh method
- Piston in proper position at end of pre-heating time
- Results:

\[
MFR_{Method A} = \frac{10 M}{t_A}
\]

where

- \( MFR \ (g/10\text{min}) \): Melt flow rate
- \( M \ (g) \): Extrudate mass
- \( t_A \ (\text{min}) \): Cutting time
Method B

Automatically Timed Flow Rate Measurement

- Volumetric displacement of polymer melt over time
- No cutting and weighing (simpler method)
- More precise for routine analysis
- Piston in proper position at end of pre-heating time to activate calibrate encoder
- Results:

\[
MVR = \frac{10\pi R^2 L}{t_B}
\]

where

- \( MVR \, (\text{cm}^3/\text{10min}) \): Melt volume – flow rate
- \( R \, (\text{cm}) \): Barrel radios (0.477 cm)
- \( L \, (\text{cm}) \): Length of piston travel (0.635 cm)
- \( t_B \, (\text{min}) \): Piston travel time

\[
MFR = MVR \times \rho_m
\]

where

- \( \rho_m \, (\text{g/cm}^3) \): Melt density at test temperature

Volumetric displacement measurements for MVR

Upper scribe

Lower scribe

Digital encoder (measuring time)
Method A/B
For calculation of apparent melt density

- Measuring melt mass-flow rate (MFR) and melt volume-flow rate (MVR) on the same charge of sample
- The ratio of the two values is a measure of the melt density of the polymer in $g/cm^3$
- Piston in proper position at end of pre-heating time to activate calibrate encoder
- Results:

\[
\text{Melt density } (\rho_m) = \frac{\text{MFR}}{\text{MVR}}
\]
Method C & Method D

**Method C**
Automatically Timed Flow Rate Measurement for High Flow Rate Polyolefins Using “Half” Die

- Using a modified die (D: 1.048 mm, L/D: 3.818)
- For testing POs with a MFR of 75 or greater
- Improve the reproducibility of results by reducing the flow rate
- procedures same as Method B with 2.540 cm length of piston travel

**Method D**
Multi-Weight Using Automatically Timed Flow Rate Measurements

- Flow Rate Ratio (FRR) test
- Using two/three different test loads on one charge of material
- Results:
  \[ FRR = \frac{MFR_{Higher \ test \ load}}{MFR_{Lower \ test \ load}} \]
- For comparison of MWD (higher FRR means broader MWD)
Operation Points

- Stabilizing the temperature of barrel with piston and die in place for ~ 15 min prior to testing
- Swabbing out the barrel using cotton patches and barrel cleaning tool
- Cleaning the die using a proper die cleaning tool
Operation Points

- Using a die plug for materials with very high MFR
- Properly drying the hygroscopic samples (e.g. PET, PA, PC, PU, PBT, PEEK, ABS)
- Sufficient melting time (7 minutes)
Measuring MFR using various weights
Graph of MFR vs Weight
Describing the polymer flow behavior
Higher slope → more shear thinning
For comparing the MWD

Shear thinning of the polymer melt

Intrinsic/solution Viscosity of PET

Determining of IV of PET at 285 °C by melt rheometer (avoid using of noxious solvents)
Both viscosity/MFR and IV are related to the polymer molecular weight. So, they can be correlated to each other!

1Fox-Flory and Mark-Houwink relationships
Thermal stability

- resistance of polymer to a change in MFR at the test temperature over specific period of time
- Can show the presence of moisture or reactive chemicals in polymer.
- can measure the degradation rate or reactivity of polymer
- Repeating the test at various temperatures to give “processing window” of the polymer
Thank You !

“Everything Flows” - Heraclitus

https://www.beautifulworld.com/north-america/united-states/the-wave/