Ray Ran

What is MFI or MFR and why is it important?

Melt flow index (MFI) or Melt Flow Rate (MFR) is a measure of a given polymers' flow characteristics also known as the Rheological properties in the molten state under a known applied pressure. The MFI value quoted on many datasheets refers to the amount of polymer that is extruded through a known given orifice (die) and expressed as quantity in g/10 mins or for Melt Volume Rate in cm^3/10mins .

Since polymers are made up of varying lengths of polymer molecular chains, the length of the chain determines the flow characteristics. Since it is difficult to control the exact chain length during polymerisation, the resulting mix or distribution of chain lengths (long and short) also known as the molecular weight distribution, affects the resulting flow properties. This molecular weight distribution is also an important contributor to the physical and mechanical properties of the resulting polymer amongst other items.

The basic principle of MFI is a simple one. Polymer resin, flake or powders are introduced in to a heated barrel at the bottom of which is a die with a known bore diameter. The standard bore die size is 2.095mm in diamter. It is important to ensure that when the polymer granules are introduced to the barrel that all entrapped air is removed by tampering down the granules, as any air entrapment will give erroneous results. Once the bore is full a piston is placed in the barrel with a known dead weight on top of it. For very basic machines the Extruded samples are cut and the weighed from which the MFI value than calculated.

On the **Ray-Ran 6MPCA** model no physical cut is required. The unique microprocessor multi slicing feature gives accurate MFR values plotted against piston displacement which is all calculated from the materials density at test temperature. Accurate melt volume results rate (MVR) are also calculated alond with shear stress, viscosity and apparent IV.

Why is it Important

Variations in the MFI value on incoming material can have detrimental effects on productivity and quality. It is therefore very important to test the incoming material to ensure Quality Standards are adhered to. It is not uncommon to find that there are batch to batch variations in materials and this can have costly implications. For example, material exceeding the expected MFI can result in flashing of an injection mould leading to an increased reject rate and hours or days of cleaning the mould resulting in lost production from that mould/machine. A Badly flashed hot runner mould could require new nozzles and tips to be replaced which are very costly items. A material with lower than expected MFI could result in parts not filling properly and again leading to an increase in the reject rate and an increase in the quality cost to the business. If the problem is not spotted on the moulding lines, then it could cause problems with finishing departments downstream.

MFI vs MVR

MFI is the flow of extrudate expressed in g/10 mins, whereas the MVR (melt volume flow rate) is the volume of extrudate which flows and is expressed as cm^3/10 mins. Multiplying the MVR with the melt density will give the MFI. Please note that the melt density is not the same as the specific density of the material as specified in the material datasheet. For example, Polypropylene is generally quoted as having a specific density of 0.91g/cm^3. However, the melt density of Polypropylene is nearer 0.70g/cm^3.

Remember the relationship: **Mass** = **Volume** x **Density** (M=VxD), for a given mass if the density changes so must the volume to compensate and vice versa.

It is important to understand the melt density value of your material, especially If you want to calculate the shot weight inside the barrel of an injection moulding machine. Using the specific density value quoted on the datasheet will give you the wrong answer.

International Standards

The two common standards used worldwide for MFI testing are listed below. It is very important to read and understand the standard that you wish to use to ensure that the tests are conducted in total compliance with the specified standard.

- **ASTM D1238 –** Standard Test Method for Melt Flow Rates for Thermoplastics
- **ISO 1133 –** Determination of Melt Mass Flow Rate (MFR) and Melt Volume Flow Rate (MVR) of Thermoplastics

ISO 1133 was updated in 2011 – it now specifies tighter tolerances on the temperature in the cylinder and on the time duration over which the material is subjected to that temperature. Some older models of MFI units no longer comply with this change. Please contact **RAY-RAN** to ensure your unit meets the standard and how we can help you comply with the changes.

RAY-RAN

We offer 2 models of machines which are built to comply with both the above standards. Our basic model (**RR/6MBA**) is manually operated. Whilst our Advanced model (**RR/6MPCA**) is microprocessor controlled and offers many enhancements. Please visit our products page for detailed information.

Filled Polymers

These days many polymers are filled for various reasons from cost reductions by using cheap fillers like calcium carbonate or talc to more expensive fillers to improve mechanical, electrical and thermal properties such as glass fibre, metal powders for magnet detection etc, and let us not forget the addition of a percentage of recycled material to the virgin material. All these materials require testing to ensure conformity to agreed standards.

Fillers are normally categorised as:

1. Reinforcing filler – used to improve properties
2. Non-reinforcing filler – used mainly for cost reduction

An example of a reinforcing filler is carbon black, and calcium carbonate is an example of a non-reinforcing filler.

Depending upon the filler being incorporated and the addition rate, these materials can cause the barrel of the MFI unit to wear much more quickly with time than standard non-filled materials due to the abrasion caused by the incorporation of the filler. This is also true of materials such as PVC and CPVC, which upon degradation releases hydrogen chloride, which is an extremely corrosive gas.

As with injection moulding machine barrels and screws, when using these abrasive/corrosive materials, special coated screws and barrels are used to minimise wear. To this end, **RAY-RAN** offers Hastalloy cylinder, liner and die for their MFI units. Hastalloy is a corrosion-resistant alloy made from nickel-molybdenum and has exceptional corrosion resistance properties.

Hygroscopic Polymers

Hygroscopic polymers are those that will absorb atmospheric water. These materials must be pre-dried in order to ensure the absorbed water is eliminated and therefore water does not have a detrimental effect on the properties of the material. If left unchecked, this could lead to poor performance and cause jetting leaving flow marks around the gate area leading to increased reject rates and quality failures. The appropriate drying temperatures for each material together with their corresponding drying time should be taken from the manufacturer's material datasheets.

Care should be taken when testing these materials for MFI, MVR and the samples must be pre-dried in accordance with the manufacturers' directions. Otherwise, erroneous results will be recorded.

Hygroscopic	**Non-Hygroscopic**
Nylon (polyamides)	Polyethylene
PET, PBT	Polypropylene
ABS	PVC
PC	Polystyrene
PMMA	
Polyurethane	

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