INOFLON®
Polytetrafluoroethylene Resins

PROCESSING GUIDE

INOFLON® M280

INTRODUCTION

INOFLON® M280 is free flow modified resin processed by ram extrusion which is a continuous process and combines both preforming and sintering into a single operation. The feed resin is forced to move down by a reciprocating ram through the heated section of the extruded die which is followed by a cooling zone. Compaction, heating and cooling are carried out in series with in a single extruder die. The temperature of the heated section of the die is above the crystalline melting point of the resin to weld the successive charges of the powder. The advantage of ram extrusion over compression molding is the possibility to obtain very long parts (rods and tubes) suitable for automatic machining. The design of the extruder, extrusion rate, back- pressure generated by the resin itself and temperature must all be carefully controlled. Variation in these parameters affects the quality of the extrudate.

TYPICAL END USE PRODUCT

Many end products are made by extruding INOFLON® M280. It is especially recommended for the extrusion of small rods and thin wall tubes. More complex profiles are also produced using this resin. The extrudate of this resin are machined into parts and components used as electrical insulators, fluid handling seal rings and bearings, bushings and many other parts.

FDA COMPLIANCE

When products made from INOFLON® M280 are correctly processed, that is sintered at high temperatures as practiced by the industry; they may comply with FDA Regulation 21CFR 177.1550 for use in contact with food.

Typical Properties of INOFLON® M280

Properties	Test Method	Unit	Nominal Value
Bulk density	ASTM D 4894	g/l	700
Average particle size (d_{50})	ASTM D 4894	µm	500
Powder flow	ASTM D 1895	g/min	400
Std. specific gravity (SSG)	ASTM D 4894	-	2.160
Melting points	ASTM D 4894	°C (°F)	342 (648) (Initial) 327 (621) (Final)
Tensile strength	ASTM D 4894	MPa (psi)	20 (2900)
Elongation	ASTM D 4894	%	400

Note-These are typical properties and not to be used for specification purpose

PROCESSING

Inoflon® M280 is processed by ram extrusion. Ram extrusion is a continuous process and combines both preforming and sintering into a single operation. The feed resin is forced to move down by a reciprocating ram through the heated section of the extruded die which is followed by a cooling zone. Compaction, heating and cooling are carried out in series with in a single extruder die of uniform diameter. The temperature of the heated section of the die is above the crystalline melting point of the resin to weld the successive charges of the power. The advantage of ram extrusion over compression molding is the possibility to obtain very long parts (rods and tubes) suitable for automatic machining. The design of the extruder, extrusion rate, back- pressure generated by the resin itself and temperature must all be carefully controlled. Variation in these parameters affects the quality of the extrudate.

Higher extrusion pressure is observed in modified PTFE compared to conventional grades of PTFE as, Modified PTFE has more adhesion to the inner surface of the extrusion tool. Push forward speed of ram to be reduced to make movement more "Continuously" and avoid pressure peaks.

RESIN FEEDING

Resin feed section is very sensitive. Resin feed section should be maintained at ambient temperature with enough insulation and jacketed air/water circulation. Higher temperature in feed area may restrict smooth flow of material in to cavity.

COMPACTION OF RESIN

After feeding the resin in to the cavities, the forward movement of ram compacts the charged resin and forwards the charged lengths in to sintering area of the extruder die. This process is continuous to obtain a large length of finished product after sintering.

SINTERING AND COOLING OF RESIN

This successive charges of compacted resin in the extruder die are forwarded to the sintering area where, the temperature is kept above melting temperature of resin. In this area, successive charges of compacted resin gets welded and sintering of the resin is done. The holding time of resin in sintering area may depend up on the size of the profile being extruded. After completion of sintering, resin moves to the last area of the die where cooling of the sintered resin takes place. Cooling rate of the extruded profile needs to be controlled properly to obtain good quality of extrudate. Rapid cooling may result the extrudate with defects.

Table 2-Processing Parameters for Cylindrical Rods

Discription	Units	Value
Solid rod diameter	mm	30
Length of sintering zone	mm	1100
Sintering temp - Upper(1^{st}) zone	°C (°F)	320-330 (608-626)
- Middle(2^{nd}) zone	°C (°F)	360-370 (680-698)
- Lower(3^{rd}) zone	°C (°F)	340-350 (644-662)
- Additional(4^{th}) zone	°C (°F)	320 (608)
Extrusion rate	m/hr	0.4

Note-These are typical properties and not to be used for specification purpose

SAFTEY PRECAUTIONS

Handling and processing of PTFE must be done in ventilated area to prevent personnel exposure to the fumes liberated during sintering and heating of the resin. Fumes should not be inhaled and eye and skin contact must be avoided. In case of skin contacts wash with soap and water. In case of eye contact flush with water immediately and seek medical help. Smoking tobacco or cigarettes contaminated with PTFE may result in a flu-like condition including chills, fever and sore throat that may not occur for a few hours after exposure has taken place. This symptom usually passes within about 24 hours.

Vapors and gases generated by PTFE during sintering must be completely removed from the factory areas. Mixtures of some metal powders such as magnesium or aluminum are flammable and explosive under some conditions. Please read the Material Safety Data Sheet and the detailed information in the "Guide to the Safe Handling of Fluoropolymer Resins" published by the Fluoropolymer Division of The Society of the Plastics Industry available at www.fluoropolymers.org

HANDLING AND STORAGE

For best results the powder processing areas should be kept clean and free of all contamination. Organic contamination and foreign matter usually appear as dark spots often easily visible against the white PTFE background. Organic contamination material degrades at the sintering temperatures and forms discolored spots. They oxidize away as carbon dioxide wherever sufficient oxygen exposure takes place. It is, therefore, not unusual to encounter discoloration inside a part away from the surface where hardly any oxygen is present. Storage of PTFE at 20°C (68°F) or lower prevents lump formation as a result of movement and transportation.

NOTE warning: Do not use any of INOFLON® modified PTFE resins in medical devices that are designed for permanent implantation in the human body. For other medical uses, prior permission of GFL may be sought.

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