Selection Guide of PTFE

PTFE is available in virgin & filled compounds to improve the basic characteristics to match very diverse applications & optimization for specific end users. The grade of PTFE is selected from Virgin & Filled PTFE grades of PTFE, based on required property for required service conditions / applications. The selection guide elaborates various grades of PTFE & Filled PTFE, filler content in PTFE, basic properties & relevant service conditions / End user applications.

Sr.No.	Grade	Filler Content by Weight %	Standard Series	Properties
1	Virgin PTFE	-	Yes	• Hygienic • Excellent chemical resistance • Outstanding electrical properties • Excellent flexural properties
2	Chemically Modified PTFE	-	Yes	• Less Creep • Improved Permeation Resistance • Smoother Surfaces • Less Porous • Better High Voltage Insulation • New Fabricating Versatility with welding
3	Pigmented PTFE	-	No	• Improved Visibility
4	Glass filled PTFE	15 - 25	Yes	• High compressive strength • Excellent chemical resistance • Improved wear resistance under load & deformation
5	Carbon / Coke filled PTFE (soft amorphous/ hard fiber)	25-35	Yes	• High compressive strength • Improved wear resistance under load & deformation • Better thermal / electrical conductivity
6	Graphite filled PTFE (pure crystalline carbon)	15	Yes	• High compressive strength • Improved wear resistance under load & deformation • Better thermal / electrical conductivity. • Good chemical resistance • Improved frictional properties
7	Carbon + Graphite + Glass Filled PTFE	12 + 3 + 10	Yes	• High compressive strength • Improved wear resistance under load & permanent defo • Better thermal / electrical conductivity

8	Bronze filled PTFE(oxidising / Non oxidising)	40 - 60	Yes	• High compressive strength • Excellent wear resistance improved under load & deformation • Better thermal / electrical conductivity. • Good chemical resistance • Very low cold flow
9	Bronze plus, Molybdenum Disulphide filled PTFE	55 + 5	Yes	• Improved fictional properties • High compressive strength • Excellent wear resistance improved under load & deformation • Good thermal / electrical conductivity. • Very low cold flow
10	Aluminium Oxide filled PTFE	7 - 15	No	• Excellentelectrical properties • Excellent compressive strength • Excellent1 wear resistance improved under load & deformation
11	Calcium Fluoride filled PTFE	5 - 10	No	• Excellent chemical resistance • Improved wear resistance under load & permanent defo • Excellent compressive strength • Good with chemicals that attack glass
12	Stainless Steel filled PTFE	5 - 10	No	• Excellent chemical resistance • Outstanding mechanical properties • Good wear resistance
13	Mica filled PTFE	5 - 10	No	• Excellent compressive strength • Very low coefficient of thermal expansion • Poor tensile properties
14	Glass + MoS_2 filled PTFE	5 + 10	Yes	• Excellent chemical resistance • Improved wear resistance under load & permanent defo • Excellent compressive strength • Improved frictional properties
15	PEEK Filled PTFE	15	Yes	• Excellent compressive strength • Excellent chemical resistance • Outstanding mechanical properties at elevated temp. • Good wear resistance
16	MoS_2 Filled PTFE	0.1 - 0.2	No	• Self-lubrication in presence of apolar gas • Low friction coeff. • Retained high dielectric performance even in presence thermal and electrical conductivity due to the filler • Good dimensional stability and not fragile like ceramic • Service temperature range from -272 up to +260℃
17	Borum Nitrite Filled PTFE	10	No	• Self-lubrication in presence of apolar gas

				• Low friction coeff. • Retained high dielectric performance even in presence thermal and electrical conductivity due to the filler • Excellent compressive strength • Service temperature range from -272 up to +260℃
18	Cobalt Aluminate Filled PTFE	0.3	No	• Self-lubrication in presence of apolar gas • Low friction coeff. • Retained high dielectric performance even in presence thermal and electrical conductivity due to the filler • Very high compressive strength • Service temperature range from -272 up to +260℃

There are many popular filled grades PTFE Products brand named as Trexonn, Turcite B, Rulon AR, Rulon AJ Gold having specific properties, designed for specific service and applications.

Chemical Resistance Guide of PTFE

Virgin PTFE :
The chemical resistance of PTFE is excellent. It is stable in most aggressive and corrosive media, exceptions being liquid or dissolved alkali metals, flourine and other extremely potent oxidisers.

PTFE is not chemically resistive to:-

- Moltem or dissolved Alkali metals – Sodium, Potassium, Rubidium, Cesium, Francium
- Fluorine Gas
- Fluorine compounds & complexes at elevated temperature

Fillled PTFE Compositions :
The resistance of Filled PTFE compositions to number of Chemicals is given below. In general carbon and glass filled compositions give better performance in chemical service.

A = Excellent, B = Fair, C = Unsatisfactory.

Chemical	Filler		
	Carbon	Glass	Bronze
Acetaldehyde	A	A	A
Acetone	A	A	A
Aluminium Sulphate	A	A	B
Ammonium chloride	A	A	C

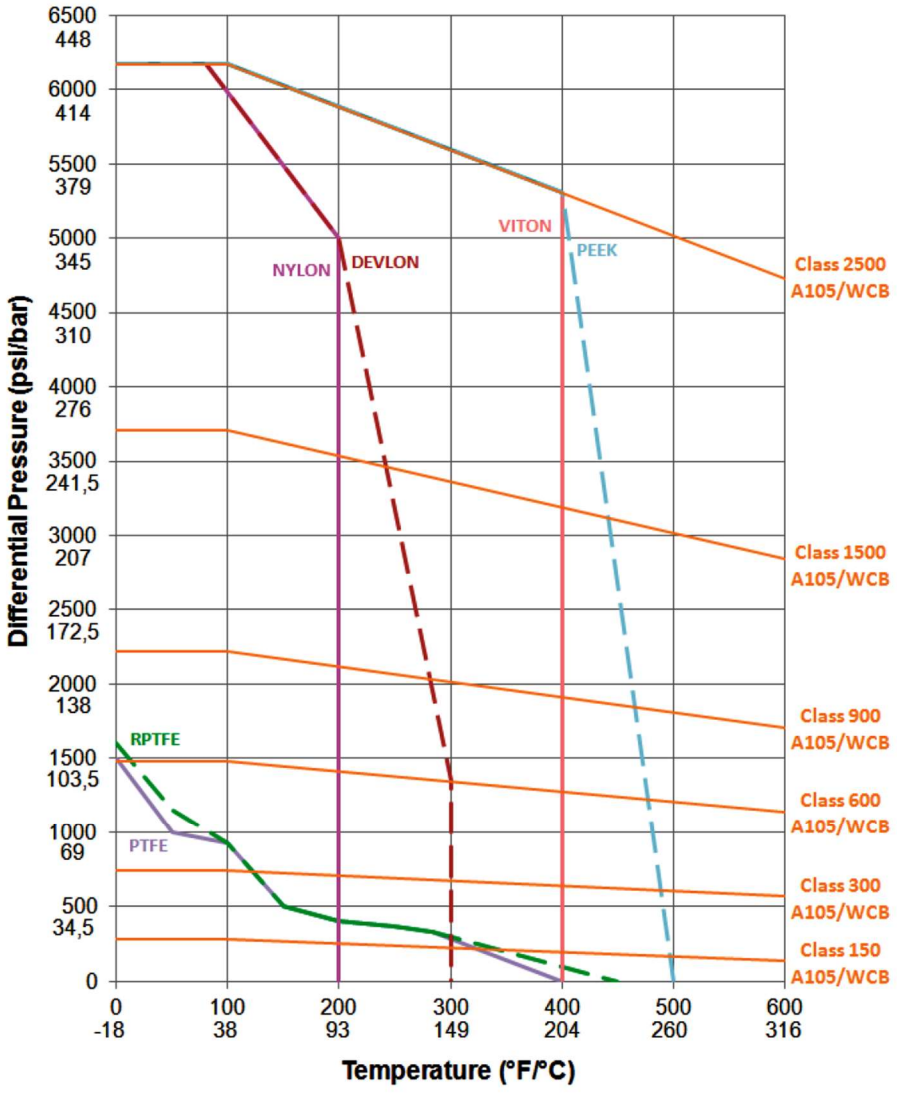
Chemical	Filler		
	Carbon	Glass	Bronze
Ammonium hydroxide	A	B	C
Aniline	A	A	C
Benzene	A	A	A
Brine	A	A	A
Bromine (anhydrous)	C	B	C
Carbon Disulphide	A	A	A
Chloroacetic acid	A	A	B
Chlorobenzene	A	A	A
Chloroform	A	A	A
Chromic acid	B	B	C
Citric acid	A	A	A
Diethyl ether	A	A	A
Ethylene glycol	A	A	A
Fatty acids	A	A	A
Ferric Chloride	A	A	C
Ferric sulphate	A	A	C
Fluorosilicic acid	B	B	C
Formic acid	A	A	A
Freon (liquid)	A	A	A
Hydroboric acid	A	B	C
Hydrochloric acid	A	B	C
Hydrocyanic acid	A	B	C
Hydrogen sulphide(solution)	A	C	C
Lead acetate	A	A	C
Maleic acid	A	A	B

Chemical	Filler		
	Carbon	Glass	Bronze
Mercury salts	A	A	C
Molasses	A	A	B
Naptha	A	A	B
Naphathalene	A	A	B
Nickel salts	A	A	A
Nitric acid	C	B	C
Nitro benzene	A	A	A
Phenol	A	B	A
Phosphoric acid	A	A	C
Picric acid	A	A	A
Pyridine	A	A	C
Salicylic acid	A	A	B
Silver nitrate	A	A	C
Sodium carbonate	A	A	A
Sodium hydroxide	A	B	A
Sodium nitrite	A	A	A
Sodium peroxide	B	A	C
Sodium silicate	A	C	A
Sodium sulphide	A	A	C
Starch	A	A	A
Sulphuric acid	B	A	C
Tallow	A	A	A
Tannic acid	A	A	A
Tartaric acid	A	A	A
Trichloroethylene	A	A	B

Chemical	Filler		
	Carbon	Glass	Bronze
Zinc Oxide	A	A	C

A = Excellent, B = Fair, C = Unsatisfactory.

Pressure / Temperature Chart:



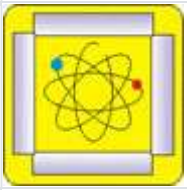
**Only for reference. Please consult us for each particular applicaction*

Basic Properties of PTFE

PTFE is polymer which is extensively used- in chemical, mechanical, electronic & electrical industries due to its unique characteristics.

- Chemical inertness to all known chemicals, however attacked by molten alkali metals, chlorine, trifluorides, fluorine & related fluorine complexes at elevated temperature & pressure.
- Resistance to solvents, insoluble in all solvents up to 260℃. Certain high fluorinated oils swell & dissolve PTFE at temperature close to crystalline melting point.
- Wide operating temperature range -250℃ to +260℃, at atmospheric pressure.
- Lowest coefficient of friction among all known metals & nonmetals.
- Nontoxic & antistick properties.
- Negligible water absorption.
- Nonflammable
- Resistance to radiations, electrical properties remain practically unchanged during & after irradiation, both in air & vacuum.
- Excellent weathering resistance.
- Outstanding electrical/insulating properties over wide frequency range.

PTFE Properties at a glance	
Exemplary Chemical Inertness	
Exceptional weathering resistance	
Excellent electrical insulation characteristics	
Remarkable Heat resistance	
Non-adhesive Properties	
Very low coefficient of friction	

Resistance to Magnetic Field	
Non-Flammable	
High Resistance to Radiation	
Negligible Water Absorption	
Non Toxic	

Service Conditions that PTFE Can Work
Corrosive
Radiation
Subzero - Cryogenic
Ultraviolet Exposure
Hygienic
Low - Zero - high gravity - Space
Marine
Erosive
Magnetic Fields
Electrical Insulations
Non adhesive
Non Friction
Heat Up to 200℃
Vacuum

Properties & Grades of Filled PTFE

PTFE is available in many different Grades as Virgin PTFE, Chemically Modified PTFE, Carbon Filled PTFE, Glass Filed PTFE, Carbon / Coke Filled PTFE, Graphite Filled PTFE, Bronze Filled PTFE, Bronze + Molybdenum Disulphide Filled PTFE, Aluminum Oxide Filled PTFE, Calcium Fluoride Filled PTFE, Stainless Steel Filled PTFE, Mica Filled PTFE, Glass + MoS_2 Filled PTFE, MoS_2 Filled PTFE, Chemically Modified PTFE etc.

The Filled grades of PTFE can be compounded & customized for specific service conditions & applications. Filled PTFE grades have specific properties improvement based on filler, type of filler & percentage of filler.

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1	Virgin PTFE	-	Yes	• Hygienic • Excellent Chemical Resistance • Outstanding electrical properties
2	Chemically Modified PTFE	-	Yes	• Less Creep. • Improved Permeation Resistance • Smoother Surface • Less Porous • Better High Voltage Insulation • New Fabricating Versatility with welding
3	Pigmented PTFE	-	No	• Improved Visibility
4	Glass filled PTFE	15 - 25	Yes	• High compressive strength • Excellent chemical resistance • Improved wear resistance under load & permar

5	Carbon / Coke filled PTFE (soft amorphous carbon hard fiber)	25 - 35	Yes	• High compressive strength • Improved wear resistance under load & permar • Better thermal / electrical conductivity
6	Graphite filled PTFE(pure crystalline carbon)	15	Yes	• High compressive strength • Improved wear resistance under load & permar • Better thermal / electrical conductivity. • Good chemical resistance • Improved frictional properties
7	Carbon + Graphite + Glass Filled	12 + 3 + 10	Yes	• High compressive strength • Improved wear resistance under load & permar • Better thermal / electrical conductivity.
8	Bronze filled PTFE(oxidising /Non oxidising)	40 - 60	Yes	• High compressive strength • Excellent wear resistance improved under load • Better thermal / electrical conductivity. • Good chemical resistance • Very low cold flow
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13	Mica filled PTFE	5 - 10	No	• Excellent compressive strength • Very low coefficient of thermal expansion • Poor tensile properties
14	Glass + MoS_2 filled PTFE	5 + 10	Yes	• High compressive strength • Excellent chemical resistance • Improved wear resistance under load & permar • Improved frictional properties

15	MoS_2 Filled PTFE	0.1 - 0.2	No	• Self-lubrication in presence of a Polar gas • Low friction coefficient • Retained high dielectric performance even in p to the filler • Good dimensional stability and not fragile like c • Service temperature range from -272 up to +26
16	Peek Filled PTFE	15	Yes	• High compressive strength • Excellent chemical resistance • Outstanding mechanical properties at elevated • Good wear resistance
17	Borum Nitrite Filled PTFE	10	No	• Self-lubrication in presence of a Polar gas • Low friction coefficient • Retained high dielectric performance even in p to the filler • Excellent compressive strength • Service temperature range from -272 up to +26
18	Cobalt Aluminate Filled PTFE	0.3	No	• Self-lubrication in presence of a Polar gas • Low friction coefficient • Retained high dielectric performance even in p to the filler • Very high compressive strength • Service temperature range from -272 up to +26

- There are many popular filled grades PTFE Products brand named as Trexonn, Turcite B, Rulon AR, Rulon AJ Gold having specific properties, designed for specific service and applications.

FILLERS IN PTFE

Practically any material that can withstand the sintering temperature of PTFE can be used as filler. Characteristics such as particle shape and size, and the chemical composition of the filler greatly affect the properties of the compound. All fillers used in PTFE compounds have been carefully selected and were in several cases specially developed to give the best balance of properties. The following paragraphs discuss the main features of the most commonly used fillers.

GLASS Filler in PTFE

Glass fibre is the most widely used filler. It improves the creep resistance of PTFE, both at low and high temperature. It is chemically stable (except to strong alkalis and hydrofluoric acid - HF).It has little effect on the electrical properties of PTFE, and improves its wear and friction behavior. A not uncommon problem with glass-filled PTFE is discoloration of the finished parts, in particular on the inside of large billets. The glass used in PTFE compounds has been treated by a proprietary process to reduce this

CARBON Filler in PTFE

Amorphous carbon is one of the most inert fillers, except in oxidizing environments where glass performs better. Carbon adds to the creep resistance, increases the hardness and raises the thermal conductivity of PTFE. Carbon filled compounds have excellent wear properties, in particular when combined with graphite. The combination of the above properties makes carbon/graphite compounds the preferred material for non-lubricated piston rings. The use of softer carbon has the additional advantage that it lowers tool wear during machining, thus allowing machining to very close tolerances. Carbon-containing compounds have some electrical conductivity and are therefore antistatic.

	CARBON
Base	partly graphitised coke
Purity	> 99% C
Particle size	< 75 µm
Density	1.8

CARBON FIBRE Filler in PTFE

Addition of carbon fibre to PTFE changes its physical properties in the same way as glass fibre does: Lower deformation under load, higher compressive and flex modulus and increased hardness.

In general, less carbon fibre than glass fibre is needed to achieve the same effect. Carbon fibre is chemically inert and can be used in strong alkali and in HF, where glass-filled compounds fail. Compounds of PTFE with carbon fibre have the advantage of higher thermal conductivity and lower thermal expansion coefficients than glass-filled ones with the same filler percentages, and they are lighter.

They wear less in contact with most metals, and are also less abrasive on the mating surface. The wear in water is particularly low. This makes carbon-fibre-filled PTFE an excellent bearing material, especially when lubricated with water. It is widely used in the automotive industry for bearings and seal rings, for example in water pumps and in shock absorbers.

GRAPHITE Filler in PTFE

Graphite is a crystalline modification of high purity carbon. Graphite-filled PTFE has one of lowest coefficients of friction. It has excellent wear properties, in particular against soft metals, displays high load-carrying capability in high-speed contact applications and is chemically inert. It is often used in combination with other fillers

	GRAPHITE
Source	synthetic
Purity	> 99% C

	Irregular shaped
Particle size	< 75 µm
Density	2.26

BRONZE Filler in PTFE

Bronze is an alloy of copper and tin. Addition of high percentages of bronze powder to PTFE results in a compound having high thermal conductivity and better creep resistance than most other compounds. Bronze-filled PTFE is often used for components in hydraulic systems, but is not suited for electrical applications and is attacked by certain chemicals. Bronze has a tendency to oxidize: bronze-filled compounds should therefore be used fresh and containers should always be kept closed. Some discoloration of the finished part during the sintering cycle is normal and has no impact on its quality.

	BRONZE
Cu / Sn	9 / l
	Low in phosphorus
Particle size	< 75 µm
Particle shape	Spherical Irregular (2146-N)
Density	8.95

MOLYBDENUM DISULPHIDE (MoS_2) Filler in PTFE

Molybdenum disulphide adds to the hardness and stiffness of PTFE and reduces friction. It has little effect on its electrical properties. It is quite unreactive chemically and dissolves only in strongly oxidising acids. It is normally used in low percentages and together with other fillers. Compounds containing molybdenum disulphide need special attention during preforming and sintering.

	MoS_2
Source	mineral
Purity	> 98%
Particle size	< 65 µm
Density	4.9

ALUMINA (Al_20_3) Filler in PTFE

Alumina or aluminium oxide is an excellent electrical insulator and is used to improve mechanical properties of compounds used in high voltage applications. As it is very hard, machining of the sintered part should be avoided whenever possible. Complicated shapes should be made by isostatic moulding.

CALCIUM FLUORIDE (CaF_2) Filler in PTFE

Calcium fluoride is a suitable filter for PTFE in uses where it comes in contact with chemicals that attack glass, such as hydrofluoric acid and strong alkalis. High purity grades of CaF_2 are also used in electrical applications.

POLYMERS Filler in PTFE

In recent years, polymeric fillers with sufficient heat stability to be used in PTFE have become available. Some remarkable properties have been obtained with polymer filled compounds, particularly with respect to friction against soft metal.

MICA Filler in PTFE

Mica is a mineral with a plate like structure. During processing, the particles orient themselves perpendicular to the pressing direction. This results in very low shrinkage and low thermal expansion in the cross direction. Tensile properties are poor, so that mica- filled compounds are only suitable for parts under compressive stress.

PIGMENTS Filler in PTFE

It is possible to pigment PTFE, using inorganic pigments that withstand the sintering temperature of PTFE. Pigments do not significantly change the properties of PTFE. Combinations of pigments and other fillers can be used.