Ultra High Molecular Weight Polyethylene (UHMWPE)

UTEC®

Braskem

UTEC is the trade name of the Ultra High Molecular Weight Polyethylene (UHMWPE) developed and produced by Braskem with our own catalyst and production technology.

UTEC has a molecular weight about 10 times higher than High Density Polyethylene (HDPE) resins. The ultra high molecular weight of UTEC results in excellent mechanical properties such as high abrasion resistance, impact strength and low coefficient of friction. These special properties allow the product to be used in several high performance applications.

UTEC is sold in powder form in grades according to the molecular weight and average particle size. The molecular weight may be in the low range (3 million g/mol), medium range (5 million g/mol) or high range (7 to 10 million g/mol). Products with these different molecular weights are available in small (average diameter around 150 µm) or large particle sizes (average diameter around 205 µm).

UTEC®

Control Properties	Intrinsic Viscosity	Molecular Weight [a]	Density	Average Particle Size D50	Tensile Strength at Break	Charpy Impact Strength [a]	Hardness (Shore D) (15s)	Abrasion Index (ISO 15527 refeence set to 100)	Kinetic Friction Coefficient	Melt Temperature	Coefficient of Linear Thermal Expansion (between -30°C and 100 °C)	Specific Heat @ 23 °C	Specific Melt Enthalpy
Method	ASTM D 4020	Braskem	ASTM D 792	ASTM D 1921	ASTM D 638/ ISO 527	ISO 11542-2	ASTM D 2240/ ISO 868	Braskem (sand slurry method)	ASTM D 1894	ASTM D 3418	ASTM D 696	ASTM E 1269	ASTM D 3418
Units	dl/g	g/mol	g/cm^3	µm	MPa	kJ/m^2	-	-	-	°C	$°C^{-1}$	cal/g °C	cal/g
UTEC 3040	14	3.0×10^6	0.925	205	> 30	> 180	64	100	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require high impact resistance - technical and porous parts, filters, compression molded sheets and pipes.												
UTEC 3041	14	3.0×10^6	0.925	150	> 30	> 180	64	100	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require a good combination between impact and wear resistance and use or pigments and/or additives - technical and porous parts, filters, compression molded sheets.												
UTEC 4040	18	4.0×10^6	0.925	205	> 30	> 130	64	91	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require a good combination between impact and wear resistance - technical and porous parts, filters, compression molded sheets and pipes.--												
UTEC 4041	18	4.0×10^6	0.925	150	> 30	> 130	64	91	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require high wear resistance and use of pigments and/or additives - technical parts, RAM extruded and compression molded sheets, rods, profiles and battery separators.												
UTEC 5540	24	6.0×10^6	0.925	205	> 30	> 100	64	82	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require high wear resistance - technical parts, RAM extruded and compression molded sheets, rods, profiles and pipes.												
UTEC 5541	24	6.0×10^6	0.925	150	> 30	> 100	64	82	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require high wear resistance and the use of pigments and/or additives - technical parts, RAM extruded and compression molded sheets, rods, profiles and battery separators.												
UTEC 6540	28	8.0×10^6	0.925	205	> 30	> 100	64	76	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require highest wear resistance - technical parts, RAM extruded and/or compression molded sheets, rods and profiles.												
UTEC 6540G	28	8.0×10^6	0.925	225	> 30	> 100	64	76	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require highest wear resistance - technical parts, RAM extruded and/or compression molded sheets, rods and profiles.												
UTEC 6541	28	8.0×10^6	0.925	150	> 30	> 100	64	76	0.09	133	1.5×10^{-4}	0.48	34
	Applications which require highest wear resistance and the use of pigments and/or additives - technical parts, RAM extruded and compression molded sheets, rods and profiles.												

a) Calculated using Margolies' equation. b) Determined with double-notched specimens (14° v-notch on both sides) in accordance with ISO 11542-2. Braskem does not recommend the use of its products for manufacturing packages, pieces or any other type of product that will be used for storing of or be in contact with parenteral solutions or that will have any type of internal contact with the human body, except when explicitly indicated otherwise.

Impact Strength

UTEC is the best solution because of its remarkable impact strength compared to other materials. Figure 1 compares the impact strength of the most important commodities resins and engineering plastics with UTEC.

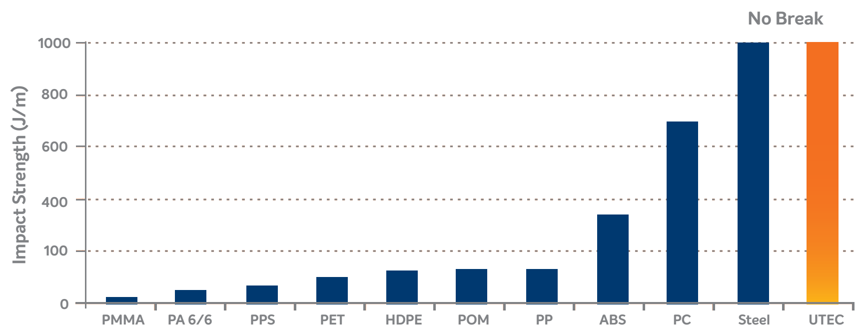


Figure 1 – Notched Izod Impact Strength (ASTM D 256): UTEC vs. other materials.
Data source: HARPER, CHARLES A. Modern Plastics Handbook. 1999.

Coefficient of Friction

UTEC is an excellent material for sliding applications (low coefficient of friction), working as a self-lubricating material. Figure 2 compares the static and dynamic coefficient of friction of UTEC with other engineering thermoplastics, where it can be seen that, even without additives, UTEC is still the best performance solution for sliding applications.

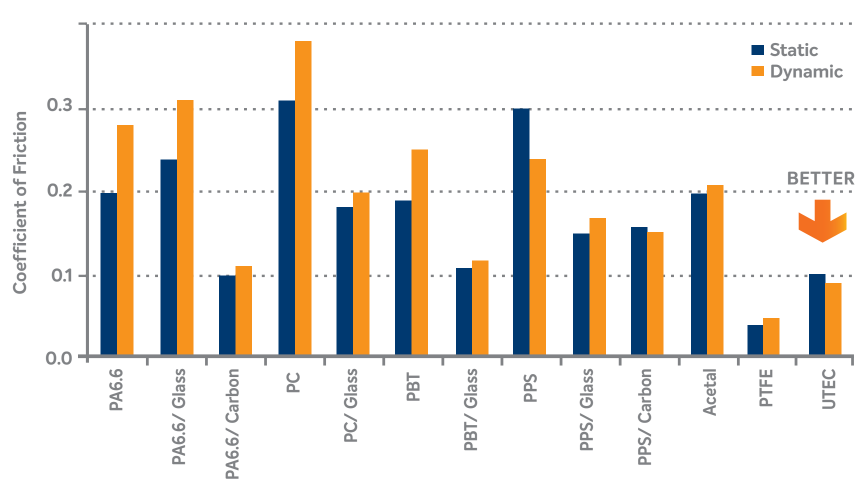
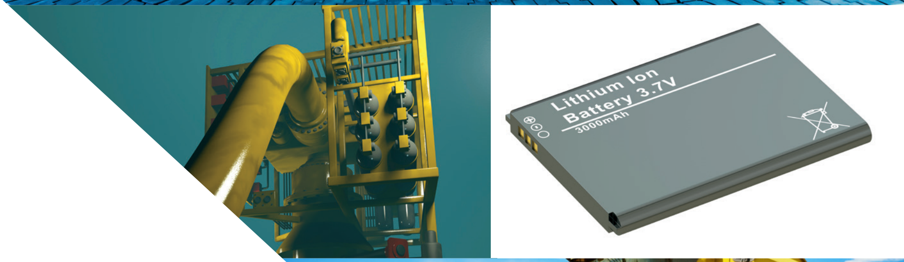
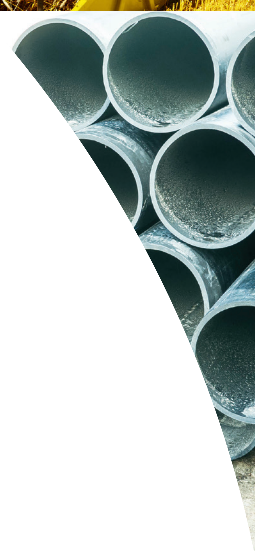


Figure 2 – Static and Dynamic Coefficient of Friction of UTEC and other materials.
Data Source: CRAWFORD, R.J. Plastics Engineering. 3rd edition, 1998.



Industries

- Automotive and Transportation
- Electronics
- Industrial and Heavy Equipment
- Material Handling
- Fibers and Textiles
- Oil and Gas
- Pipe and Mining
- Water Filtration
- Recreation and Consumer



Molecular Chain Length

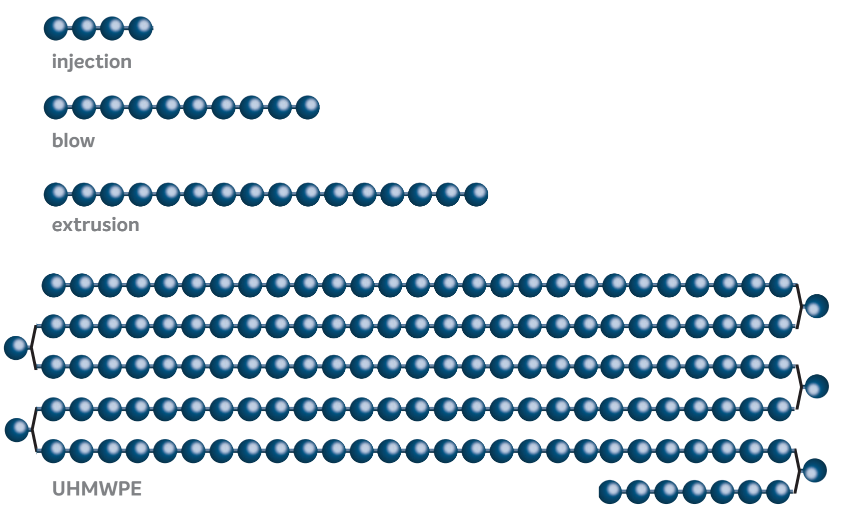
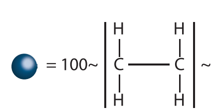


Figure 3 – Comparing polyethylenes for injection, blow and extrusion molding with UTEC® UHMWPE polymeric chain



Chemical Resistance

UTEC is extremely resistant to a wide variety of substances. The material is almost totally inert, therefore it can be used in the most corrosive or aggressive environments at moderate temperatures. Even at high temperatures, UTEC is resistant to several solvents, except aromatic, halogenated hydrocarbons and strong oxidizing materials, such as nitric acid.

Compatibility tests between a product sample and the chemical environment are strongly recommended to verify satisfactory part performance, at the same conditions, for a period of time equal to the life time expected, for each new application. Even substances classified with high attack or absorption characteristics show good practical results.

Abrasion Wear Resistance

Another outstanding UTEC property is the abrasion wear resistance. This makes UTEC suitable for replacing metals in applications that require high abrasion resistance and, while providing light-weighting benefits as well.

Figure 4 compares the relative wear resistance of UTEC with other materials used in high wear applications such as tubes, liners, silos, containers and other equipment.

In the UHMWPE technology, it is well-known that the abrasion wear decreases with molecular weight as shown in Figure 5.

Figure 4 – Relative abrasion wear of UTEC grades and various materials, STEEL SAE 1020 = 100. The pictures show the tested parts. Measured by Braskem internal sand slurry method.

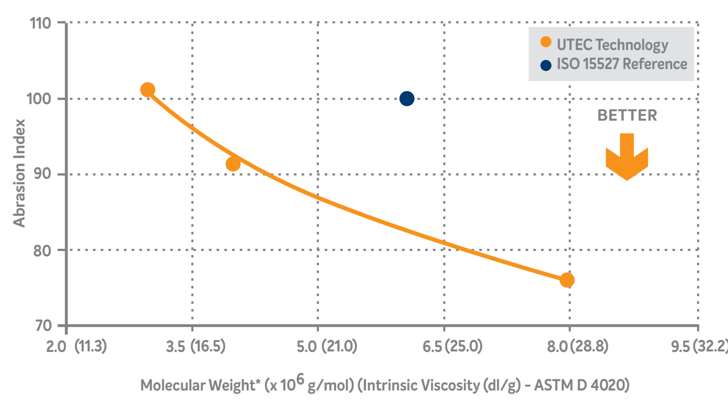


Figure 5 – Abrasion Index (Braskem internal sand slurry method) as a function of the Molecular Weight for the UTEC technology, measured according to ISO 15527 (ISO reference set as 100).

Nomeclature

Additional Properties

- Elongational Viscosity x Molecular Weight
- Impact Strength x Temperature
- Stress x Strain
- Yield Stress x Temperature
- Specific Enthalpy x Temperature
- Specific Heat x Temperature

Molecular Structure

The UTEC molecular structure has direct impact on its physical and thermal properties as well as processing performance. There are some characterization methods which can be used to measure the molecular weight of polymers. In the case of UHMWPE resins, the viscosity of polymer diluted solutions is widely used for that purpose.

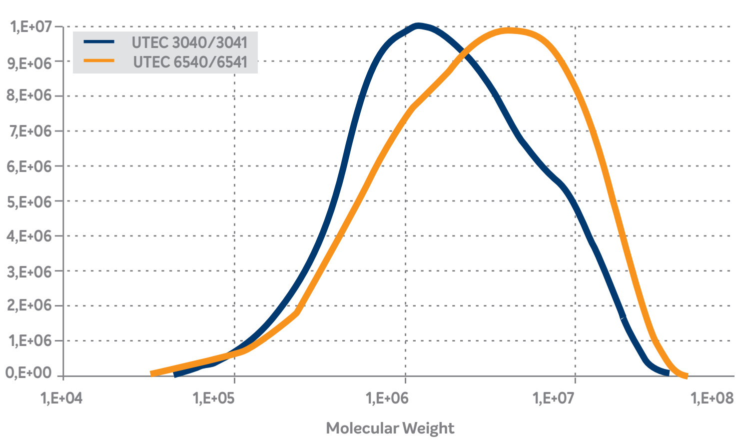
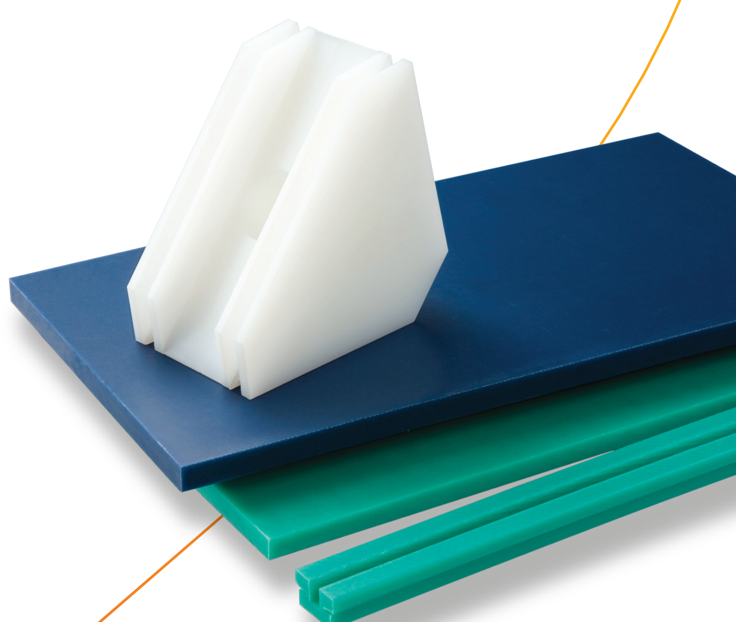


Figure 6 – typical UTEC technology MWD (Molecular Weight Distribution) curves measured by GPC (Gel Permeation Chromatography) method.

Processing

It is not possible to process UTEC through conventional methods such as injection, blow or extrusion molding, because this material does not flow even at temperatures above its melting point. It requires special processing techniques, the most common are RAM extrusion and compression molding. These processes are generally used to produce semi-finished parts such as rods and sheets. UTEC can also be sintered into porous parts (filters). Battery separators for a variety of applications can be produced from cast or calendered films using UTEC.

Those semi-finished parts can then be machined into parts for a wide range of applications. It is possible to use the same machining techniques as those used for wood or metal, such as sawing, milling, planing, drilling and turning. Other conversion processes may also be used.



For more information, visit **www.braskem.com/utec**

With a human-oriented global vision of the future, Braskem strives every day to improve people's lives by creating sustainable solutions with chemicals and plastics.

Braskem is the largest producer of thermoplastic resins in the Americas and the leading producer of biopolymers in the world, creating more environmental-friendly, intelligent and sustainable solutions through chemicals and plastics. Braskem exports to clients in approximately 100 countries and operates 41 industrial units, which are located in Brazil, United States, Germany and Mexico, the latter in partnership with the Mexican company Idesa.

Braskem America is an indirect wholly owned subsidiary of Braskem S.A. headquartered in Philadelphia. The company is the leading producer of polypropylene in the United States, with six production plants located in Texas, Pennsylvania and West Virginia, and an Innovation and Technology Center in Pittsburgh. For more information, visit www.braskem.com/usa.