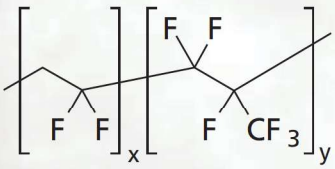
PEKK AND GRAFTED PVDF

Two Innovative Chemistries Offering Primerless Coating Solutions for the Most Demanding CPI Applications

Grafted PVDF – What is It ?

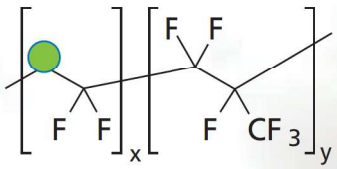
Polyvinylidene difluoride (PVDF) is a thermoplastic fluoropolymer, widely used in CPI industries due to a unique combination of chemical compatibility, thermal and UV resistance and mechanical properties.



Standard Kynar® Flex PVDF copolymer (Sigma Aldrich, s.d.)

PVDF-based copolymers are similar to homopolymer resins in purity and chemical resistance, but also have chemical compatibility in high pH solutions, increased impact strength at ambient and low temperatures.

The grafting technique consists in substituting one Hydrogen atom of the CF2H2 molecule by a reactive group, thus enabling the long-chain molecule to enhance reactivity with other substances.



Grafted Kynar® ADX Flex PVDF copolymer

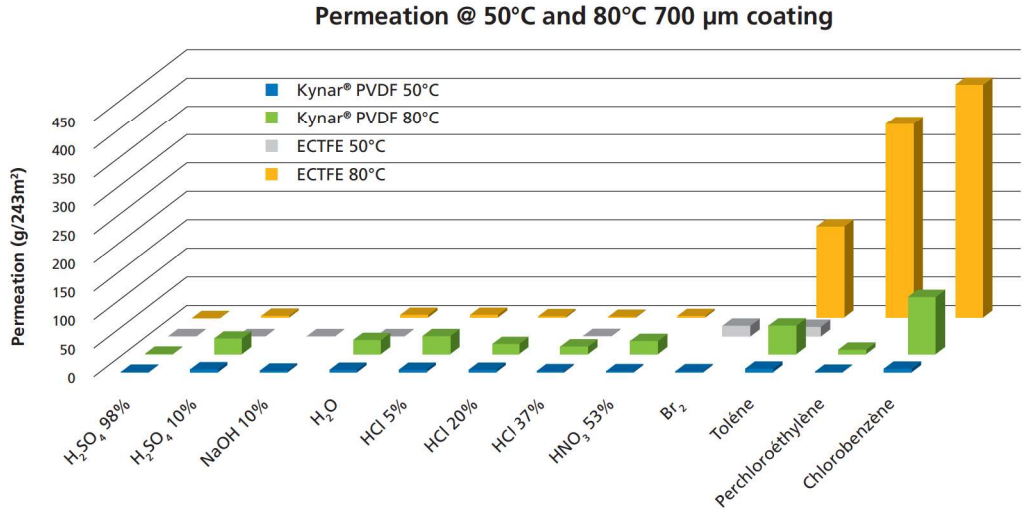
Grafted group

In particular, grafted-PVDF has a strong reactivity with metal. It makes it an ideal choice for a coating resin. Direct adhesion with metal eliminates the need for a primer, which creates benefits in terms of productivity and exposure to hazardous substances.

Superior resistance to chemicals

Kynar® PVDF resins are chemically resistant to a wide range of chemicals. Most acids and acid mixtures, weak bases, halogens, halogenated solvents, hydrocarbons, alcohols, salts and oxidants pose little problem for Kynar® PVDF.

At ambient temperatures, Kynar® Flex® copolymers are generally resistant to chemicals with a pH up to 13.5. Many factors can affect a material's chemical resistance. These



BY SANTIAGO CARRERAS; ERIC THOMAS, ARKEMA

include, but are not limited to, exposure time, chemical concentration, extreme temperature and pressure, frequency of temperature and pressure cycling, attrition due to abrasive particles, and the type of mechanical stress imposed. The fact that certain combinations of chemical exposure and mechanical load can induce stress cracking in many otherwise chemically resistant materials, both metallic and nonmetallic, is of particular significance. In general, the broad molecular weight distribution of Kynar® resins results in greater resistance to stress cracking.

Factors such as permeability and adhesion affect the chemical resistance of Kynar® PVDF coatings. Consequently, coatings may not exhibit exactly the same properties as melt-processed Kynar® resin.

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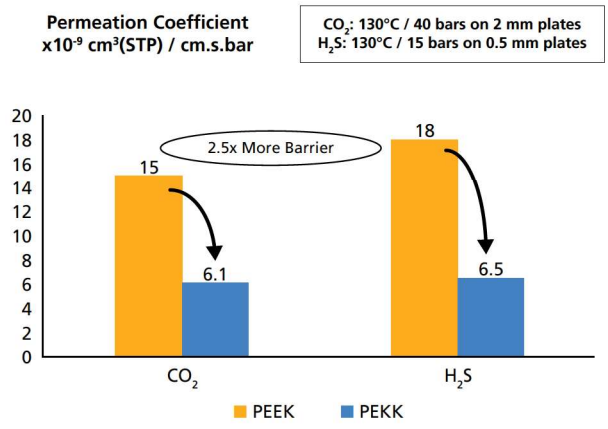

Chart 1. Permeation vs $C0_2$ and H_2S

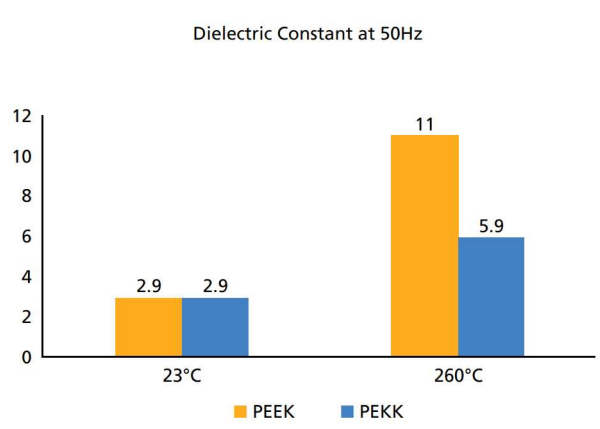

Chart 2. Dielectric Properties vs. Temperature

Resistance to nuclear radiation

The resistance of Kynar® fluoropolymers to nuclear radiation is excellent. The original tensile strength of the resin is essentially unchanged after exposure to 100 megarads (Mrads) of gamma radiation from a Cobalt-60 source at 50°C (122°F) and in high vacuum (10-6 torr). This resistance to effects of radiation, combined with chemical resistance, has resulted in the successful use of Kynar® components in nuclear reclamation plants.

Grafted PVDF for Chemical Processing Handling Industries

Because it has high temperature resistance, low permeability and high mechanical strength, Kynar® PVDF is used as a contact surface for the production, storage and transfer of corrosive fluids. Kynar® PVDF resin is used in mechanical components, fabricated vessels, tanks, pumps, valves, filters, heat exchangers, tower packing, piping systems, and many other applications.

Due to its unrivalled chemical resistance, fluorinated polymers offer a suitable alternative to phenolic epoxy when protecting iso containers. As a thermoplastic, the product is easy to apply and its mechanical properties will not be affected by time or temperature change. Compared to phenolic epoxy resins, Kynar® PVDF offers increased ***abrasion resistance***, easier and ***safer*** application process, with ***no VOCs*** involved. In addition, PVDF is ***fire resistant*** and complies with UL94 V-0 classification.

Maintenance is also easily facilitated with Kynar® PVDF. Thanks to a smooth and hydrophobic surface, Kynar® ADX Flex 281 G is easy to clean with water at 50°C, or hydro jetting up to 100 bar or 200 bar.

One potential drawback of thermoplastic polymers is that the maximum operating temperature is restricted by the melting point of the polymer. For operating at very high temperatures, other thermoplastic polymers exist, such as Poly Aryl Ether Ketones (PAEKs), which combine unrivalled heat resistance and chemical compatibility.

PEKK at the Top of the Pyramid

PAEKs are used in technically challenging industry sectors, e.g. aerospace industry, industrial equipment and oil and gas, for instance. PEKK exhibits very high mechanical properties, chemical and fire resistance and can withstand a continuous use temperature above 240°C. Due to its high melt temperature, PEKK is also unique in terms of processing technologies due to its tunable crystallization speed.

Among PAEK family, one of the new comers is Poly Ether Ketone Ketone (PEKK), which shows best in class behavior. Due to its tunable crystallization speed, PEKK is also unique in terms of processing technologies.

PEKK general chemical structure

PEKK exhibits superior mechanical performance and a high temperature rating because of its high ketone/ether ratio. In addition, thanks to its wide temperature processing window, this material is compatible with a large array of processes, which includes not only extrusion, 3D-printing, carbon-fiber reinforcement, but also compression molding and thermoforming.

The main features of PEKK include: Highest Tg of PAEK family, high tensile and compression strength/high stiffness, high

chemical resistance in harsh conditions, and excellent fire properties.

PEKK material is among the rare PAEK polymers to combine both exceptional mechanical properties, high temperature rating, and chemical compatibility with aggressive fluids. Additionally, properties such as permeation and creep make this polymer an ideal candidate for CPI and Oil & Gas applications, as shown in Chart 1.

On the other hand, Chart 2 shows that the properties are much more stable with increasing temperature compared to other PAEKs.

"What is most surprising about PEKK is not the unmatched performance, but rather the consistency of those properties at temperatures above 200°C", says Pierre Gonnetan, PEKK expert at ARKEMA.

Benefits of Powder Coating for Protecting Containers

There are many reasons explaining why powder coatings are so attractive and growing at a global scale.

First, they are easy to apply. Process versatility allows adjusting thickness, which is usually around 500 µm. Two common ways to apply a powder coating film are by dipping in a fluidized bed or by spraying.

Even complex and large applications like the internal coating of ISO containers or tanks with Kynar® PVDF are possible thanks to a unique proprietary process.

Secondly, both Kynar® PVDF and Kepstan® PEKK can be applied directly on the metal surface without primer, thanks to their inherent adhesion to metals.

It means no limited shelf life, no mixing steps and at no VOC, which represents significant progress in terms of health and safety for the coating process.

In addition, Kynar® PVDF is easily repaired (even in the field if needed) by melting Kynar® PVDF wire on the defect area with a gun like the one shown below[1]. ▪

Rack coated with Kynar® ADX Flex 281[2]

Part coated with PEKK Kepstan® 6002 PL

1 Source Lithcote. 2 Image courtesy of SALCO PRODUCTS.