Corrosion Protection With Fluoroplastics

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INTRODUCTION

New fluoropolymer systems and coating processes have been through rapid development in the last 10 years. Most of the service requirements put forward by the chemical and pharmaceutical industries, the flue gas cleaning industry and others can now be satisfied with the use of fluorplastics. Some of the typical service requirements would be chemical and temperature resistance, FDA compliance, and easy cleaning.

TYPES AND PROPERTIES

Table 1 shows the chemistry and some physical properties of the commercial fluoropolymers for corrosion protection.

Next to the chemical structure, the table also contains the melting point, the maximum temperature of use and the critical surface tension (γc) of the fluoropolymers.

The properties of Polyethylene (PE) are included in *Table 1* for comparison. It shows that the only chemical difference between PE and PTFE is that all the hydrogen (H) in PE has been replaced by fluorine (F) to obtain PTFE. In general, the more fluorine in the molecule the better the properties and consequently the better the corrosion protecting ability. *See Table 1.*

When there only is fluorine (F) together with carbon (C) the polymer is called "fully fluorinated". PTFE, PFA and FEP belong to this category.

Name	Chemical name	Chemical structure	Temperature maximum°C	γc	Melting point °C
PTFE	Polytetra-fluoroethylene	F F -C-C- F F	260	18	327
PVDF	Polyvinyliden-fluoride	F H -C-C- F H	140	25	170
E-CTFE	Ethylen chloro-trifluoroethylene	H H F F -C-C-C- C- H H CL F	150	31	245
FEP	Fluorinated ethylene propylene	F F-C-F F F F | (-C-C-)-(-C-C-) F F F F	205	16	270
PFA/TFA	Perfluoroalkoxy	(R = -C3F7) F F F O (-C-C-)- (-C-C-) F F F F	260	17	305
ETFE	Ethylentetra-fluoroethylene	H H F F (-C-C-C-C-) H H F F	150	17	270
PE	Polyethylene	H H (-C - C-) H H	70	31	100

Table 1 - Properties of fluoroplastics

The reason for the excellent properties is the strong C-F bond, the highest bond strength obtainable. Also, the bond radius is the smallest. It is assumed this fact gives the resistance to all common chemicals, low surface tension (which gives non-stick properties), low friction, and the extreme low permeability of small molecules.

COATING THICKNESS

The thickness of the coating has much influence on the permeation and consequently on the corrosion protection. *Figure 1* shows water permeation through polymers with different thicknesses at 100° C.

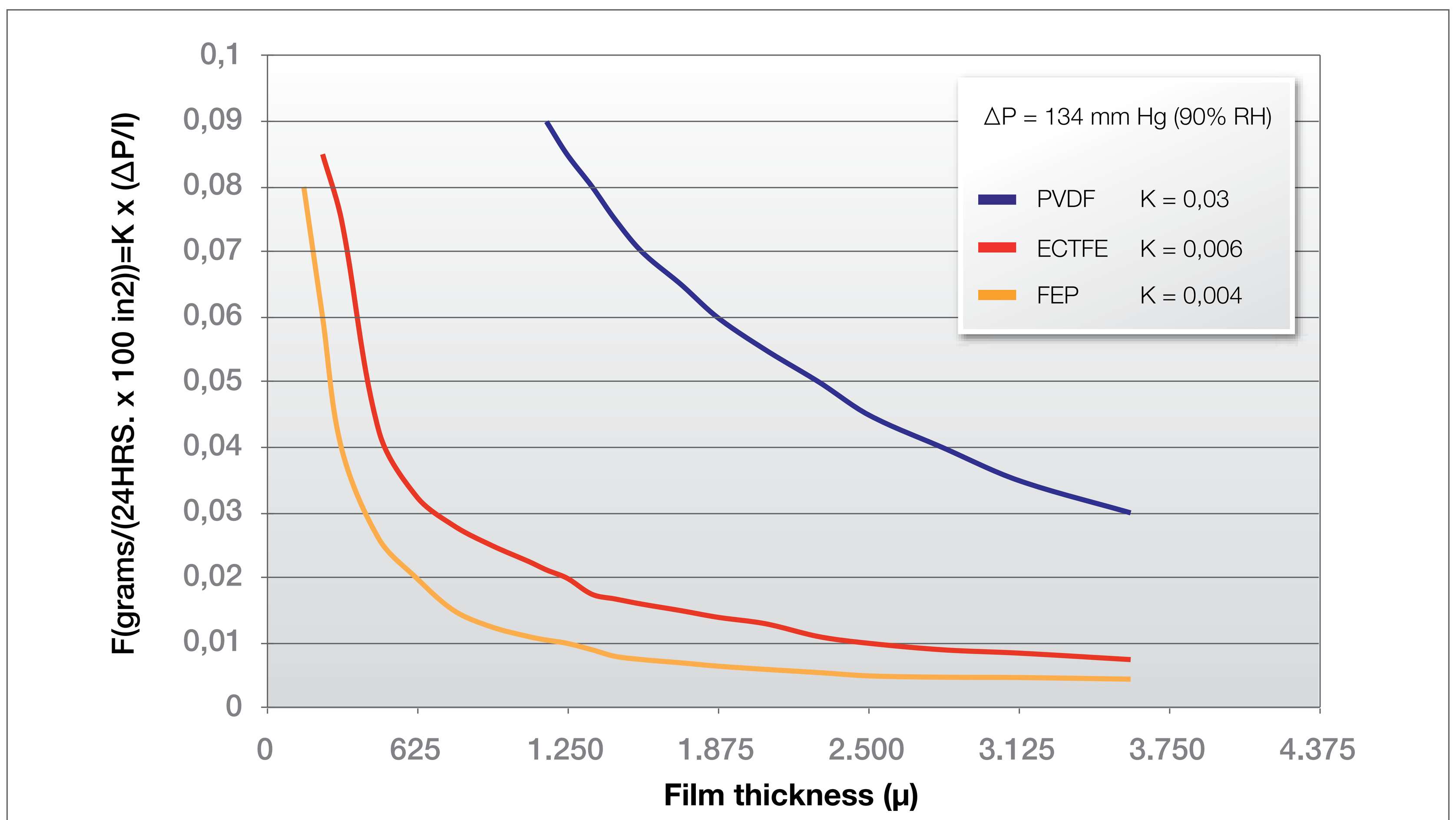

Figure 1 - Permeation vs. film thickness

Figure 1 shows how permeation decreases with increased film thickness. When the thickness is above 500 - 600 µm (0.5 – 0.6 mm), the permeation value levels off.

On complicated parts like reactors, tubes and similar items, it is difficult to obtain a completely even film thickness. This means that if the minimum film thickness is specified at 600 µm, then the mean film thickness will be between 800 - 1000 µm for the fluoroplastic coating.

Solving corrosion problems, for example, in the food industry for ventilators in low corrosive areas and for bolts in the off-shore industry, coatings with film thicknesses of 25 - 200 µm may often be used. The ability of a thin coating to protect against acid materials and salt can be seen in their daily use in pots and pans.

THE COATING PROCESS

Thick fluoropolymer corrosion protection coatings are normally applied on a clean, sandblasted part using an electrostatic spraying process, where the fine fluoropolymer powder is charged to a high voltage in relation to the part, which is grounded. The powder is then attracted to all the metal part's surfaces, even the areas difficult to reach. This helps to consume less powder material. The total coating process, including pretreatment of the part, takes place at temperatures between 300 - 400°C. Thus, the part has to resist being heated to 400°C several times.

CASE: CORROSION PROTECTION AGAINST SULPHURIC ACID

Accoshield is used for corrosion protection of steel equipment in plants for manufacturing of Sulpuric Acid.

Transition piece Ø: 2,2 m coated with Accoshield

Transition piece: After installation and brick lining

CONCLUSION

Using fluorinated products for corrosion resistance is a highly efficient way of protecting process equipment. In spite of the fact that fluorinated polymers have been known for more than 70 years, they still show the highest tolerance among plastics resistant to heat and chemical aggression.

Where performance comes before cost, these polymers offer long term protection. The size of the process equipment determines which coating solution is the most appropriate.