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Table 0 Tonnage of parts in PFAS materials for industrial automation components.

Broad category	Functional property	Product Applications	Industry sector used	Chemical name	CAS	Chemical name (English)	Global usage (tonnes)	Usage for the EU (tonnes)
1. Resin	Abrasion resistance, oil repellence, electrical insulation, water repellence, heat resistance, chemical resistance, weather resistance, cleanliness, release properties, coefficient of friction, bending strength, elasticity, non-flammability.	Valves, tubes and filters	Industrial facilities and equipment Medical equipment Building equipment Transport Semiconductor manufacturing	PFA	26655-00-5	POLY[TETRAFLUOROETHYLENE-CO-PERFLUORO (ALKYL VINYL ETHER)]	949.1	148.0
				FEP	25067-11-2	Perfluoroethylene propylene copolymer	212.5	33.1
				PTFE	9002-84-0	Poly(tetrafluoroethylene)	430.3	67.1
				polyvinylidene fluoride	24937-79-9	Polyvinylidene fluoride	2.8	0.4
				PCTFE	9002-83-9	Polychlorotrifluoroethylene	1.8	0.3
		Adsorption transfer, electronics.	Food equipment Semiconductor manufacturing	ETFE	25038-71-5	Poly(ethene-co-tetrafluoroethene)	3.2	0.5
				ECTFE	25101-45-5	poly(ethene-co-chlorotrifluoroethene)	0.4	0.1
2.Grease	Lubrication, improved sliding properties, low coefficient of friction, heat resistance, chemical resistance, low outgassing	Valves, actuators and filters	Industrial facilities and equipment Building equipment Transport Vessels Semiconductor manufacturing	PTFE	9002-84-0	Poly(tetrafluoroethylene)	7.7	1.2
				PFPE	60164-51-4 etc.	Perfluoropolyether	18.3	2.9

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3. Rubber, seals	Heat and hot water resistance, abrasion and corrosion resistance, improved sliding properties, environmental resistance, excellent elongation tracking, durability, flame resistance, low water absorption, low moisture permeability, chemical resistance, low outgassing.	General hydraulic and pneumatic equipment	Industrial facilities and equipment Medical equipment Building equipment Transport Home appliances Ships	PVDF/***.	9011-17-0	POLY(VINYLIDENE FLUORIDE-CO-HEXAFLUOROPROPYLENE).	**54.9**	**8.6**
				Bisphenol AF	1478-61-1	2,2-Bis(4-hydroxyphenyl)hexafluoropropane	**0.5**	**0.1**
					75768-65-9	Benzyl(triphenyl)phosphonium 4-[1,1,1,3,3,3-hexafluoro-2-(4-hydroxyphenyl)propan-2-yl]phenolate	**0.4**	**0.1**
					25190-89-0	1-Propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and 1,1,2,2-tetrafluoroethene	**24.8**	**3.9**
				PFA	26655-00-5	POLY[TETRAFLUOROETHYLENE-CO-PERFLUORO (ALKYL VINYL ETHER)]	**1.8**	**0.3**
				PTFE	9002-84-0	Poly(tetrafluoroethylene)	**39.0**	**6.1**
				Fluororubber	64706-30-5 etc.	Family of Fluorocarbon-based Fluoroelastomer Materials	**79.7**	**12.4**
	Plasma resistant properties			FFKM	26425-79-6, etc.	Perfluorelastomers	**8.9**	**1.4**
				FEPM	27029-05-6	Tetrafluoroethylene-propylene copolymer	**1.8**	**0.3**
4.Surface treatment	Low coefficient of friction, electrical insulation, heat resistance, improved sliding properties, chemical resistance, mould release, improved weather resistance	Actuators, boards and product outer surfaces	Industrial facilities and equipment Medical equipment Transport Home appliances	PTFE	9002-84-0	Poly(tetrafluoroethylene)	**1.9**	**0.3**
	Plating Low coefficient of friction, improved sliding properties, mould release	actuator	Industrial facilities and equipment	PTFE	9002-84-0	Poly(tetrafluoroethylene)	**1.8**	**0.3**

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Table 1 Uses of Fluoropolymers

Examples showing the use of Products and parts	fluoropolymer	hydraulic and pneumatic equipment (Product group)	functional property
body diaphragm	PFA FEP PTFE PVDF PCTFE ETFE ECTFE	directional control equipment drive (engine) Cleaning equipment Pressure control equipment Pumps, sensors	Abrasion resistance, oil repellence, electrical insulation, water repellence, heat resistance, chemical resistance, weather resistance, cleanliness, release properties, coefficient of friction, bending strength, elasticity, non-flammability.
Sealing parts	PTFE PFA	All hydraulic and pneumatic equipment	Heat resistance, chemical resistance, cleanliness, bending strength, elasticity, non-flammability
Hoses and tubes	PTFE PFA	Piping and fittings equipment	Heat resistance, chemical resistance, cleanliness, bending strength, elasticity, non-flammability
electronics	PTFE	Industrial electrical and electronic control equipment	Excellent dielectric properties, low dielectric constant for microwave permeability, low dielectric loss tangent, non-flammable
adsorption transfer	PCTFE	Vacuum equipment	Cleanliness, mould release, coefficient of friction, bending strength, elasticity,

Table 2 Materials commonly used for hoses and tubes and their chemical and heat resistance properties

material properties	organic solvent	alkali	acid	heat-resisting property
PTFE	A	A	A	260°C
PU	B	C	C	80°C
PP	A	A	A	100°C
PA	B	B	C	120°C
A: Very good, B: Good, C: Normal, D: Poor				

Table 3 Uses of greases

Examples showing the use (Products and parts)	fluoropolymer	hydraulic and pneumatic equipment (Product group)	functional property
Sliding parts Sliding and fixed sealing section	PTFE PFPU	directional control equipment drive (engine) Cleaning equipment pump Vacuum equipment	Lubrication, improved sliding properties, low friction, wear resistance, heat resistance, individual lubrication, oxidation resistance, chemical resistance, cleanliness, flame resistance, low outgassing, water resistance, low temperature resistance, affinity to contact materials.

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Table 4 Base Oil

	mineral oil	synthetic oil	
		silicone oil	PEFE
heat-resisting property	D	B	A
low temperature characteristics	D	A	A
Affinity for rubber and resins.	C	A	A
A: very good, B: excellent, C: good, D: normal, E: poor.			

Table 5 Thickener

	soap-based thickener	Non-soap thickener	
	Li-based	urea	PTFE
(Max. operating temperature °C)	130	180	260
heat-resisting property	C	B	A
water resistance	B	A	A
machine-stabilized (seizure, high speed/high frequency, chemical resistant)	C	B	A
A: very good, B: excellent, C: good, D: normal, E: poor.			

Table 6 Use of rubber and seals

examples showing the use (Products and parts)	fluoropolymer	hydraulic and pneumatic equipment (Product group)	functional property
Exercise and immobilisation sealing section	PTFE PVDF/***. Bisphenol AF	General hydraulic and pneumatic equipment	Lubrication, improved sliding properties, low friction, heat and chemical resistance,

Table 7 Use of surface treatment

examples showing the use (Products and parts)	fluoropolymer	hydraulic and pneumatic equipment (Product group)	functional property
Sealing section, sliding section, electronic board.	PTFE	directional control equipment drive (engine) Vacuum equipment Piping equipment and components	Self-lubricating, low friction, abrasion and damage resistance, adhesion, sound deadening effect, water and oil repellent, conductive and anti-static.

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Table 8 Fluorine lubricant plating film characteristics (PFOA free)

Comparative Table of Fluorine Lubricant Plating Film Characteristics (PFOA Free)						
Plating type		electroless nickel	10 vol% fluorine lubricated plating	20 vol% fluorine lubricated plating	20 vol% fluorine lubricated plating	30 vol% fluorine lubricated plating
Processing type		Barrel	Barrel	Barrel	Rack	Rack
Coating layer (wt%)	nickel (Ni)	90.0~92.0	85.0~87.0	83.0~86.0	83.0~86.0	77.0~83.0
	phosphorus	8.0~10.0	8.5~10.5	7.5~11.0	7.5~11.0	7.5~11.0
	PTFE		2.0~4.0 (7.0~13.0vol%)	6.5~ 9.0 (20.0~26.0vol%)	5.5 ~7.5 (17.0~23.0vol%)	9.5 ~12.5 (27.0~33.0vol%)
Hardness (Hv)	As plated	500~550	350~450	300~350	250~300	200~250
	After baking	Max1000	Max680	Max520	Max540	Max340
Surface roughness*1	Ra		0.09	1.52	0.13	0.12
	Rz.		0.66	6.31	0.89	1.14
Contact angle (degree) *2	As plated	73.6	101.9	107.8	108.2	109.7
	300°C 1h		103.2	111.6	108.6	110.7
Static friction coefficients*3 (reference values)	As plated	0.189	0.111	0.13	0.107	0.102
	300°C 1h					
Dynamic friction coefficient*4 (reference value)	As plated	0.152	0.11	0.113	0.101	0.092
	300°C 1h					
Wearability*5 (mg) (Reference value)		108	85.2	19.8	45.7	4.3

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1 Measurement material SUS304 Plating thickness 5μm Surface roughness: Ra=0.03μm Rz=0.3μm
2 Measuring material SUS304 Plating thickness: 10μm
3 Friction coefficient measurement conditions Material/Halsell plate Indenter 10SUSBall Vertical load: 500g Travel speed: 50mm/min Travel distance: 50mm Plating thickness: 10μm (The value varies depending on the indenter material and loading conditions.)
4 Wear test measurement conditions Material: Stainless steel disk Mating material: 10SUSBall Weight: 1kg Rotation distance: 5000m Plating thickness: 10μm (Values vary depending on mating material and weighting conditions.)
5 The average size of PTFE particles is 0.2μ.

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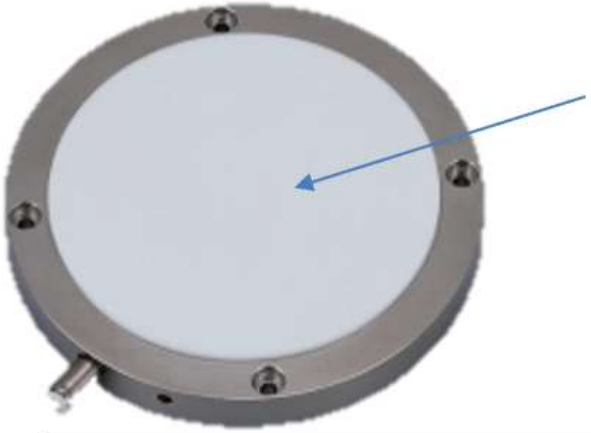
Image 1 Example of valves for chemical solutions

Examples of valves for chemical solutions

Image 2 Example of precision suction plate.



Example of precision suction plate

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Image 3 Sectional view of cylinder grease

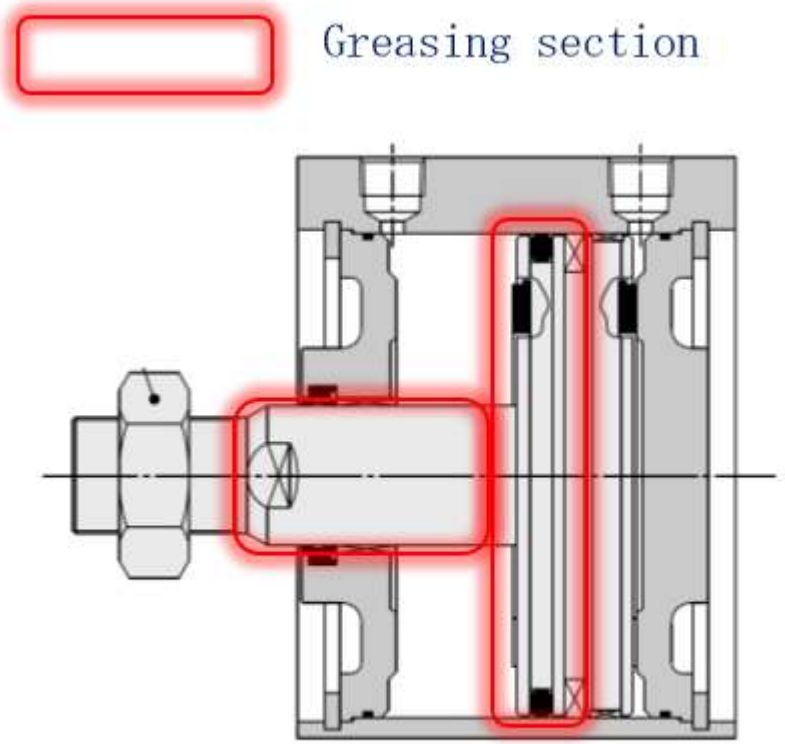

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Image 4 Section view of directional control valve grease