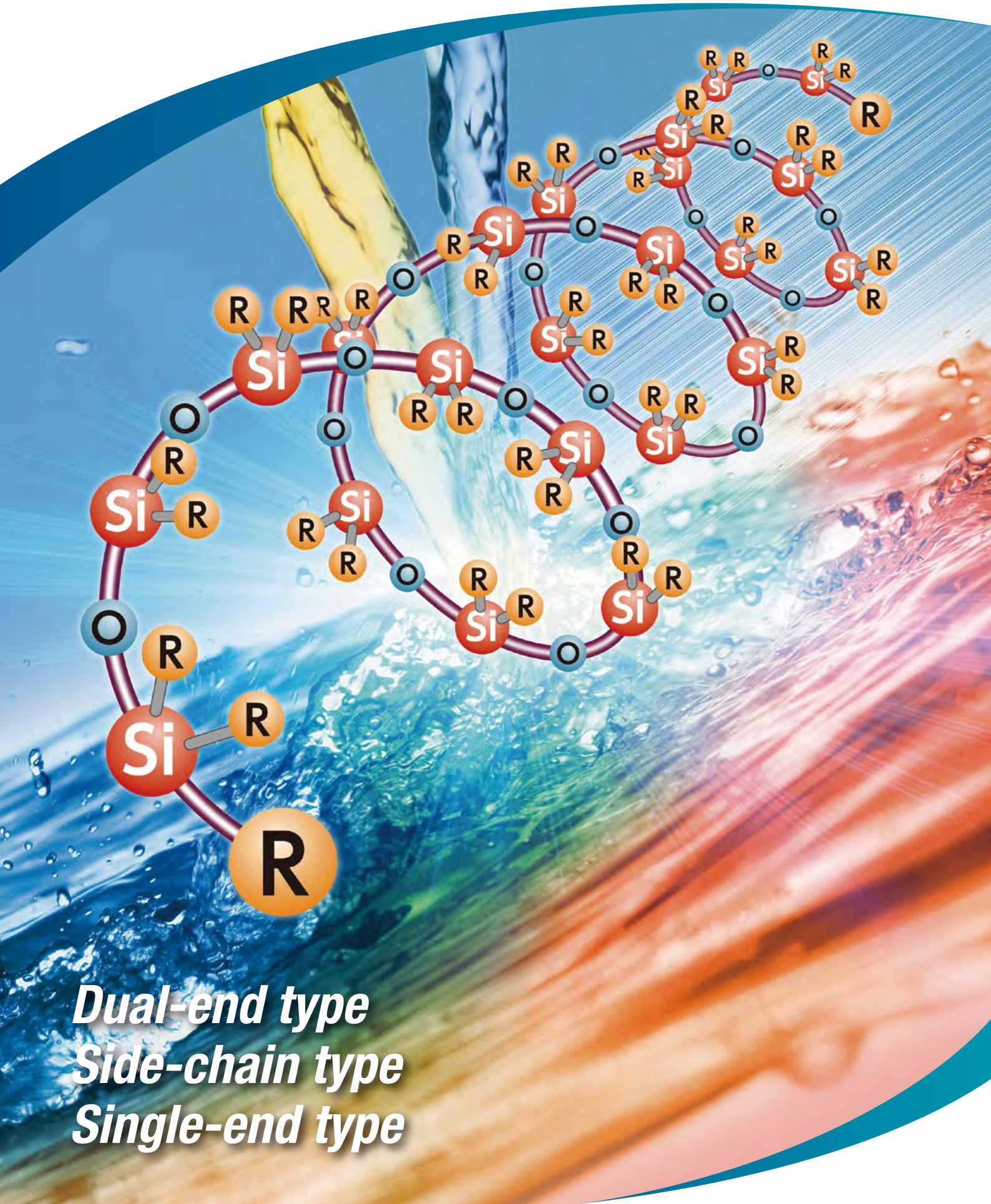
Modified Silicone Fluid for Resin Modification

(For North and South America)

Shin-Etsu Silicone



What is Modified Silicone Fluid for Resin Modification?

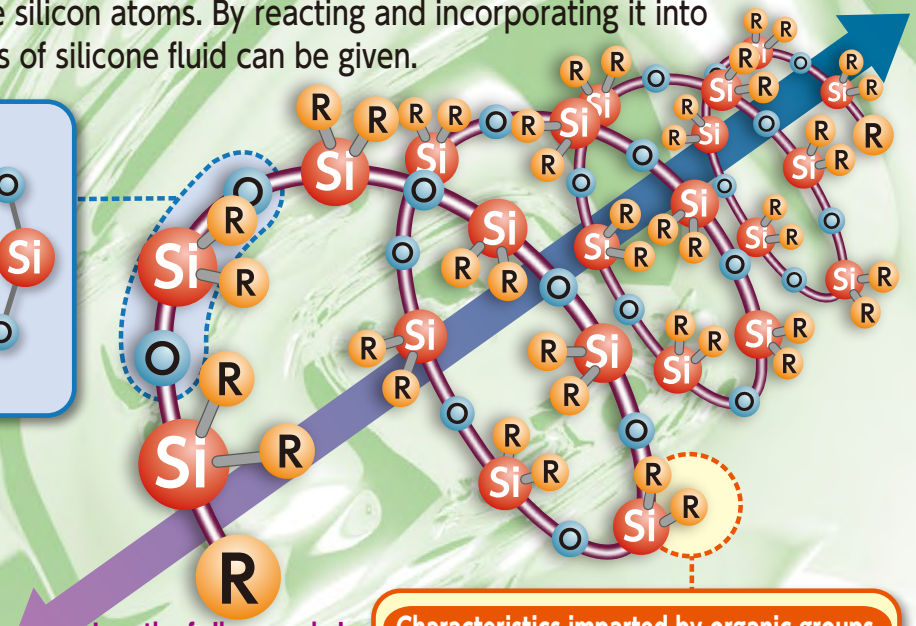
Modified silicone fluid for resin modification is a silicone fluid that incorporates various organic and reactive functional groups into some silicon atoms. By reacting and incorporating it into other resins, the excellent properties of silicone fluid can be given.

Features of materials with siloxane bonds

●**High bonding energy (106 kcal/mol):**
Resists breakdown from heat and light. Around 25% higher bonding energy than C-C bonds.

Features of materials with siloxane chain

●**Helical molecule & low intermolecular force:**
Excellent water repellency, defoaming, and release properties (interfacial characteristics); gas permeable. Physical properties are not strongly temperature dependent.



Length of siloxane chains can be controlled

- Flexible, expanding and contracting helical structure
- Strong and difficult to break
- Has a reactive functional group bonded to other organic resins
- Lower surface energy
- Water-shedding

Characteristics imparted by organic groups

●**Primary Organic Groups**

Methyl groups: hydrophobicity
Phenyl groups: compatibility with resins, heat resistance
Polyether groups: hydrophilicity
Alkoxy groups: adhesiveness, moisture-cure properties
Amino groups: reactive with epoxies and other resins
(Meth)acrylic groups: radical polymerization

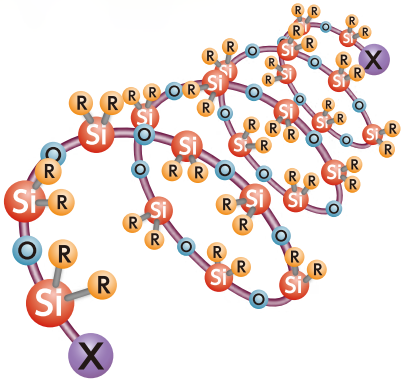
Three Types of Modified Silicone Fluid for Resin Modification

●Expected effect

Improvement of Mechanical Properties ← → Surface Modification

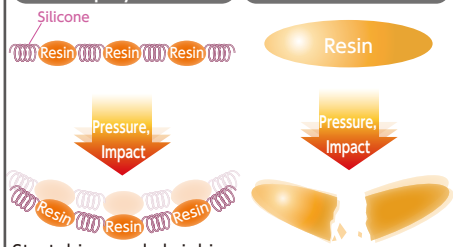
Dual-end type

●Structure model



●Model of modification

Block copolymerization | Untreated

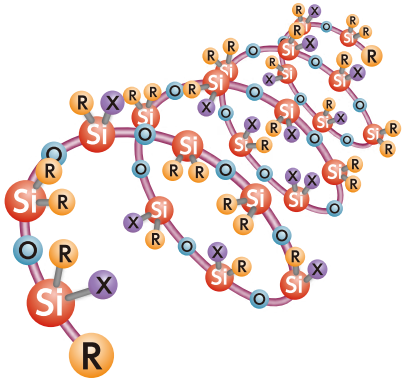


Stretching and shrinking of silicone improves resin strength

Broken

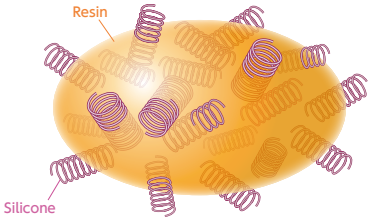
Side-chain type

●Structure model



●Model of modification

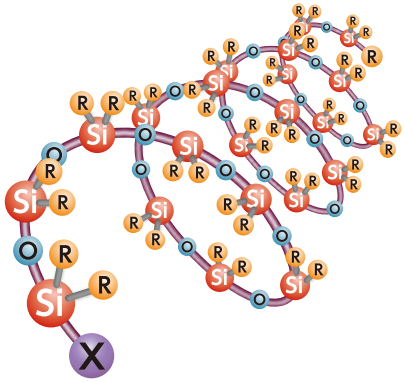
Random copolymerization



Silicone randomly incorporated into resin surfaces or internal resin that improves resin strength, water repellency, and slip properties.

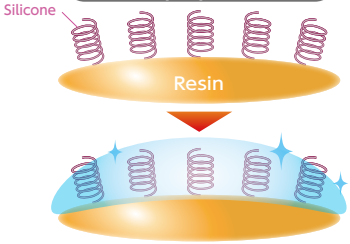
Single-end type

●Structure model



●Model of modification

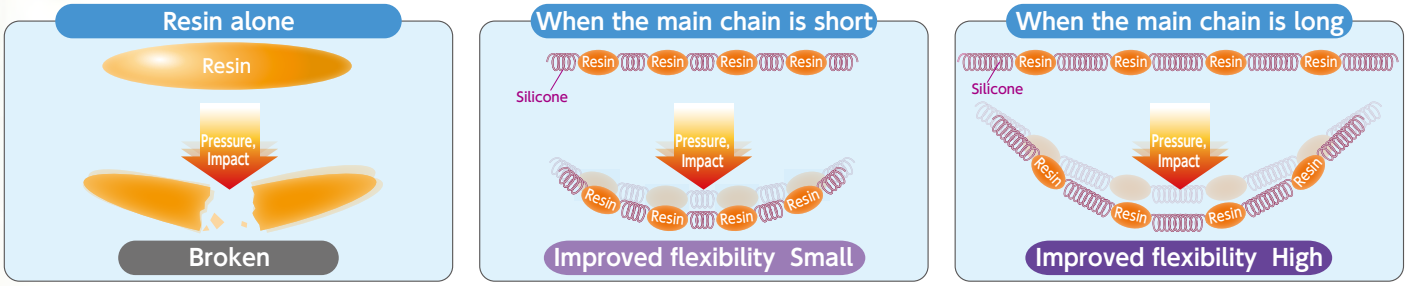
Graft copolymerization



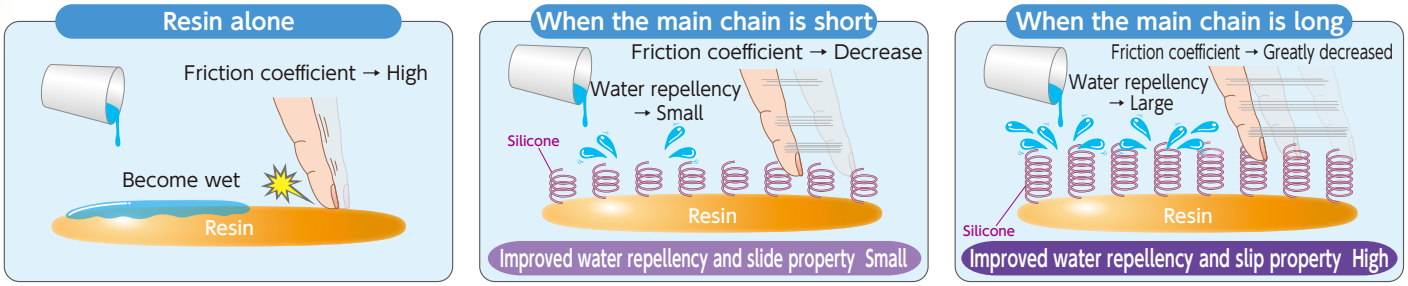
As silicone exits the surface of the resin, water repellency and slip property are imparted.

Example of characteristic improvement with length of siloxane main chain

●Model of flexibility improvement by block copolymerization of dual-end type

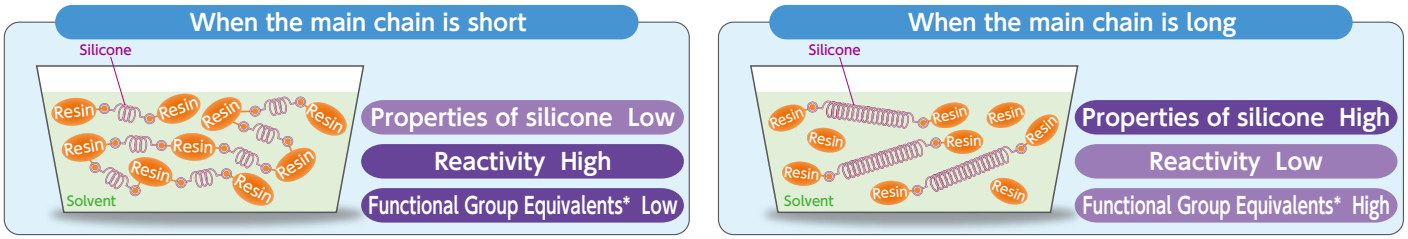


●Model of water repellency and slip property improvement by graft copolymerization of single-end type



Relationship between siloxane main chain length and reactivity

●Select the product by looking at the balance between the siloxane backbone and reactivity.

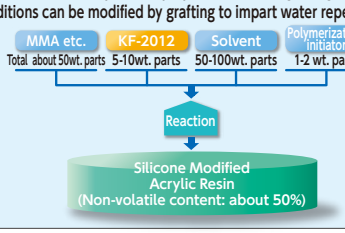


*Functional group equivalents are the number of functional groups relative to the length of the siloxane main chain.
Products with a short main chain have a relatively high proportion of functional groups in the molecule.

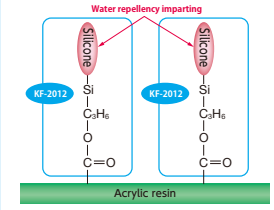
Example of application

●Imparting water repellency to acrylic paint

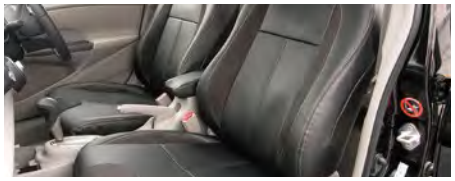
●An example of modification by radical polymerization using a single-end silicone fluid (KF-2012).
Surface conditions can be modified by grafting to impart water repellency.



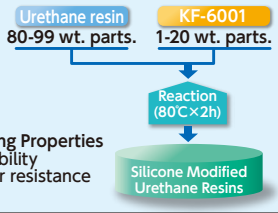
●Model of resin modification



●Improved tactile quality of polyurethane synthetic leather

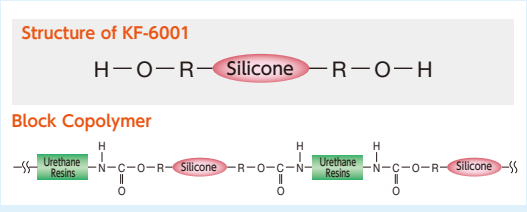


●Modification example with dual-end carbinol fluids



●Resulting Properties
1. Flexibility
2. Wear resistance

●Model of Block Copolymer



Organic functional groups and applicable resins

Reactive groups \ Types of resins		Thermoset resin		Thermoplastic resin			
		Polyurethane	Epoxy	Acrylic	Polyimide	Polyamide	Polyester
Amino groups			●		●	●	
Epoxy groups			●				●
Hydroxyl groups	Carbinol type	●					●
	Diol type	●					●
	Polyether type	●					●
Methacrylic groups				●			
Carboxyl groups			●			●	●
Mercapto groups				●			
Acid anhydride groups			●		●	●	●

Product List

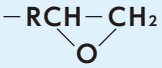
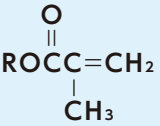
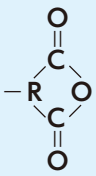
●Side chain type

Modification type	Organic functional group	Product name	Viscosity at 25℃ mm²/s	Specific gravity at 25℃	Refractive index at 25℃	Functional group equivalent weight(FGEW) g/mol	Packaging	UN hazard classification
Mono amino	$-RNH_2$	KF-868	90	0.95	1.403	8,800	1kg, 16kg, 180kg	Not applicable
		KF-865	110	0.97	1.405	5,000	1kg, 16kg, 180kg	Not applicable
		KF-864	1,700	0.98	1.406	3,800	1kg, 16kg, 180kg	Not applicable
Diamino	$-RNR'NH_2$ (H)	KF-859	60	0.96	1.403	6,000	1kg, 16kg, 180kg	Not applicable
		KF-393	70	0.98	1.422	350	1kg, 16kg	Not applicable
		KF-860	250	0.97	1.404	7,600	1kg, 16kg, 180kg	Not applicable
		KF-880	650	0.98	1.407	1,800	1kg, 18kg, 180kg	Not applicable
		KF-8004	800	0.98	1.408	1,500	1kg, 18kg, 180kg	Not applicable
		KF-8002	1,100	0.98	1.408	1,700	1kg, 18kg, 200kg	Not applicable
		KF-8005	1,200	0.97	1.403	11,000	1kg, 16kg, 180kg	Not applicable
		KF-867	1,300	0.98	1.407	1,700	1kg, 18kg, 180kg	Not applicable
		KF-8021	15,000	0.97	1.403	55,000	1kg, 16kg	Not applicable
		KF-869	1,500	0.97	1.405	3,800	1kg, 16kg	Not applicable
		KF-861	3,500	0.98	1.408	2,000	1kg, 16kg	Not applicable
Amino - Polyether	$-RNH_2$ $-R(C_2H_4O)_a(C_3H_6O)_bR'$	X-22-3939A	3,300	1.03	1.448	1,800	1kg, 16kg	Not applicable
Special amino	–★	KF-877	5,700	0.98	1.406	5,200	1kg, 16kg,200kg	UN-3082
		KF-889	500	1.00	1.429	3,000	1kg, 16kg,180kg	UN-3082
Epoxy	$-RCH-CH_2$ (O)	X-22-343	25	1.01	1.423	525	1kg, 16kg	Not applicable
		KF-101	1,500	1.01	1.437	350	1kg, 16kg	Not applicable
		KF-1001	17,000	0.98	1.407	3,500	1kg, 16kg	Not applicable
Epoxy (side-chain phenyl type)		X-22-2000	190	1.04	1.443	620	1kg, 16kg	Not applicable
Alicyclic epoxy	–R(cyclohexene oxide)	X-22-2046※	45	0.96	1.474	600	1kg, 15kg	UN-1866
		KF-102	3,500	0.97	1.408	3,600	1kg, 16kg,180kg	Not applicable
Epoxy - Polyether	$-R-CH-CH_2$ (O) $-R(C_2H_4O)_a(C_3H_6O)_bR'$	X-22-4741	350	1.06	1.448	2,500	1kg, 16kg	Not applicable
		KF-1002	4,500	1.00	1.426	4,300	1kg, 16kg	Not applicable
Epoxy-Aralkyl	$-RCH-CH_2$ (O) $-CH_2-CH(CH_3)-$(benzene)	KF-1005	2,500	1.10	1.484	250	1kg,18kg	Not applicable
Carbinol	$-ROH$	X-22-4039	90	0.99	1.413	58*1	1kg, 16kg	Not applicable
		X-22-4015	130	0.98	1.408	30*1	1kg, 16kg	Not applicable
Mercapto	$-RSH$	KF-2001	200	0.98	1.410	1,900	1kg, 16kg	Not applicable
		KF-2004	300	0.97	1.404	30,000	1kg, 16kg	Not applicable
Carboxyl	$-RCOOH$	X-22-3701E	2,000	0.98	1.409	4,000	1kg, 16kg	Not applicable
Hydrogen	$-H$	F-9W-9	20	1.00	1.396	60	1kg,18kg,200kg	Not applicable
		KF-9901	20	0.97	1.399	140	1kg,18kg,200kg	Not applicable

★Please contact our Sales Department for further information. (Not specified values)
※ Active ingredient 50% (toluene dilution)
*1 Hydroxyl group value [mgKOH/g], Functional group equivalent weight [g/mol] = 56,000/Hydroxyl group value [mgKOH/g]

Product List

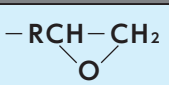
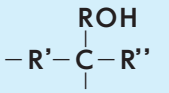
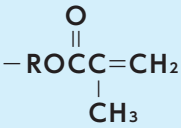
●Dual-end type

Modification type	Organic functional group	Product name	Length of siloxane main chain	Viscosity at 25℃ mm²/s	Specific gravity at 25℃	Refractive index at 25℃	Functional group equivalent weight(FGEW) g/mol	Packaging	UN hazard classification
Amino	$-RNH_2$	PAM-E	Short	4	0.90	1.448	130	1kg, 15kg	Not applicable
		KF-8010	Short	12	1.00	1.418	430	1kg, 16kg	Not applicable
		X-22-161A	Medium	25	0.97	1.411	800	1kg, 16kg	Not applicable
		X-22-161B	Medium	55	0.97	1.408	1,500	1kg, 16kg,180kg	Not applicable
		KF-8012	Long	90	0.97	1.407	2,200	1kg, 16kg,180kg	Not applicable
		KF-8008	Long	450	0.97	1.405	5,700	1kg, 16kg,180kg	Not applicable
Amino (side-chain phenyl type)		X-22-1660B-3	Medium	550	1.07	1.497	2,200	1kg, 16kg	Not applicable
		X-22-9409	Long	105	1.05	1.500	670	1kg, 16kg	Not applicable
Epoxy		X-22-163	Short	15	1.00	1.450	200	1kg, 16kg	Not applicable
		KF-105	Short	15	0.99	1.422	490	1kg, 16kg	Not applicable
		X-22-163A	Medium	30	0.98	1.413	1,000	1kg, 16kg	Not applicable
		X-22-163B	Medium	60	0.98	1.409	1,800	1kg, 16kg	Not applicable
		X-22-163C	Long	120	0.98	1.408	2,700	1kg, 16kg	Not applicable
Alicyclic epoxy		X-22-169AS	Short	30	0.99	1.433	500	1kg, 16kg	Not applicable
		X-22-169B	Medium	70	0.98	1.412	1,700	1kg, 16kg	Not applicable
Carbinol	$-ROH$	KF-6000	Short	35	0.98	1.422	120*1	1kg, 16kg,180kg	Not applicable
		KF-6001	Medium	45	0.98	1.413	62*1	1kg, 16kg,180kg	Not applicable
		KF-6002	Medium	70	0.98	1.409	35*1	1kg, 16kg,160kg	Not applicable
		KF-6003	Long	110	0.98	1.407	22*1	1kg, 16kg,160kg	Not applicable
Methacryl		X-22-164	Short	10	0.97	1.450	190	1kg, 16kg	Not applicable
		X-22-164AS	Short	12	0.97	1.425	450	1kg, 16kg	Not applicable
		X-22-164A	Medium	25	0.98	1.415	860	1kg, 16kg	Not applicable
		X-22-164B	Medium	55	0.98	1.410	1,600	1kg, 16kg	Not applicable
		X-22-164C	Medium	90	0.98	1.408	2,400	1kg, 16kg	Not applicable
		X-22-164E	Long	190	0.97	1.406	3,900	1kg, 16kg	Not applicable
Polyether	$-R(C_2H_4O)_a(C_3H_6O)_bH$	X-22-4952	Medium	100	0.99	1.428	50*1	1kg, 16kg	Not applicable
		X-22-4272	Medium	270	1.02	1.430	50*1	1kg, 16kg	Not applicable
		KF-6123	Medium	420	1.03	1.434	50*1	1kg, 18kg	Not applicable
Mercapto	$-RSH$	X-22-167B	Medium	55	0.97	1.411	1,700	1kg, 16kg	Not applicable
		X-22-167C	Medium	90	0.97	1.408	2,300	1kg, 16kg	Not applicable
Carboxyl	$-RCOOH$	X-22-162C	Long	220	0.98	1.406	2,300	1kg, 16kg	Not applicable
Silanol	$-OH$	X-21-5841	Short	30	0.97	1.404	500	1kg, 16kg,180kg	Not applicable
		KF-9701	Medium	60	0.98	1.404	1,500	1kg, 16kg, 200kg	Not applicable
Acrylic	$-R-OC(=O)CH=CH_2$	X-22-2445	Medium	55	0.98	1.407	1,600	1kg, 16kg	Not applicable
Carboxylic acid anhydride		X-22-168AS	Short	160	1.03	1.432	500	1kg	Not applicable
		X-22-168A	Medium	140	1.01	1.418	1,000	1kg	Not applicable
		X-22-168B	Medium	180	1.00	1.412	1,600	1kg	Not applicable
Carboxylic acid anhydride (side-chain phenyl type)		X-22-168-P5-B	Medium	1,300	1.09	1.498	2,100	1kg	Not applicable

*1 Hydroxyl group value [mgKOH/g], Functional group equivalent weight [g/mol] = 56,000/Hydroxyl group value [mgKOH/g]　(Not specified values)

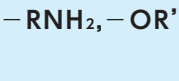
Product List

●Single-end type

Modification type	Organic functional group	Product name	Length of siloxane main chain	Viscosity at 25℃ mm²/s	Specific gravity at 25℃	Refractive index at 25℃	Functional group equivalent weight(FGEW) g/mol	Packaging	UN hazard classification
Epoxy		X-22-173BX	Medium	30	0.97	1.408	2,500	1kg, 16kg	Not applicable
		X-22-173DX	Long	60	0.97	1.406	4,600	1kg, 16kg	Not applicable
Carbinol		X-22-170BX	Medium	40	0.97	1.407	20 *1	1kg, 16kg	Not applicable
		X-22-170DX	Long	65	0.97	1.406	12 *1	1kg, 16kg	Not applicable
Diol		X-22-176F	Long	500	0.98	1.405	9 *1	1kg, 16kg,180kg	Not applicable
		X-22-176DX	Medium	130	0.97	1.409	35 *1	1kg, 16kg,180kg	Not applicable
		X-22-176GX-A	Long	400	0.97	1.405	8 *1	1kg, 16kg,180kg	Not applicable
Methacryl		X-22-174ASX	Short	9	0.95	1.415	900	1kg, 16kg	Not applicable
		X-22-174BX	Medium	27	0.96	1.409	2,300	1kg, 16kg	Not applicable
		KF-2012	Medium	60	0.97	1.407	4,600	1kg, 16kg,180kg	Not applicable
		X-22-2426	Long	200	0.97	1.405	12,000	1kg, 16kg	Not applicable
		X-22-2404	Short	5	0.93	1.418	420	1kg, 16kg	Not applicable
Carboxyl		X-22-3710 *2	Medium	60	0.97	1.412	1,450	1kg, 16kg	Not applicable

(Not specified values)

●Side-chain, dual-end type

Modification type	Organic functional group	Product name	Viscosity at 25℃ mm²/s	Specific gravity at 25℃	Refractive index at 25℃	Functional group equivalent weight(FGEW) g/mol	Packaging	UN hazard classification
Side-chain amino, dual-end methoxy		KF-857	65	0.98	1.411	790	1kg, 15kg	Not applicable
		KF-862	650	0.98	1.407	1,900	1kg, 16kg,180kg	Not applicable
		KF-858 *3	23	0.88	1.394	-	1kg, 15kg	UN-1866
Epoxy		X-22-9002	900	0.98	1.406	5,000	1kg, 16kg	Not applicable

*1 Hydroxyl group value [mgKOH/g], Functional group equivalent weight [g/mol] = 56,000/Hydroxyl group value [mgKOH/g] (Not specified values)
*2 Including non-reactive & dual-end type carboxyl-modified silicone fluid
*3 Active ingredient 50% (acetate IPA dilusion)

⚠ Storage & Handling Precautions

1. Many modified silicone fluids contain organic functional groups or hydrolyzable groups, and their reactivity varies. Before using these products, carefully consider their respective characteristics.

2. Heat, light, acids and bases may cause deterioration of modified silicone fluids. Take care to prevent contamination, and seal tightly and store in a cool, dark place.

3. Our modified silicone fluids are not produced specifically for medical use. Accordingly, they should not be used as is for orthopedic or cosmetic surgery or other medical applications.

4. If amino-modified silicone fluid is being used as an aerosol and the particles are inhaled, there is a possibility of acute inhalation toxicity. Average consumers should not use amino-modified silicone fluid in spray applications.

5. Some silicone products described herein are classified as hazardous materials under the laws of certain countries. In such cases, the laws must be followed regarding storage, labeling, and handling.

◆Safety & Hygiene

1. Some modified silicone fluids may cause skin irritation. If contact occurs, they are difficult to remove from the skin, so always wear rubber gloves (etc.) and avoid contact with the skin and mucous membranes. In case of contact, wipe with a rag, then wash with soap and water or flush thoroughly with water. In case of accidental eye contact, immediately flush with water for at least 15 minutes and then seek medical attention.

2. Be sure there is adequate ventilation when handling these products. If you feel ill after breathing in the vapors, move immediately to an area with fresh air.

3. Keep out of reach of children.

4. Be sure to read the Safety Data Sheets (SDS) for these produtcts before use. SDS are available from the Shin-Etsu Sales Department.

◆Other

1. Some of the products (product name starting with X) featured in this catalog are preproduction prototypes. Please contact Shin-Etsu to confirm the availability of all products.

2. For cosmetics, "A Grade" products are available, but in some cases a separate application is required if modified silicone fluids are to be used as a cosmetic ingredient. Please contact Shin-Etsu regarding required documents.

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Gunma Complex	ISO 9001 (JCQA-0004)	ISO 14001 (JCQA-E-0002)
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 https://www.shinetsusilicone-global.com/

This is an edited version of the product data released on Mar. 2023.