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Silicones in Liquid Rubber

Because of their unique chemical structure and properties (such as high temperature resistance, low surface energy, flexibility, electrical insulation, etc.), organosilicon products are increasingly used in liquid rubber, especially in enhancing material properties and expanding application scenarios with significant advantages. The following are its specific application directions:

First, Improvement of liquid rubber properties as an additive

1. **Enhancement of heat resistance**

Silicones (e.g. silicone oil, silicone resin) have high Si-O bonding energy (about 443 kJ/mol), which can significantly enhance the high-temperature resistance of liquid rubber (usually resistant to -50° C to 250° C). Example:

- Adding silicone oil to silicone-modified polyurethane liquid rubber can raise its thermal decomposition temperature from about 200° C to more than 280° C.
- Used in automotive engine compartment sealants to avoid aging and cracking at high temperatures.

2. **Increase flexibility and tear resistance**

Silicone molecular chain is flexible, and after blending with liquid rubber (such as nitrile rubber, fluorine rubber), it can reduce the glass transition temperature (Tg) and improve the elasticity of the material at low temperatures.

- Case: Silicone-modified acrylate liquid rubber is used for flexible electronic device encapsulation, and the bending life is increased by more than 50%.

3. **Improved surface properties**

The low surface energy of silicone (about 20-24 mN/m) can make liquid rubber products with hydrophobic and anti-sticky properties:

- Adding 1%-3% silicone oil to liquid silicone rubber (LSR), the contact angle can reach more than 110° for waterproof paint or anti-fouling coating.

Second, as a matrix material to develop special liquid rubber

1. **Liquid silicone rubber (LSR)**

Silicone-based liquid rubber that combines fluidity with high elasticity after curing:

- **Medical field**: Used for injection moulding medical catheters (biocompatibility in accordance with ISO 10993).
- **Electronic field**: Sealant for 5G antennas (dielectric constant <3.0, UV resistant).

2. **Organosilicone-epoxy hybrid system**

Silicone is introduced into epoxy liquid rubber through silane coupling agent (e.g. KH-550) to solve the

problem of brittleness of traditional epoxy resin:

- Increase impact strength by 2-3 times after curing, used for wind turbine blade bonding rubber.

Third. Functional modification applications

1. **Flame retardant function

Silicone containing phenyl or vinyl mixed with liquid rubber, with aluminium hydroxide and other flame retardants, can be certified by UL94 V-0:

- Electric vehicle battery pack potting compound (high temperature resistance + flame retardant).

2. **Electrically/thermally conductive function**

Disperse carbon nanotubes, boron nitride and other fillers through silicone carrier to achieve homogeneous dispersion:

- Thermally Conductive Silicone Rubber Paste (Thermal Conductivity >1.5 W/m-K) for LED heat dissipation interface material.

Forth. Technological Challenges and Development Trends

1. **Compatibility Issues**

Silicones are poorly compatible with polar rubbers (e.g., NBR, CR) and need to be modified by grafting (e.g., introduction of epoxy groups) or adding compatibilising agents (e.g., silane coupling agents).

2. **Demand for environmental protection**

Development of solvent-free silicone liquid rubber (such as UV curing system), in line with REACH/ROHS regulations.

****Summary**:**

Silicone products through physical blending, chemical modification, etc., to give liquid rubber more excellent comprehensive performance, to promote its innovative applications in high-end manufacturing.