REF: TT/ NOV.09/ WK1

Silicones…(the smart sand!)

Silicones are very unique in the chemical world. They are also an integral part of our daily lives. Discover here the history and beauty of an element, generally not appreciated…

A silicone is classically defined as an "organo-silicon polymer with a silicon-oxygen framework whose simplest fundamental unit is $(R_2SiO)n$".

In the early 19th century, Berzelius discovered that by reacting silicon dioxide (sand or quartz) with a fluoride, elemental amorphous silicon could be produced. This silicon, known on the periodic table as 'Si' is not only the second most common element on earth, it is also the primary ingredient of silicones. Silicones are comprised mostly of silicon and oxygen, the latter being extremely abundant as well.

In the early 20th century, Kipping (known as the Father of Silicones) created the first synthetic silicon compounds. These were organochlorosilanes, and stunned the scientific community with their amazing physical properties. Since then, silicones have reached massive industries in every part of the world. From a grain of sand, has come a material so versatile and multifaceted, that we today use it repeatedly throughout our common tasks and activities.

A simple silicone structure is composed of four elements: silicon (Si), oxygen (O), hydrogen (H) and carbon- C. The three dimensional SiO_2 backbone gets modified by incorporation of methyl groups (CH3) to form polysiloxanes, which is their correct chemical name. This is the simplest form of any silicone, and the variable placement of the elements gives way to the properties of the silicone.

Silicone products find use in a variety of industries. A plethora of industrial silicone products like silicone resins, silicone elastomers, silicone fluids (antifoams, release agents) etc., find use in the pharmaceuticals, plastics, rubber, textile, paper, construction, food, electronics and electrical industries.

The characteristics which makes silicones so unique include-

- Low viscosity
- Dielectric stability (i.e, good insulation)
- Non flammability
- Chemical inertness

Contd on pg 2

- Shear stability
- Low surface tension
- Oxidative stability
- High thermal stability
- High compressibility
- Water repellency

With a few exceptions, silicones are remarkably inert towards living organisms. There are two reasons for this. First silicones are polymeric in nature. This hampers their passage through biological membranes. Second biological systems have difficulty in breaking the Si-C bond. When ingested orally, silicones only have a laxative effect. Studies have revealed neither toxicity nor carcinogenic effects.

In the environment, there is no evidence that silicones adversely effect eco-systems. Nor has there been any experience of toxic, mutagenic, or teratogenic effects on animals or aquatic life.

Silicones in the textile industry

The textile industry has placed an ever-increasing demand on textile processors to produce higher quality fabrics with special aesthetic properties. Silicone products are used in softening and lubricating of yarns. But the predominant application area of silicones is that of high-grade finishing. Silicone finishes fall into two main categories- impregnations and coatings.

Silicone softeners fall into the impregnation category. They impart a particularly good handle, softer and fuller than that of organic softeners. Appropriate recipes can make the fabric bulkier, or silkier, extremely hydrophobic for rainwear or hydrophilic for terry goods.

Extensive use of a cross-linking agent creates elastic finishes which mainly confer a soft handle and very good crease resistance on woven goods and greater elasticity on knitted goods.

Unlike impregnated textile fabrics, which have an open structure, coated textiles have a sealed surface. The coatings are made from silicone elastomers, and their advantage is that they are impervious to water but permeable to vapour. Furthermore, they have a high thermal resistance and flame retardancy.

Silicones have also been used in highly effective antimicrobial finish for carpets, socks etc.

(*To be contd. In the next edition....)*