

SILICONES

Project work submitted to

Vikrama Simhapuri University, Nellore

In partial fulfillment for the award of the degree of

Bachelor of science in

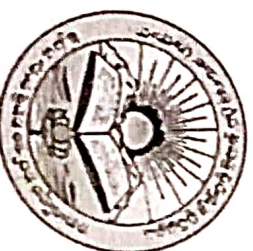
Chemistry

By,

NVR Sai Sagar

Research supervisor

Smt B Krupa Karuna Vani, Lecturer in Chemistry



DEPARTMENT OF CHEMISTRY

SKR GOVERNMENT DEGREE COLLEGE, GUDUR-524101,

TIRUPATI (Dist.), ANDHRA PRADESH, INDIA.

DECLARATION

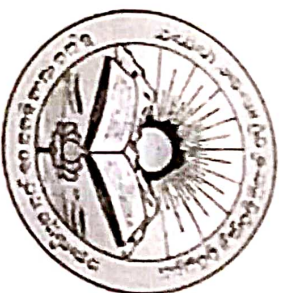
I, **NVR Sai Sagar**, B.Sc. (first year),
Department of Chemistry SKR Government Degree College,
Gudur, A.P, do hereby declare that Project work entitled
SILICONES is carried by me under the guidance of Smt B Krupa
Karuna Vani, lecturer in Chemistry, SKR College, Gudur, A.P. This
work is original and has not been submitted for any other degree
or diploma.

N.V. Rishi Sai Sagar

Place: *Gudur*

Date :

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CERTIFICATE

This is to certify that the project work entitled **SILICONES** submitted to **Vikrama Simphapuri university** is bonfire record of research work carried out by **NVR Sai Sagar** for the award of **B.Sc., degree** in record of original research work done by him during the period of his study 2022-2023 under my supervision in the Department of Chemistry **SKR government degree college, Gudur** and has not been submitted in part or full for award of any degree/diploma /associate ship /fellowship /any other similar title.

BKrupa

Place : Gudur
Date :

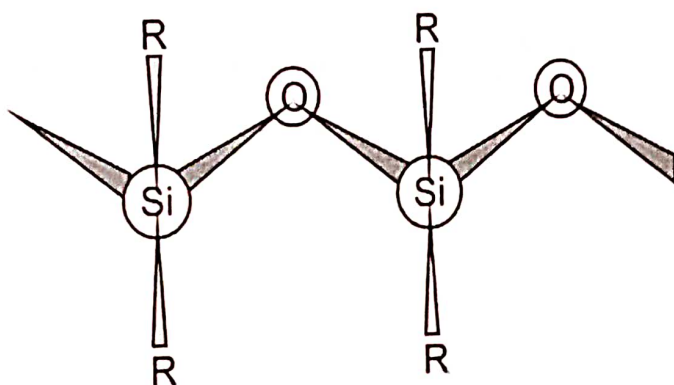
{BKK Vani}
Research Supervisor

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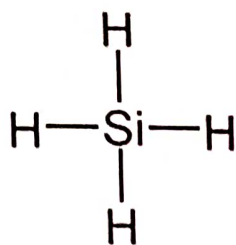
Structure and properties of silicones

Silicones are synthetic polymers with a silicon-oxygen backbone similar to that in silicon dioxide (silica), but with organic groups attached to the silicon atoms by C-Si bonds. The silicone chain exposes organic groups to the outside.

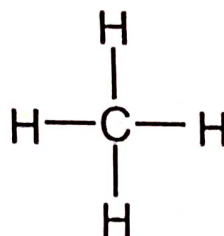


Thus, despite having a very polar chain, the physical properties of silicones are similar to those of an alkane. The Si-O bond energy is much larger than the C-C bond energy and this enables the -Si-O- framework of the silicone to give the polymers thermal stability, as in silica.

To distinguish between different silicones, systematic names are used, based on the monomer. The simplest silicon compound is **silane**, SiH_4 which belongs to the homologous series of silanes. Silanes correspond to the alkanes whose simplest member is methane, CH_4 .

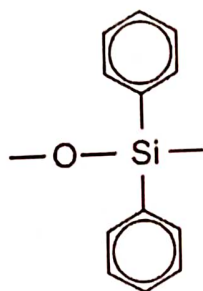


silane



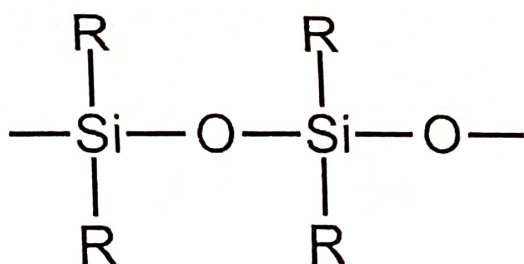
methane

The presence of the oxygen atoms in the silicone chain is indicated by using the systematic name, **siloxane**, so termed as it contains a silicon atom, an oxygen atom and it is saturated as in an alkane. When the groups attached to the siloxane chain are phenyl groups, the resulting silicone is called **poly(diphenylsiloxane)** and has these repeating units along the chain.

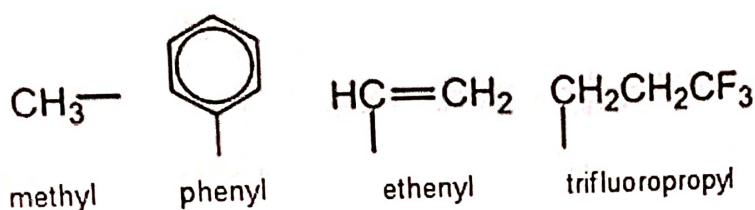


The most widely used silicones are those which have methyl groups along the backbone. Properties such as **solubility in organic solvents**, **water-repellence** and **flexibility** can be altered by substituting other organic groups for the methyl groups. For example, silicones with phenyl groups are more flexible polymers than those with methyl groups. They are also better lubricants and are superior solvents for organic compounds.

The structure of the repeating units of silicones can be represented as

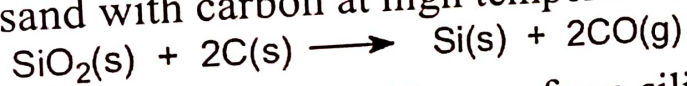


Where R represents organic groups attached to the silicone backbone, for example:



Preparation of silicones

Silicones are manufactured from pure silicon which has been obtained by the reduction of silicon dioxide (silica) in the form of sand with carbon at high temperatures:

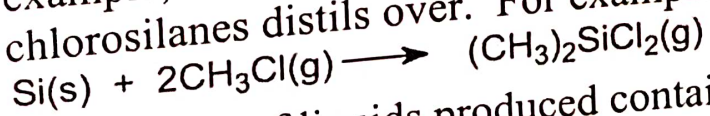


The production of silicones from silicon takes place in three stages

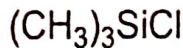
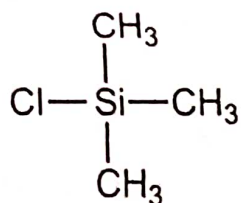
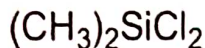
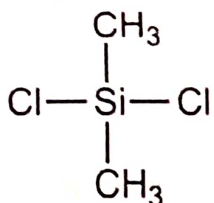
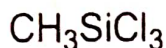
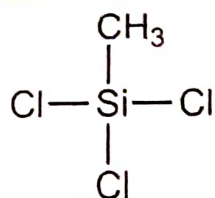
1. Synthesis of chlorosilanes

Silicon is first converted into chlorosilanes, e.g. RSiCl_3 , R_2SiCl_2 and R_3SiCl , where R is an organic group.

When chloromethane is passed through heated silicon at about 550 K under slight pressure and in the presence of a copper catalyst (often copper itself but other copper-containing materials can be used, for example, brass or copper(II) chloride) a volatile mixture of chlorosilanes distils over. For example:



The mixture of liquids produced contains these three compounds:

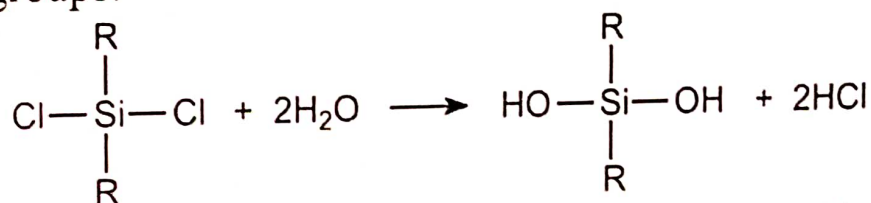


Careful distillation of the liquid mixture of chlorosilanes produces pure fractions of each chlorosilane.

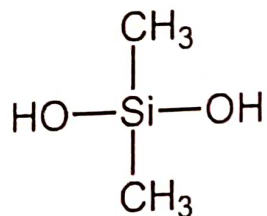
Dimethyldichlorosilane is the main product (*ca* 70-90%, the amount depending on the conditions used).

2. Hydrolysis of chlorosilanes

A dichlorosilane is hydrolyzed to a molecule with two hydroxyl groups:

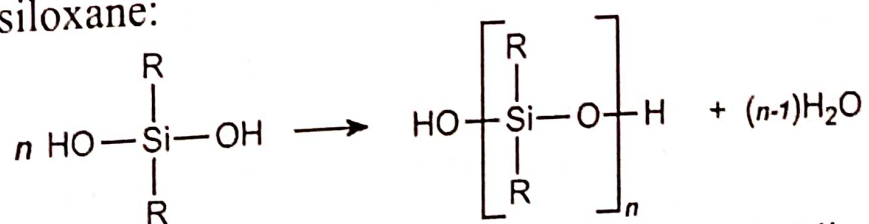


The product is a **disilanol**. The suffix *-ol* in a silanol is to show that the molecule contains at least one hydroxyl group attached to a silicon atom and the simplest example is dimethyldisilanol:



dimethyldisilanol

The hydroxyl groups of silanols react spontaneously to form a siloxane:

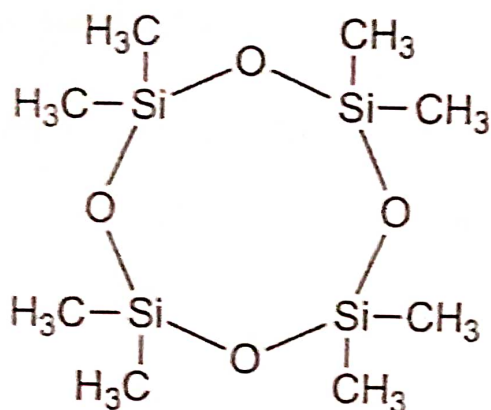


If R is a methyl group, the polymer is a poly(dimethylsiloxane).

Poly(dimethylsiloxanes) are produced with $n = 20-50$, which is not long enough to produce useful silicones.

These relatively short polymers are known as **oligomers**.

Cyclic polymers, for example $((\text{CH}_3)_2\text{SiO})_4$ are also produced and then separated out.



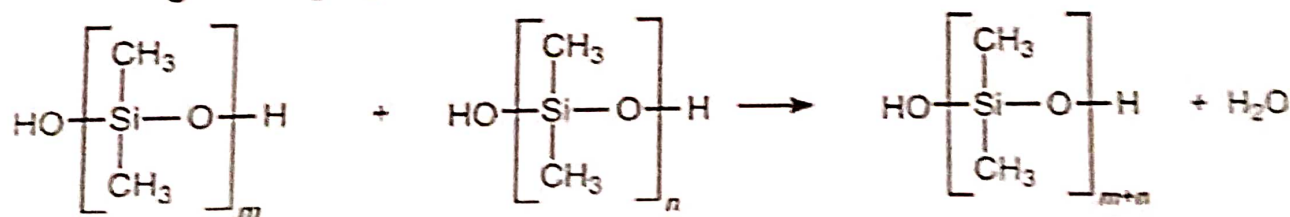
The oligomers are washed and dried.

The hydrochloric acid produced when the chlorosilanes are hydrolyzed is recycled and reacts with methanol to regenerate chloromethane:



3. Condensation polymerization

The oligomers condense rapidly in the presence of an acid catalyst to form long chain polymers:



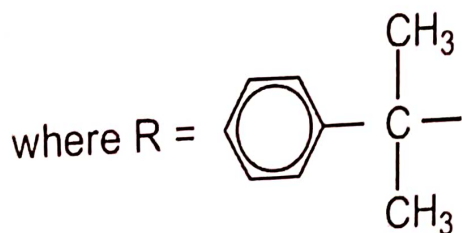
These materials are silicone fluids.

The value of $(m+n)$ is usually between 2000 and 4000. The production of longer chains is favoured if the water is removed, for example by working under vacuum.

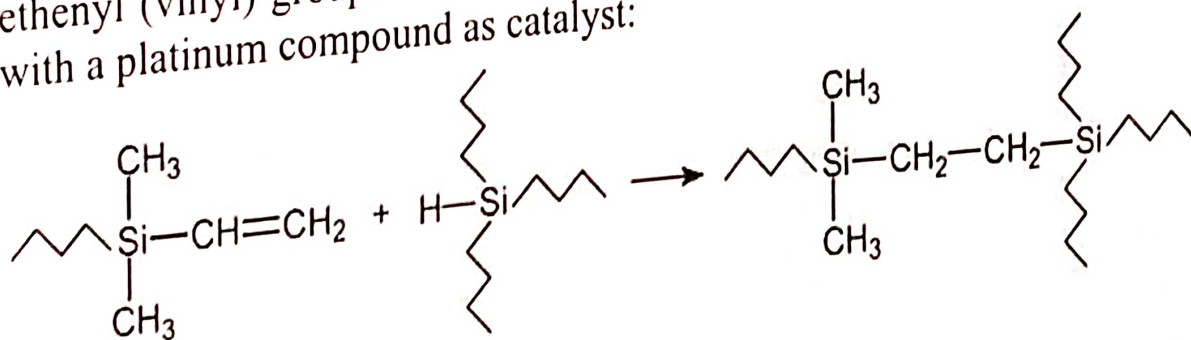
To form *silicone gels*, *elastomers* and *resins*, the long siloxane chains are induced to cross-link. There are four main ways of doing this:

(i) Cross-linking is often effected by first synthesizing silanes with a functional group, in place of a methyl group, that will react

further. For example, a silane containing an vinyl group such as ethenyl methyldichlorosilane, can be added to, for example, dimethyldichlorosilane. This leads to cross-linking between the polymer chains. As with this polymerization, the addition reactions are initiated by radicals supplied on decomposition of an organic peroxide (for example, dicumyl peroxide):



(ii) Cross-linking can also be achieved by using siloxanes with ethenyl (vinyl) groups and other siloxanes containing Si-H groups, with a platinum compound as catalyst:



Uses of silicones

The silicones are classified in a variety of forms based on their different preparation methods.

- Silicone fluids
- Silicone gels
- Silicone elastomers (rubbers)
- Silicone resins

Their physical form and uses depend not only on the