Types of Rubber and Their Essential Properties

Characteristics

- ***Upper temperature aging limits** - **heat aging resistance***
- ***Chemical resistance and concentration***
- ***Chemical resistance and temperature***
- ***Mechanical properties and temperature:***

  Butyl rubber, a fairly non-resilient material at room temperature can have a significant higher resilience at 80 "C.

- ***Grades within a type of rubber***

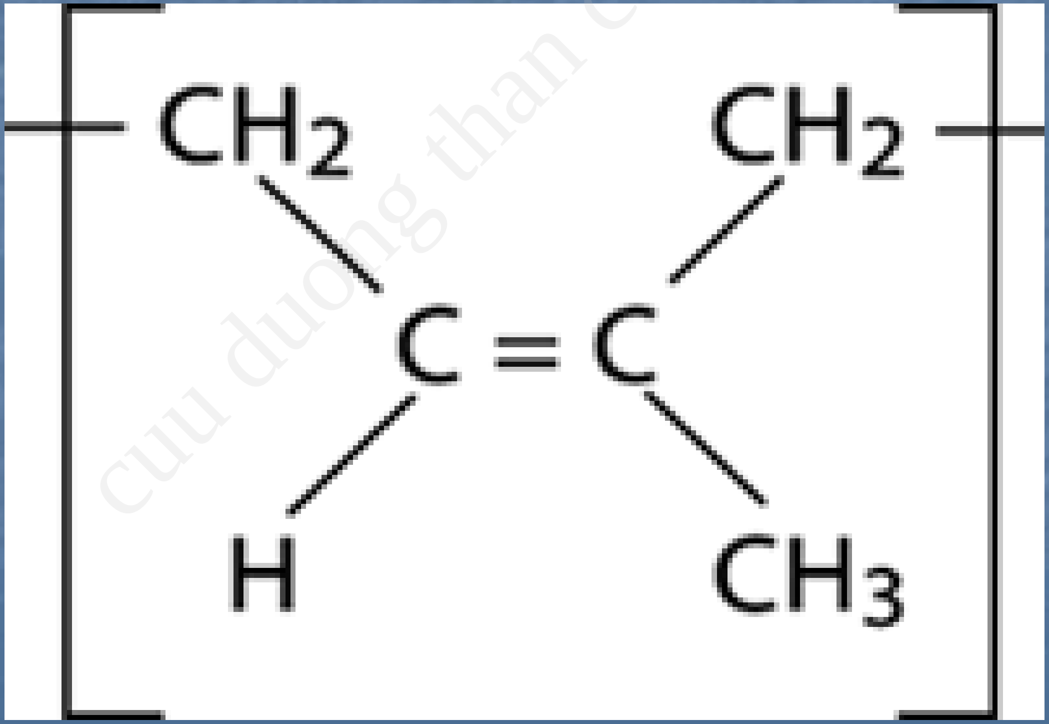
All synthetic (and natural) raw gum elastomers have subdivisions within their own family.

Natural rubber NR

Production of natural Rubber

- NR is tapped from rubber trees (Hevea brasiliensis) as latex.
- Latex is a colloidal dispersion of solid particles of polymer polyisoprene in water and dry rubber content in the emulsion is about 30%

Chemical structure of natural rubber



Natural rubber NR

- Available in many grades related to its ‘dirt’ content and precise method of production.
- Popular grades are ribbed smoked sheet (RSS) and technically specified rubber such as SVR (Standard Vietnamese Rubber)

- Addition of carbon black to a compound gives resistance to UV, antiozonants
- Antiozonants and waxes support ozone resistance.

Ozone attack is of most concern for thin products and those that are subjected to stretching during service.

- Electrical insulation is very good and, like all elastomers, depends on compounding.
- Resistance to petroleum oils is poor
- Resistance to alcohols (such as ethanol and methanol) and ketones (such as methyl ethyl ketone (MEK) and acetone) is much better

- 20, *50:* the lower the number, the cleaner the grade, and therefore the more expensive
- Specialized grade known as SMR CV with consistent viscosity control of NR (constant viscosity) is available. This grade has 0.15% of a hydroxylamine salt added to prevent a ‘cross-linking’.

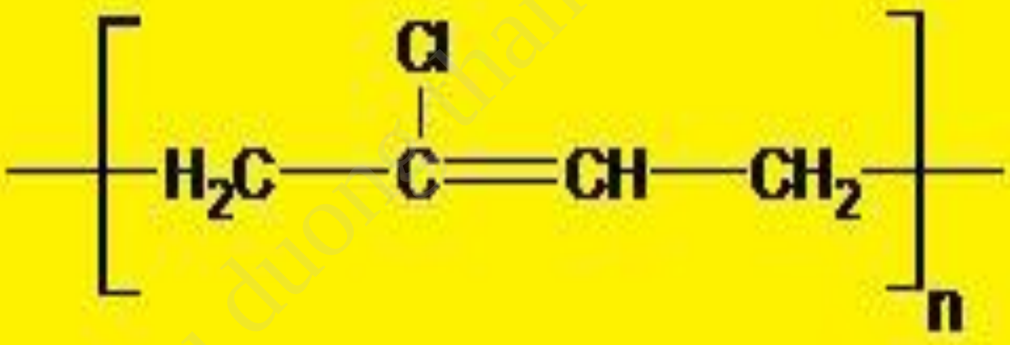
Styrene butadiene rubber SBR

Styrene butadiene rubber SBR

- From petroleum oil
- There are many subgroups of the raw gum elastomer
- In comparison with natural and CR, gum vulcanizates made from SBR have poor mechanical properties therefore must have reinforcing fillers such as carbon black

- The properties of SBR are broadly similar to NR, for chemical, solvent, and weather resistance.
- The upper temperature heat aging resistance limit is a little higher.

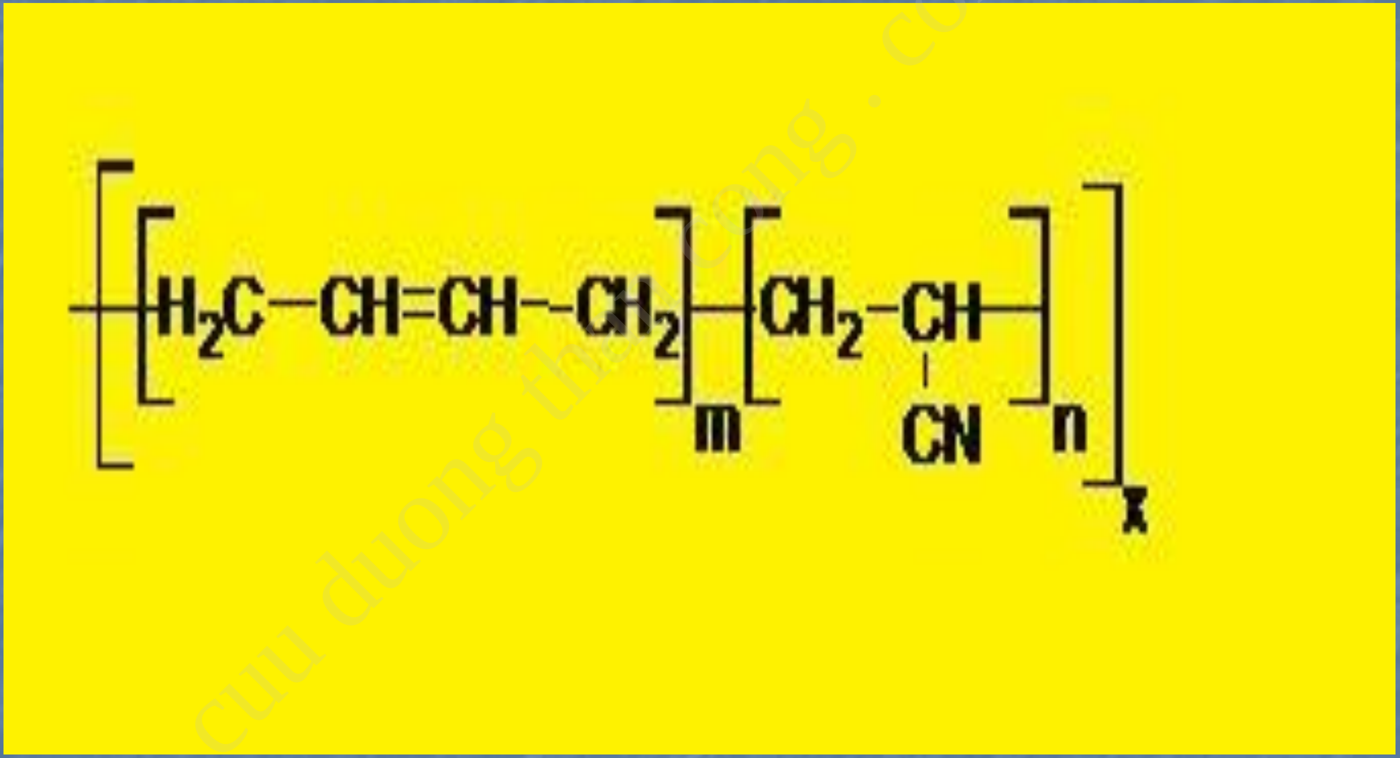
Polychloroprene CR



Polychloroprene CR

- Known as Neoprene
- More specialized than the two previous elastomers (oil and weather resistance)
- Ability to retard flame
- Resistance to dilute acids and bases is better than that of NR or SBR

Nitrile Rubber NBR



Nitrile Rubber NBR

- Known as acrylonitrile butadiene rubber, Buna-N and simply nitrile
- Oil resistant properties
- The higher the amount of ACN in the elastomer, the better the oil resistance
- The weather resistance of NBR is poor, similar to NR and SBR

- Better heat aging resistance than CR and is in the region of 107^0C for continuous use.
- Needs reinforcing fillers.
- Poor resistance to polar liquids such as ketones, esters, chlorinated solvents, and many aromatic solvents such as benzene and toluene

Ethylene propylene rubber EPM and EPDM

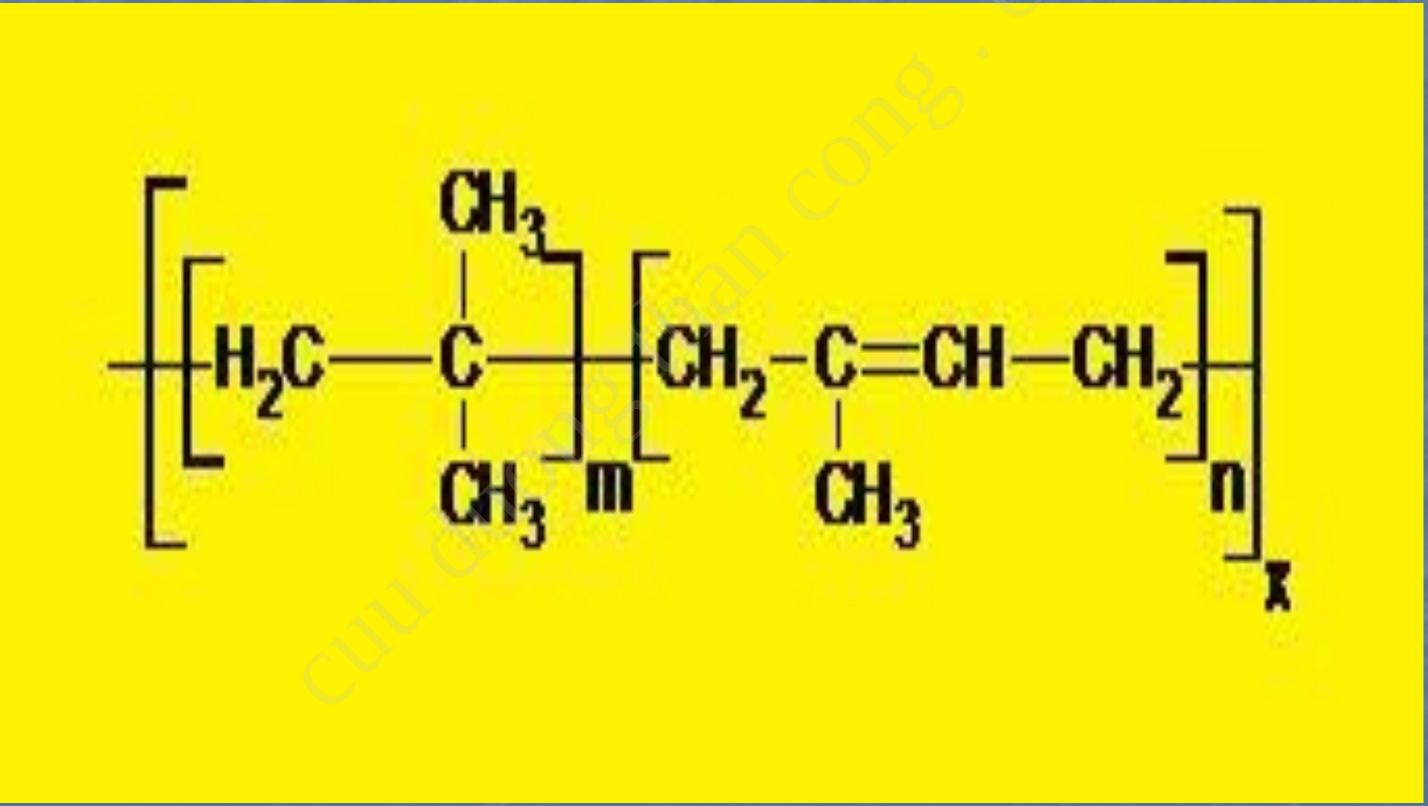
- EPM is a copolymer consisting of ethylene and propylene units as part of the main polymer chain.
- It can be cross-linked with peroxides or radiation but not sulfur

Ethylene propylene diene terpolymer-EPDM

- Unaffected by weather with very good resistance to ozone
- Upper 'continuous` heat aging temperature limits in air, anywhere from 126^0C to around 150^0C

- Low temperature flexibility is very good and even better when compare with NR.
- Very poor oil resistance.
- Resistance to a number of concentrated mineral acids and bases is significantly better than that of NR or SBR
- Excellent electrical resistance of EPDM

Butyl rubber IIR



Butyl rubber IIR and halobutyl rubber CIIR and BIIR

- Some properties similar to those of EPDM.
- Good mineral acid and base resistance.
- Good weather resistance (similar to that of EPDM).
- Excellent resistance to gase permeability
- Poor resistance to petroleum oils

- Upper continuous heat aging temperature limit is around 121^0 C degree.
- Applications for vibration and shock prevention, roof and tank linings, curing bladders and inner tubes for tires.
- Halobutyls can be blended with unsaturated elastomers such as NR, whereas for IIR it is not recommended

Silicone rubber

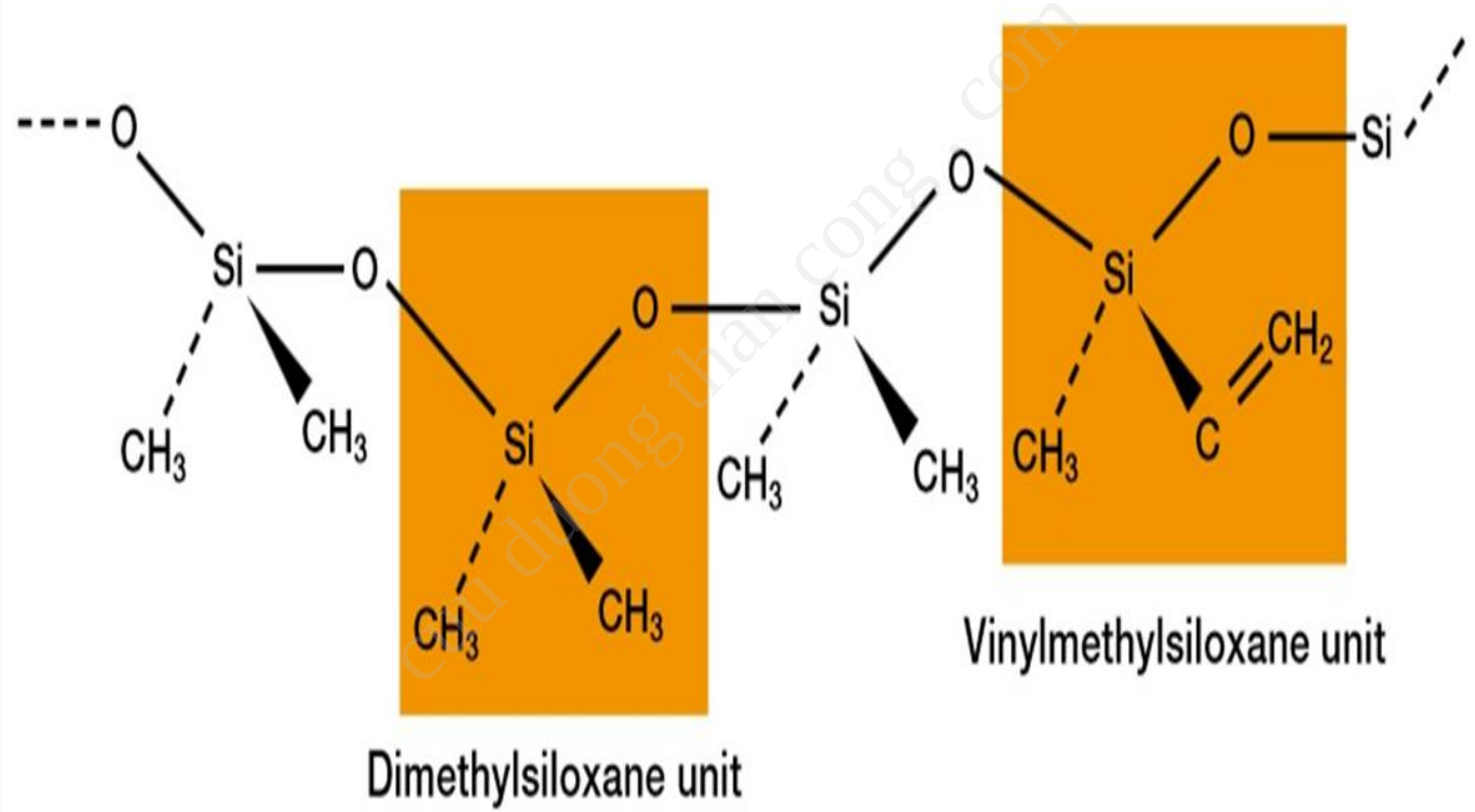
MQ = Methyl-Polysiloxane

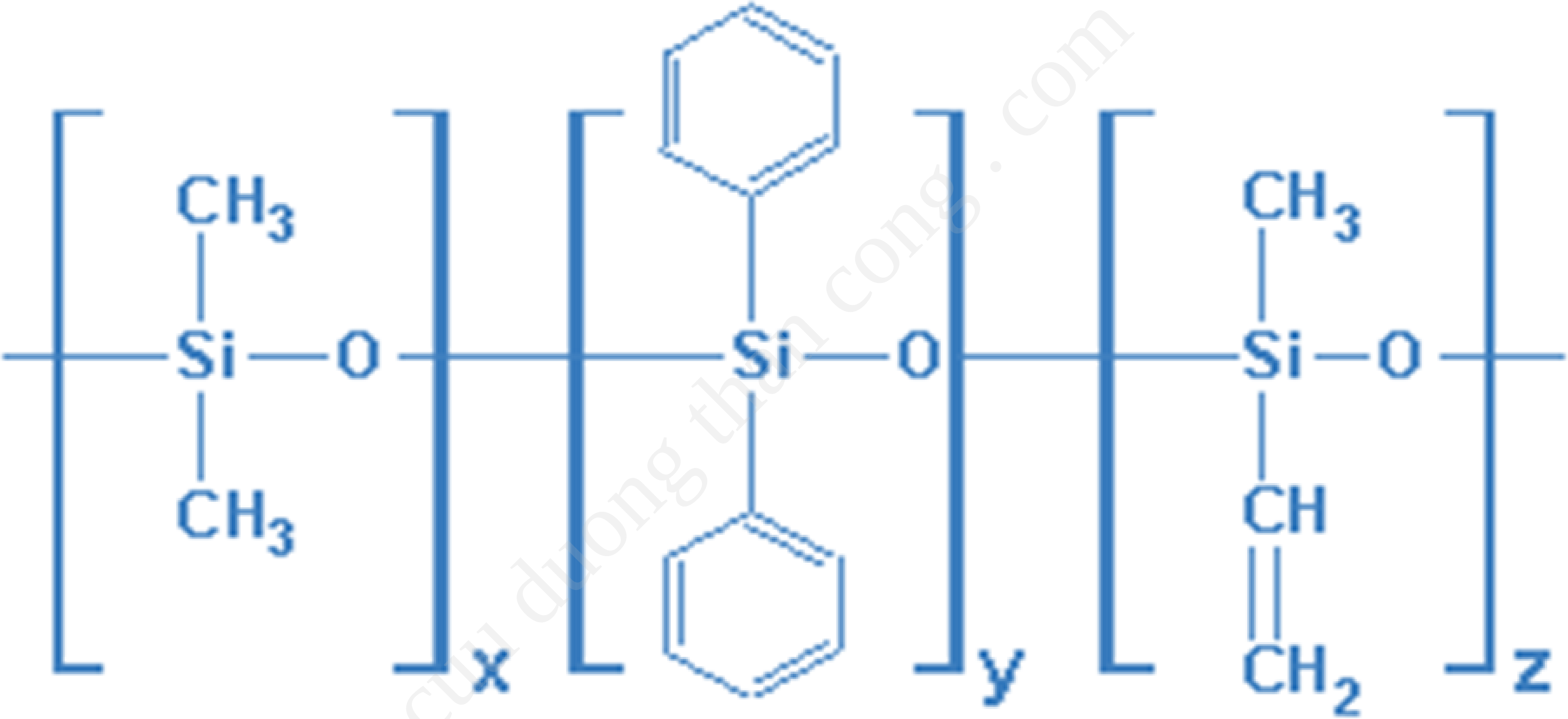
VMQ = Vinyl-Methyl-Polysiloxane

PMQ = Phenyl-Methyl-Polysiloxane

PVMQ = Phenyl-Vinyl-Methyl-Polisiloxane

Chemical Structure





Silicone rubber

- Most elastomers have a carbon main chain, while Q (Quaternary group) has a silicone oxygen backbone.
- The best elastomers for both high and low temperature resistance (-54^{0}C and 200^{0}C for general purpose compounds and -115^{0}C and 260^{0}C for special compounds)

Silicone rubber

- Excellent ozone, weather resistance and electrical insulation.
- Low tensile strength, poor tear strength and little wear resistance.
- Applications include aerospace, medical, food contact, and automotive ignition cable.

Hydrogenated nitrile rubber HNBR (HSN)

- New elastomer - first appearance in 1984
- Very good weather and abrasion. resistance, plus good mechanical strength.
- Used in oilfields where it has resistance to amine corrosion inhibitors and better hydrogen sulfide resistance than NBR.
- Peroxide cured HNBR has heat aging resistance up to 150^0C.

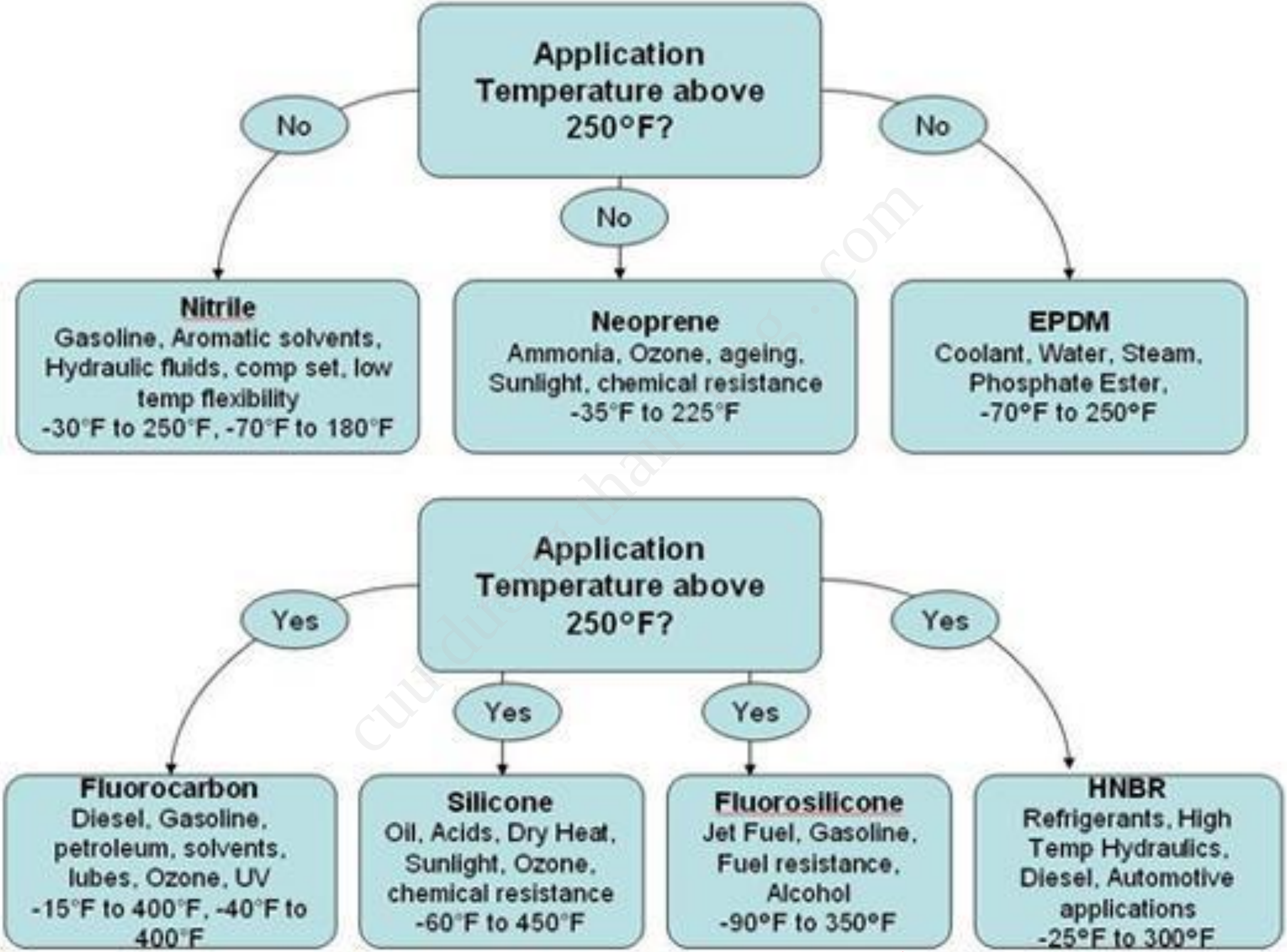
Chlorosulfonated polyethylene ***CSM***

- Best known as Hypalon.
- Excellent ozone, acid, and weathering resistance.
- Oil and heat aging resistance.

Urethane rubber

- Produced by reacting a diisocyanate (TDI, MDI) with either a polyether polyol (1,4-butanediol) or a polyester polyol (from adipic acid and ethylene glycol)

- Low molecular weigth polyols produced hard polymers.
- High molecular weith polyols give soft polymers.
- High tensile strength and abrasion. resistance combined with good oil and tear resistance.


Application Temperature above 250°F?
No
No
No
Nitrile
Gasoline, Aromatic solvents, Hydraulic fluids, comp set, low temp flexibility
-30°F to 250°F, -70°F to 180°F
Neoprene
Ammonia, Ozone, ageing, Sunlight, chemical resistance
-35°F to 225°F
EPDM
Coolant, Water, Steam, Phosphate Ester,
-70°F to 250°F
Application Temperature above 250°F?
Yes
Yes
Yes
Yes
Fluorocarbon
Diesel, Gasoline, petroleum, solvents, lubes, Ozone, UV
-15°F to 400°F, -40°F to 400°F
Silicone
Oil, Acids, Dry Heat, Sunlight, Ozone, chemical resistance
-60°F to 450°F
Fluorosilicone
Jet Fuel, Gasoline, Fuel resistance, Alcohol
-90°F to 350°F
HNBR
Refrigerants, High Temp Hydraulics, Diesel, Automotive applications
-25°F to 300°F