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M. Sc. Chemistry Semester – III
Lect- 1
Zeolites, Classification of Zeolite

History of zeolite

- In 1756 zeolite group minerals was discovered by Swedish scientist "*Baron Cronstendt*" , he then named boiling stone as a zeolite.
- In between 1756 to 1906 just beautiful sample were collected as curiosity of nature with out any professional interest.
- During the century of 1930 a larger deposites were found in the western part of United state, however, majority of professional word unaware of this report.
- In the decade of 1950 natural minerals was studied by X-ray diffraction technique and it was found that the material contained 90% single well defined zeolite minerals. In the meantime heulandite, Zeolite-A, Zeolite-X, Zeolite-Y were discovered and industry has shown considerable interest in zeolite-A and X as a commercial point of view. From this a huge market has developed over the last 50 years.

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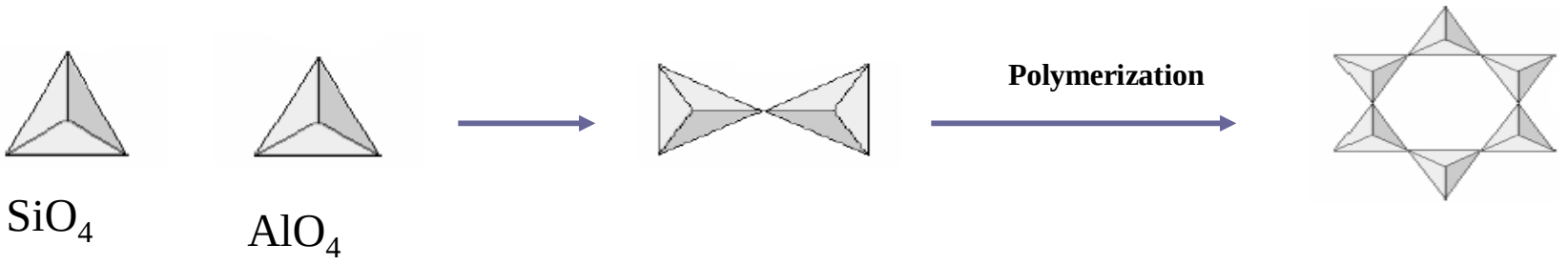
What is Zeolites

- Zeolites are porous hydrated aluminosilicates having long chain polymers with exchangeable cation from Ist or IInd group. They may be natural minerals or synthetic materials. General formula of zeolite is

$$M_{2/n}[(AlO_2)_x.(SiO_2)_y].z\ H_2O$$

M- Exchangeable cation, that are equivalent to the number of Al atom present in zeolite framework

Zeolite framework consist of different rings and various sizes of pores (10- 100A°), channels and cavities in the matrix



SiO_4 AlO_4

$Na_{55}[(AlO_2)_{55}(SiO_2)_{137}]\ 27H_2O$

Na-zeolite

$Na_{88}[(AlO_2)_{88}(SiO_2)_{104}].\ 264H_2O$

Na =Al = 88

Na-zeolite = Linde –X zeolite

Zeolite posses porosity therefore lager the number of water molecules absorbed by zeolites.

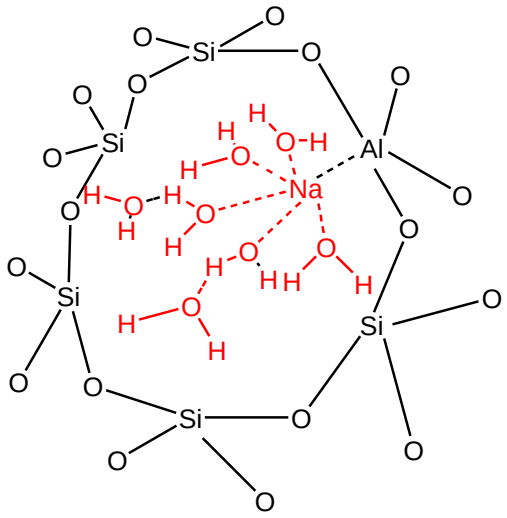
$Na_{55}(AlO_2)_{55}(SiO_2)_{137}.\ 27H_2O$

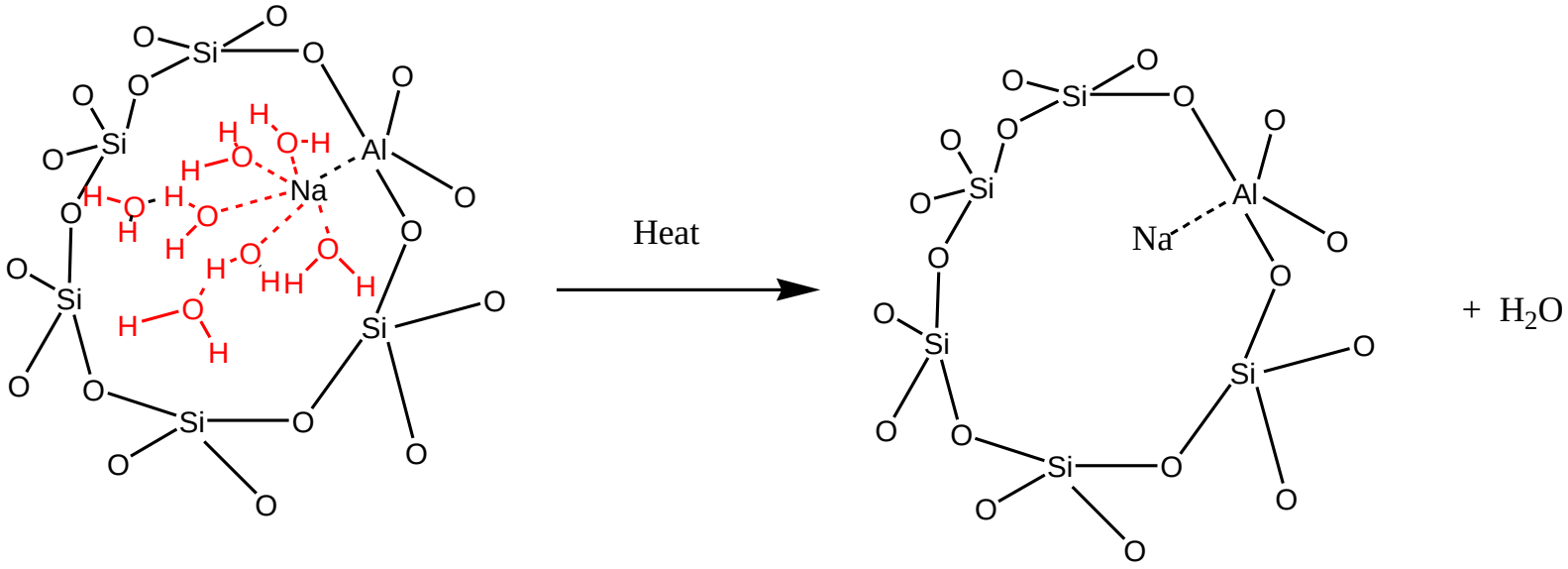
$Na_{88}(AlO_2)_{88}(SiO_2)_{104}.\ 264H_2O$

How water molecules are accommodated in the cavities of zeolite ?

How water molecules are lives in the cavities of zeolites ?

Ion- dipole interactions



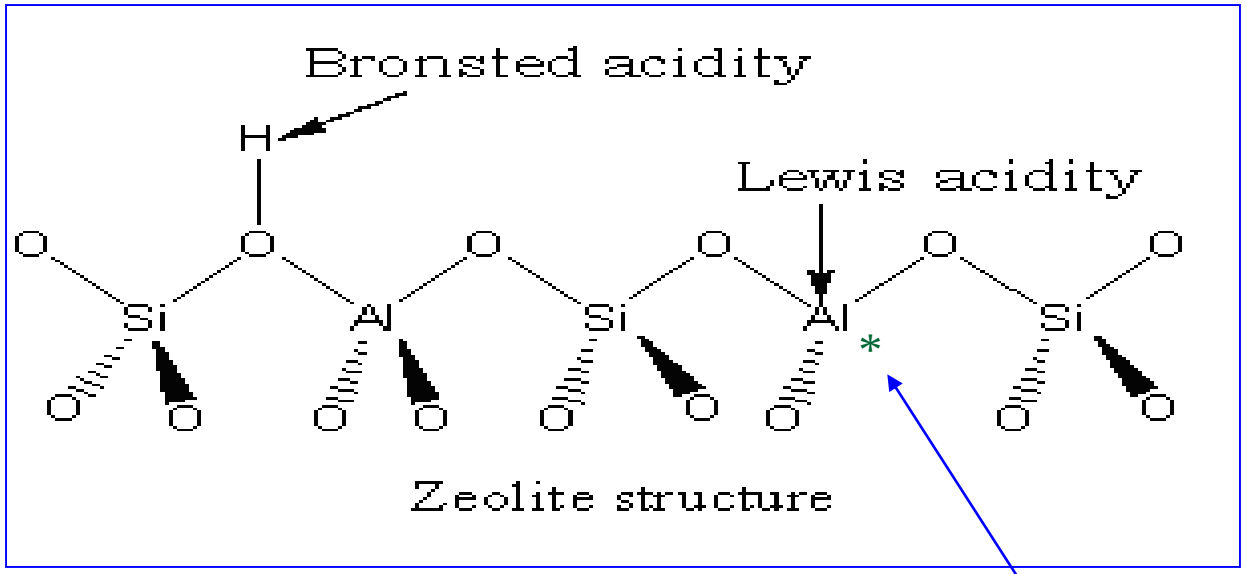


Considering above reaction, can you suggest use of such materials ?

Zeolite acidity

Proton donor - Bronsted Acidic site

Electron deficient center - Lewis acidic site



Tricoordinated Al site is electron deficient

* Can bind nucleophiles during catalytic process

Natural zeolite:

Classification of Zeolites

Morphological appearance of zeolite

Fibrous zeolite : Fiber like structure

Scolecite : $Ca_8[Al_{16}Si_{24}O_{80}].24\ H_2O$

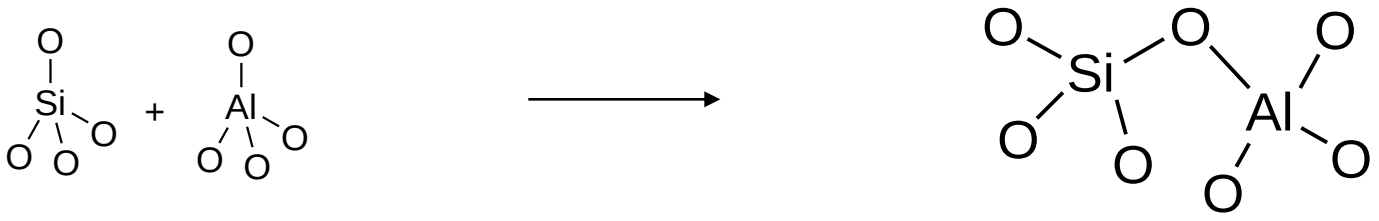
Platty zeolite : Lamellar structure type zeolite

Heulandite : $Ca_4[Al_8Si_{24}O_{72}]\ 24\ H_2O$

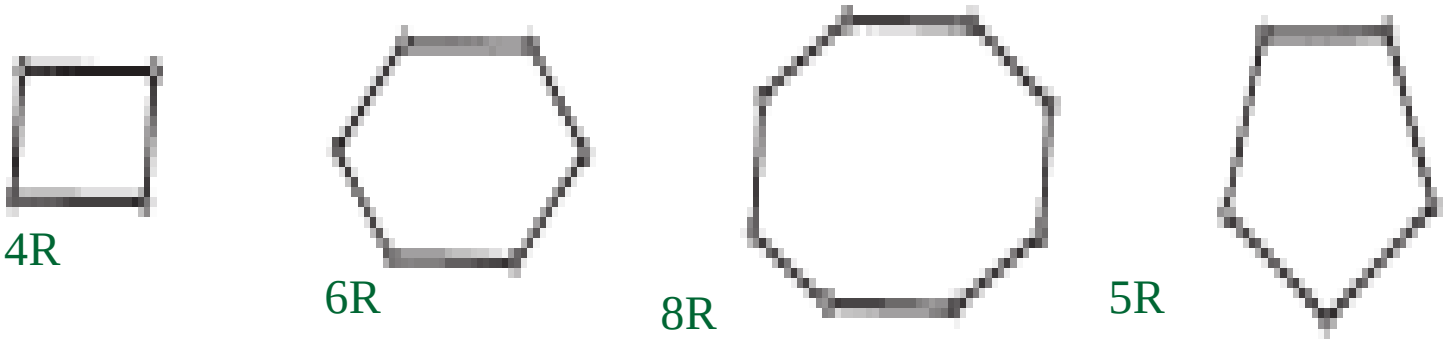
Stilbite : $Na_2Ca_4[Al_{10}Si_{26}O_{72}]\ 24\ H_2O$

Fundamental structural units of zeolite framework : PBU , SBU, TBU

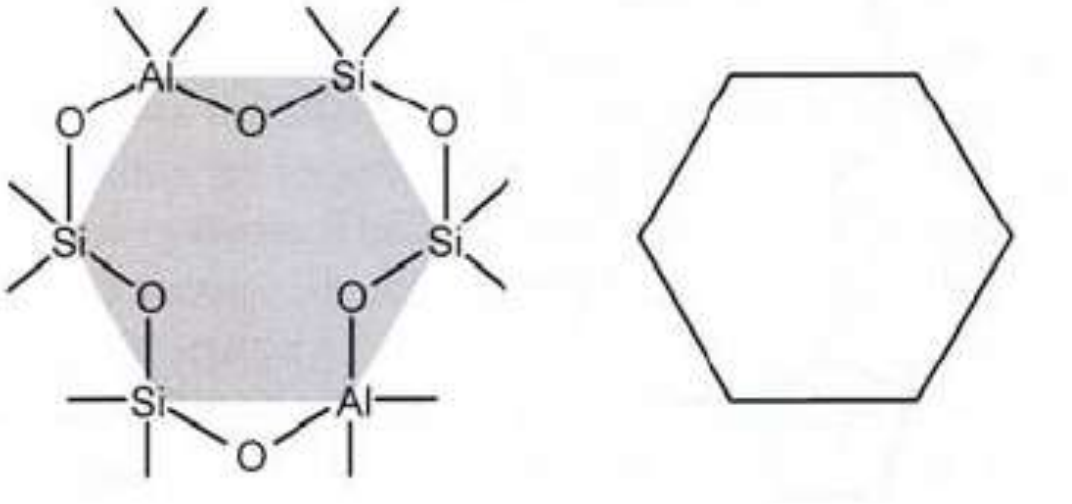
PBU



SBU

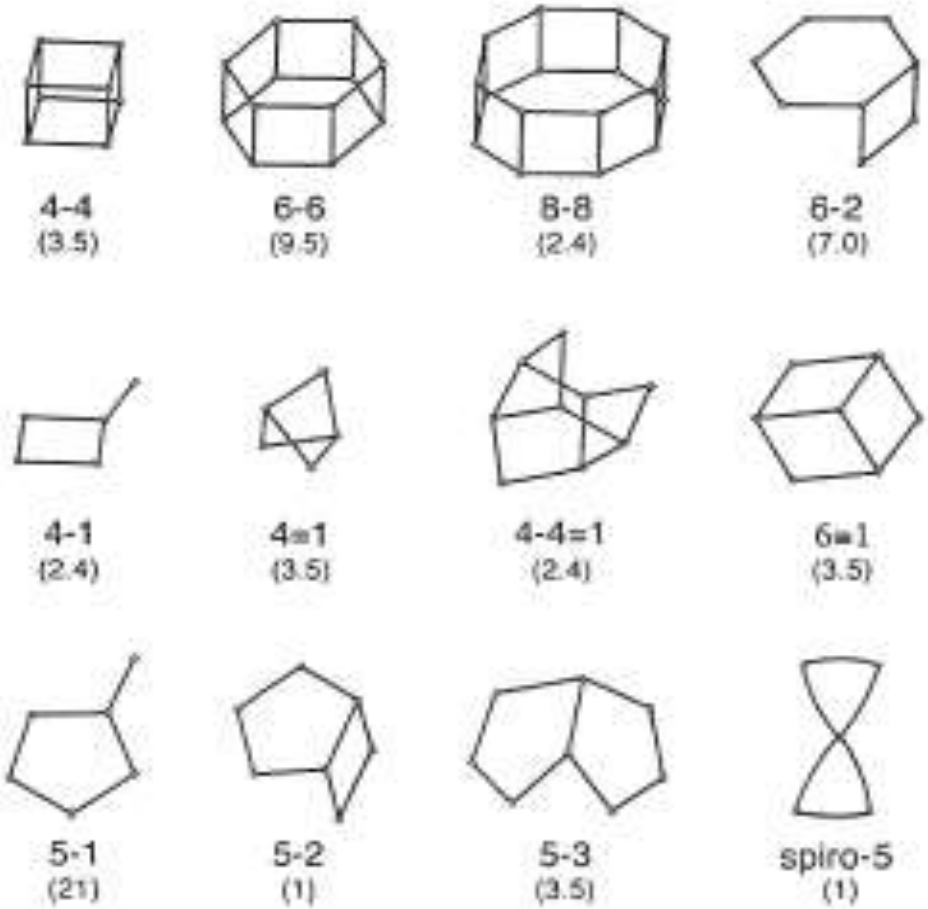


Formation of Secondary building Unit



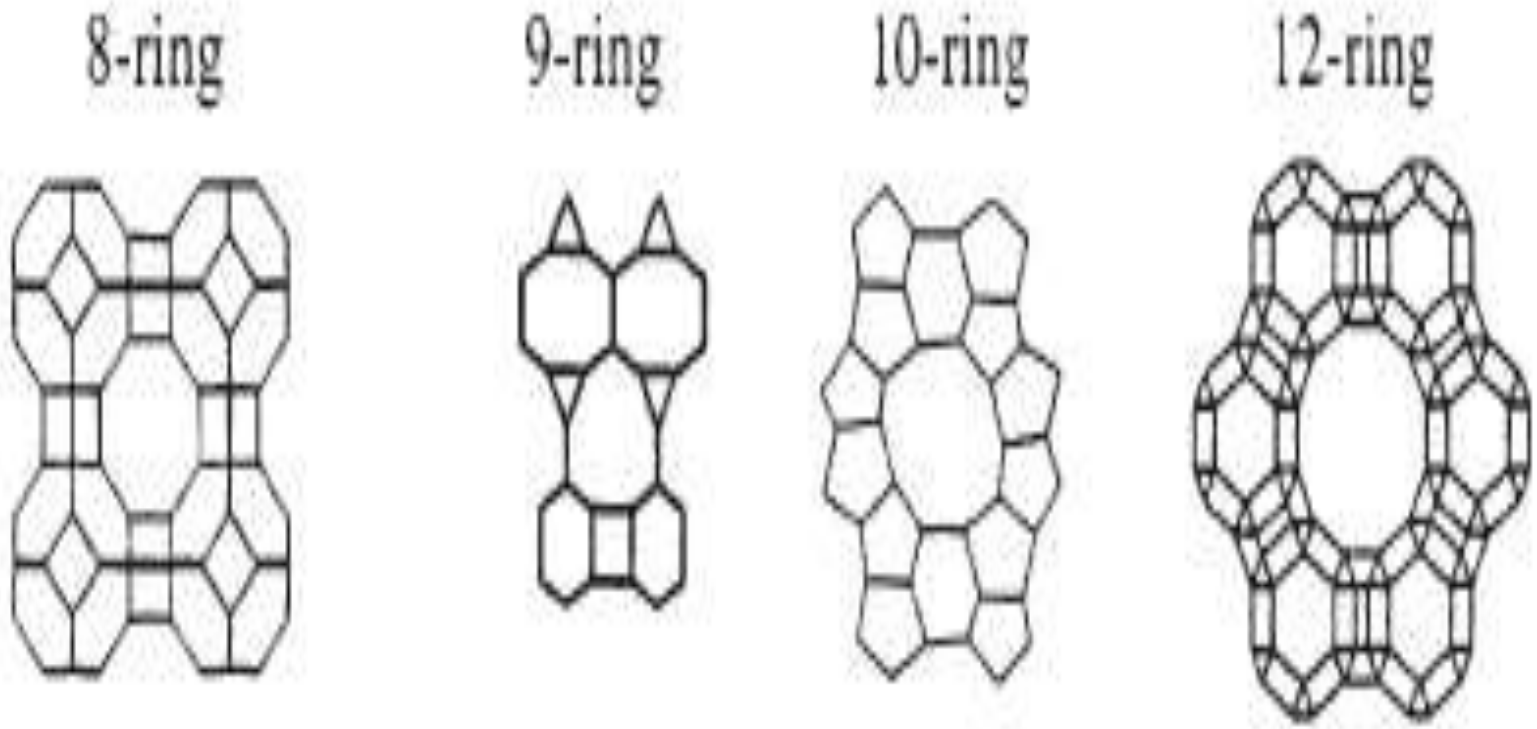
Zeolite framework structures are formed by SBU

TBU



Zeolite framework

Three dimensional framework structure of zeolites

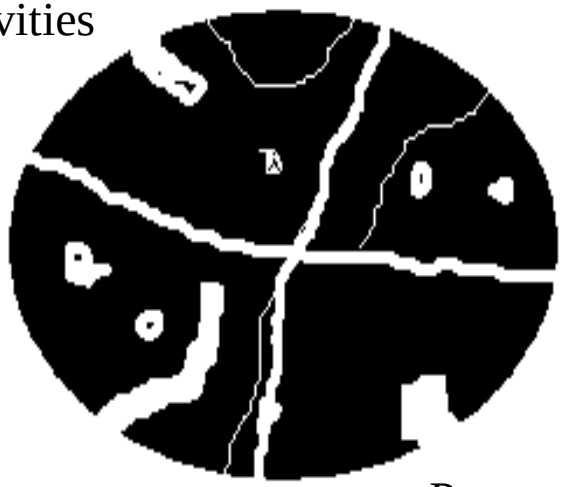


Zeolite framework contain various sizes of Pore , channels and cavities

- Micro porous zeolites : pore diameter less than 2 nm
  Mesoporous zeolite : pore diameter in the range 2 - 50 nm

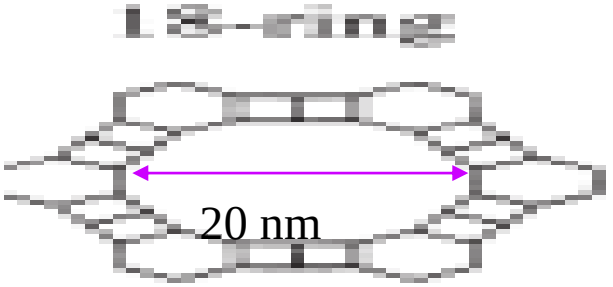
Zeolite possess , Pores, channels, cavities

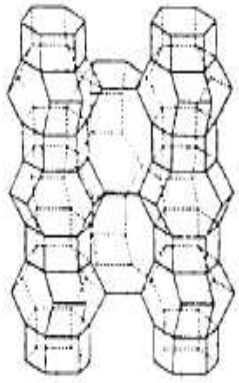
cavities

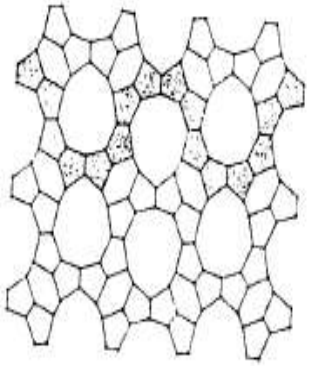


channel

Pore open
at one end







New class of zeolite can be prepared by substitution of iso-electronic metal ion in place of either Si^{4+} or Al^{3+}

- Titanosilicate Ti^{3+}, Si^{4+}
- Galosilicate Ga^{3+}, Si^{4+}
- Chromosilicate Cr^{3+}, Si^{4+}
- Aluminophosphate Al^{3+}, P^{4+}

Thank You All