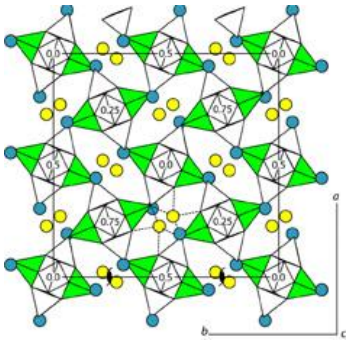
Zeolite

- Zeolite is hydrated sodium aluminium silicate having a general formula, $Na_2OAl_2O_3.xSiO_2.yH_2O$.

1) **Natural zeolite:**
   - These are about 40 naturally occurring zeolites, forming in both volcanic and sedimentary rocks
   - Natural zeolite are non-porous
   - e.g. Natrolite, Mordenite, stillbite and so on



1) **Synthetic zeolite:**
   - These are around 150 Synthetic (Artificial) zeolite which are designed for specific purposes.
   - Synthetic zeolite are porous
   - Such zeolites possess higher exchange capacity per unit weight than natural zeolites
   - Prepared by heating china clay, feldspar and soda ash.
   - e.g. Zeolite A (used as a laundry detergent), Zeolites X and Y (used for catalytic cracking) and ZSM-5 (pentasil-zeolite)

China clay $Al_2Si_2O_5(OH)_4$

Feldspars ($KAlSi_3O_8$ – $NaAlSi_3O_8$)

Zeolite or Permutit Process

- **Common Zeolite is $Na_2OAl_2O_3.3SiO_2.2H_2O$ known as natrolith.**
- Other gluconites, green sand (iron potassium phyllosilicate with characteristic green colour, a mineral containing Glauconite), etc. are used for water softening.
- **It exchanges Na^+ ions for Ca^{2+} and Mg^{2+} ions.**
- **Artificial zeolite used for water softening is Permutit.**
- These are porous, glassy particles having higher softening capacity compared to green sand.
- They are prepared by heating china clay (hydrated aluminium silicate), feldspar ($KAlSi_3O_8$-$NaAlSi_3O_8$ – $CaAl_2Si_2O_8$) are a group of rock-forming tectosilicate minerals which make up as much as 60% of the earth's crust) and soda ash (Na_2CO_3)

Zeolite process

- **Method of softening:**

$$Na_2Ze + Ca(HCO_3)_2 \longrightarrow 2\,NaHCO_3 + CaZe$$

$$Na_2Ze + Mg(HCO_3)_2 \longrightarrow 2\,NaHCO_3 + MgZe$$

$$Na_2Ze + CaSO_4 \longrightarrow Na_2SO_4 + CaZe$$

$$Na_2Ze + CaCl_2 \longrightarrow 2\,NaCl + CaZe$$

- **Regeneration of Zeolite:**

$$CaZe\ (or)\ MgZe + 2\,NaCl \longrightarrow Na_2Ze + CaCl_2\ or\ MgCl_2$$

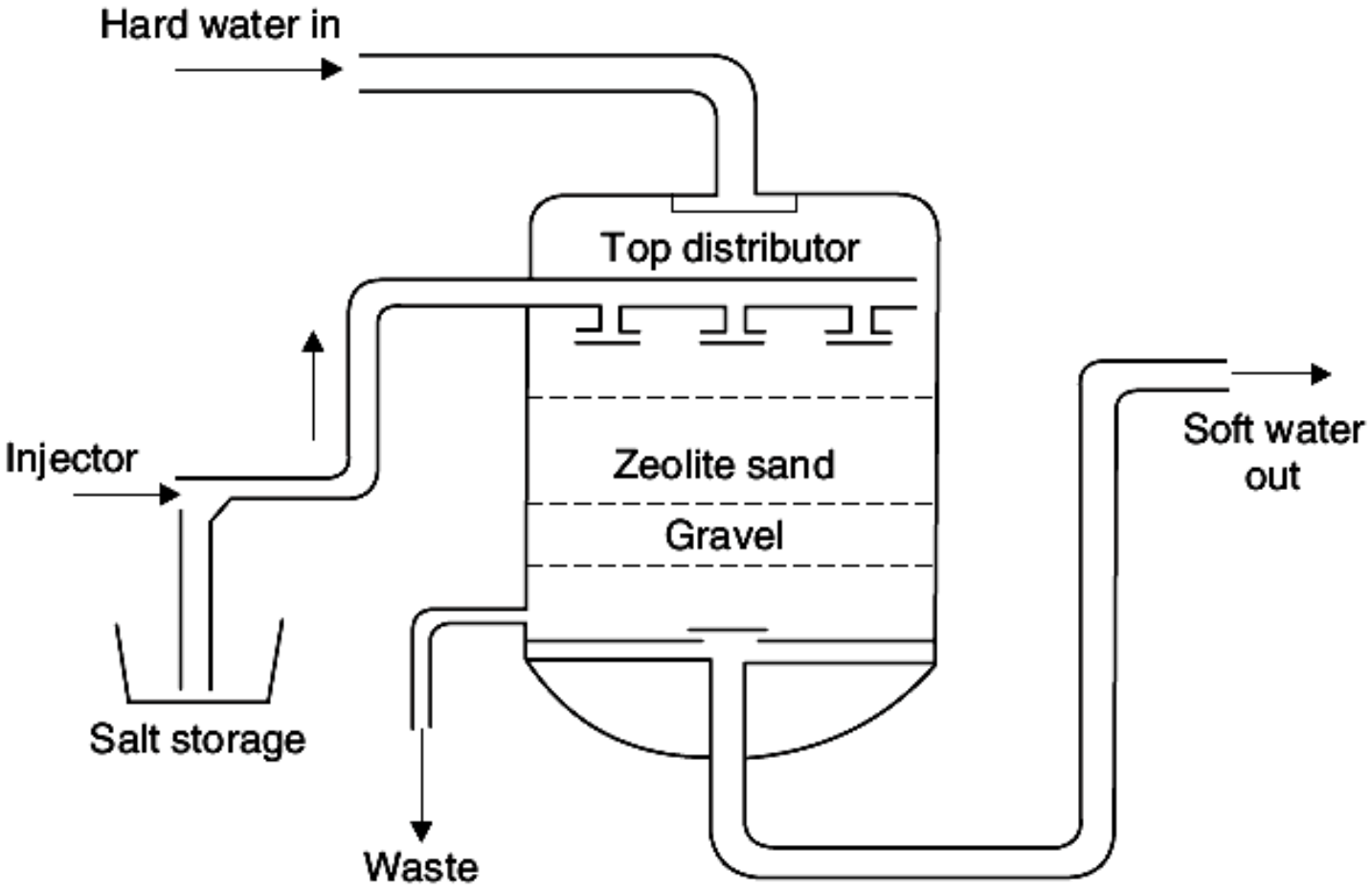
$\downarrow$

Brine solution

Note:

***Ze = Zeolite**

Zeolite process equipment diagram



Softening of hard water by permutit process.

Zeolite Process

Advantages:

- Residual hardness of water is about 10 ppm only
- Equipment is small and easy to handle
- Time required for softening of water is small
- No sludge formation and the process is clean
- Zeolite can be regenerated easily using brine solution
- Any type of hardness can be removed without any modifications to the process

Disadvantages:

- Coloured water or water containing suspended impurities cannot be used without filtration
- Water containing acidic pH cannot be used for softening since acid will destroy zeolite.