Sri Aurobindo College of Dentistry

Indore, Madhya Pradesh

INDIA

Module plan

- Topic : Defluoridation of Water
- Subject : Public Health Dentistry
- Target Group : Undergraduate Students
- Mode : PowerPoint Presentation
- Platform : Institutional LMS
- Presenter : Dr. Shantanu Sontakke

Learning objectives

- **General objective** –Defluoridation and methods of Defluoridation
- **Specific learning objective**:

1. Define
2. Enumerate various methods of Defluoridation
3. Understand the detail about Nalagonda technique

Defluoridation

"Downward adjustment of concentration of fluoride ion in public water supply in such a way, that the concentration of fluoride in water is maintained constantly at 1ppm"

OR

"It is the process of removing excess fluoride present in water supply in order to prevent dental fluorosis or more severe disability"

Defluoridation methods

1. Based on ion exchange process or adsorption
2. Based upon addition of chemicals to water during treatment

In India, the 1st defluoridation was taken by NEERI (National Environmental Engineering Research Institute) at Nagpur in 1961

Ion exchange resins

I) Anion exchange resins

- polysterene anion exchange resins & strongly basic quaternary ammonium type resins

(tulsion A-27, Deacedite, FF-IP Lewatit, MIH-59 & Amberite,IRA-400)

- provide 20-145 bed volume of defluoridated water per cycle

- Loose their capacity on prolong use (10-15 cycles)-→ total replacement
- Drawbacks :
  - Costly (capital cost of plant– Rs 10,000)
  - Imparts unacceptable taste

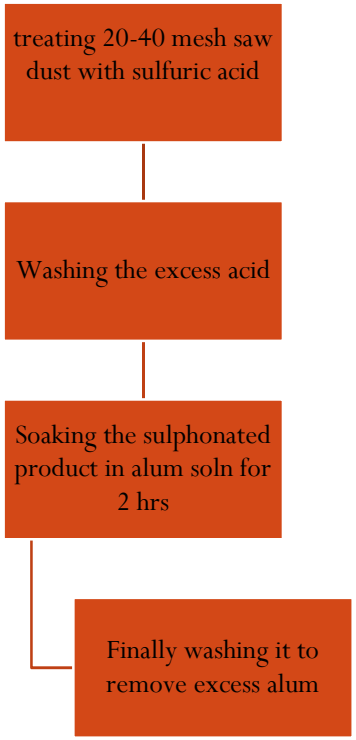
II cation exchange resins

a) ***Defluoron 1:-***

- Bhakuni (1964,1970)

- sulphonated saw dust impregnate with 2% alum solution

prepared by:-



- Cost → Rs 0.60 / m3 of water containing 4.3mg/l fluoride
- Drawbacks :-
  - The medium had poor hydraulic properties
  - Suffered from heavy attritional losses

b) *carbion:-*

is a cation exchange resin of good durability and can be used for both sodium and hydrogen cycles

c) *magnesia:-*

- dose of 1500mg / lts & contact period of 3hrs was required to reduce fluoride extent to 1mg /lts of water

-the study established that magnesia removed excess fluorides but PH of treated water was beyond 10 and its correction by acidification or recarbonation was necessary

- Acid requirement → CaCO3 (300mg/lts)
- Drawbacks:
  - High cost of magnesia
  - Large conc required
  - Complexity of preparation
  - Alkaline PH of treated water

d) *Defluoron 2:-*

- developed in 1968

- is a Sulphonated Coal and works on Aluminum cycles

- life of medium 2-4 yrs

- average fluoride removal capacity → 484mgF/lts of defluoron2

Municipal corporation, Nalgonda

Central Training institute, Hyderabad

Adsorption

1. *Bone Charcoal:-*

The Bone is processed by burning in air and pulverizing it to fine powder

Fluoride removal capacity → 1000mg/lts

2. *Processed Bone:-*

- Bone contains Calcium Phosphate and has great affinity for Fluorides

- The bone is de-greased, dried and powdered ,the powder can be used as a contact bed for removal of Fluoride in water

- The exhausted bed is regenerated with Sodium Hydroxide solution.

3. ***Tricalcium phosphate:***

- natural or prepared synthetically by reacting milk of lime and phosphoric acid have been used for defluoridation.

4. ***Activated carbon :-***

- has high defluoridation capacity

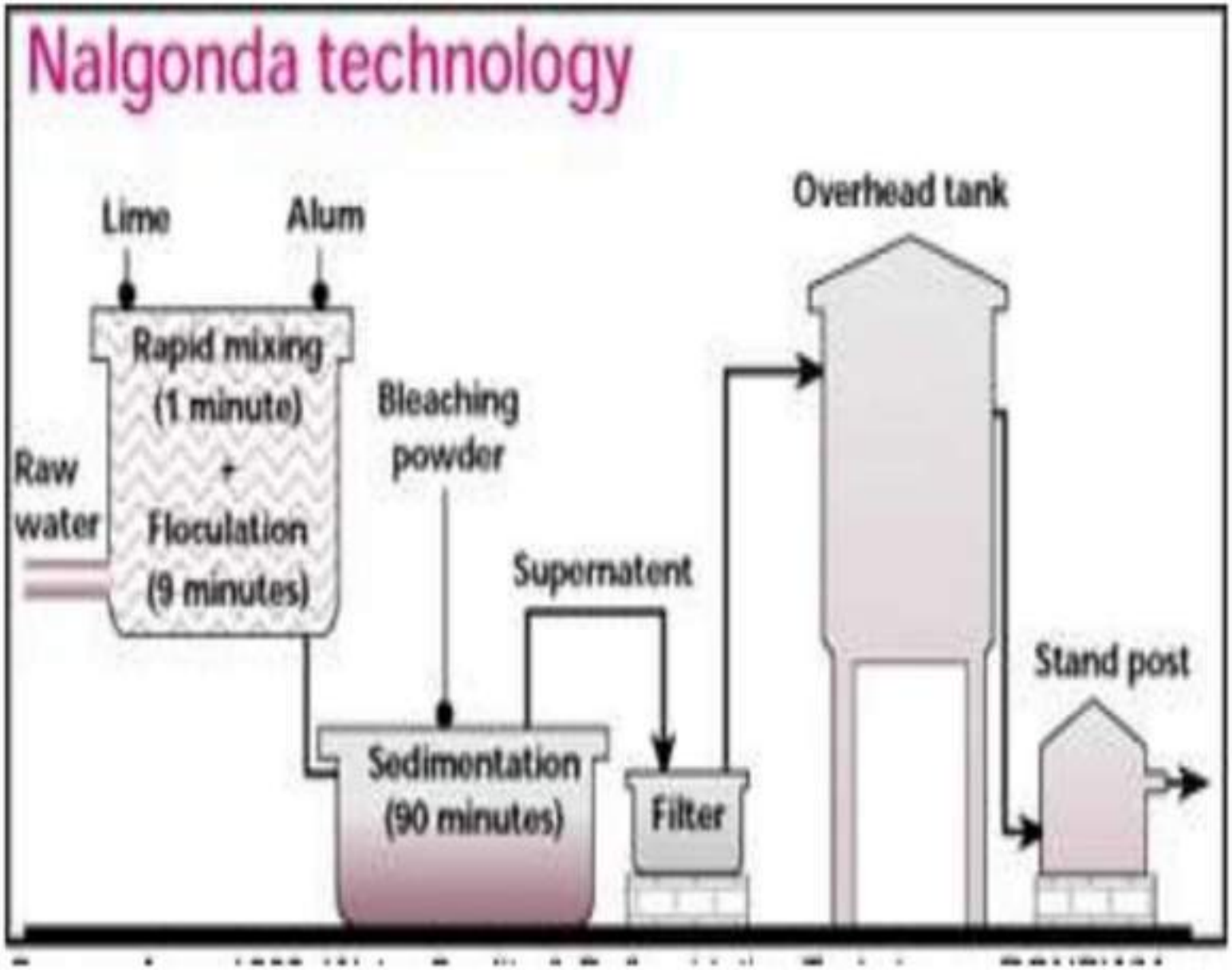
- prepared from paddy husk

- similarly activated carbon prepared from cotton waste, coffee waste & coconut waste were tried, but all these are of academic interest only

Chemical method

- ***Nalgonda technique:-***
  - 1961– NEERI
  - Involves addition of aluminum salts (alum), Lime, Bleaching powder followed by rapid mixing, flocculation, sedimentation, filtration and disinfection.

- Aluminum salts may be → aluminum sulphate or chloride or combination of two
- Selection of aluminum sulphate or chloride depends on sulphate or chloride content of raw water to avoid exceeding permissible limit
- Dose of lime → $1/20^{th}$ dose of aluminum salts
- Lime facilitates dense flocs for rapid settling
- Bleaching powder → 3mg/l for disinfection


Nalgonda technology
Lime
Alum
Overhead tank
Rapid mixing
(1 minute)
+
Flocculation
(9 minutes)
Raw
water
Bleaching
powder
Supernatent
Stand post
Sedimentation
(90 minutes)
Filter

- Mechanism of Nalgonda technique
  - Rapid mix:- provides thorough mixing of chemicals
  - Flocculation:- gentle agitation

    - combination of poly hydroxy aluminum complexation with fluoride & their adsorption on polymeric aluminum hydroxides (flocs)

    - turbidity, color ,odour → removed; bacterial load reduces

    -Lime ensures that residual aluminum does not remain in treated water

- Sedimentation:- permits settling of flocs loaded with fluorides & other impurities
- Filtration:-rapid gravity sand filters
- Disinfection :- rechlorinated with bleaching powder before distribution

- Salient features of Nalgonda techniques:-
  - No regeneration of media
  - No handling of caustic acids & alkalies
  - Readily available chemicals
  - Adaptable to domestic use
  - Applicable in batches as well as in continuous operation

- Simplicity of design, construction, operation & maintainance
- Highly efficient removal of fluorides 1.5-20mg/l to desirable level
- Simultaneous removal of color, odour, turbidity, bacteria,
- Sludge generated is convertible to alum for use elsewhere
- Little wastage of water and least disposal problems

- Applicability Nalgonda technique
  - Absence of alternate low fluoride source for drinking water
  - Total dissolved solids → below 1500mg/l
    > 1500mg/l → desalination
  - Hardness → below 600mg/l
  - Alkalinity must be sufficient to ensure complete hydrolysis of alum added
  - Raw water fluoride → 1.5 – 20 mg/l


Nalgonda technique
Domestic
Fill and draw for small community
Fill and draw for rural water supply

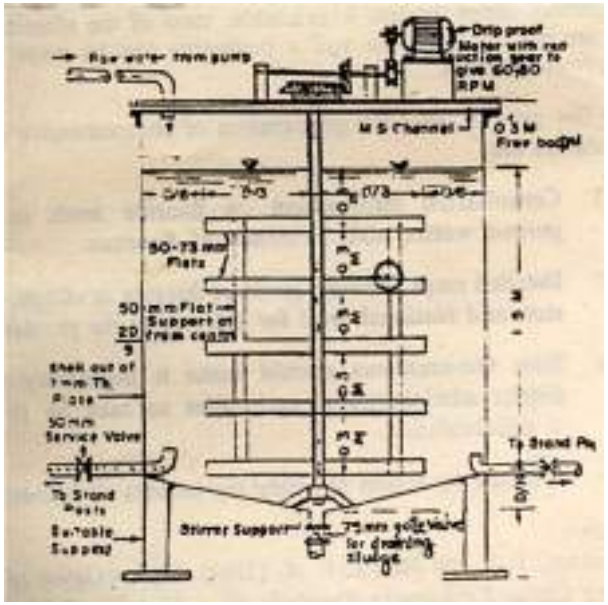
Domestic defluoridation

- Carried out in a container(bucket)– 60lts capacity with tap 3-5 cm above the bottom
- The raw water in the container is mixed with adequate amount of aluminum sulphate soln (alum), Lime, & bleaching powder depending upon its alkalinity & fluoride content
- Alum soln is added first & mixed well with water

- Lime and bleaching powder is then added & stirred slowly for 20min
- Allowed to settle for nearly one hour
- The supernatant, which contains permissible amount of fluoride is withdrawn thro' the tap for consumption
- Alum soln => 1kg in 10 lts =➔ 1ml contains 100mg of alum
- Lime soln => 100mg in 10 lts =➔ 1 ml contains 10mg of lime

Fill and draw defluoridation for small community

- Batch method for communities with up to population 200
- Consists of a Hopper- bottom cylindrical tank with a depth of 2mts equipped with a hand operated or power driven stirring mechanism
- 5min and then allowed to settled for 1-2 hrs



- Advantages:-
  - Completes in about 4hrs→ at least 3 batches in a day can be obtained
  - Accessories are few and easily available
  - Can be located in open with precaution to cover the motor

Fill and draw defluoridation for rural water supply

- Components:-
  - Reactor (s): it is reaction-cum-sedimentation tank equipped with power driven agitator assembly.
  - Sump well.
  - Sludge drying beds.
  - Elevated service reservoir.
  - Electric room.
  - Chemical store house

- Based on one to four operations in each reactor per day
- Each reactor will be of 10,20,30 m3 capacity
- The defluoridated water is collected in the sump well which is of capacity equal to total capacity of the reactors
- The defluoridated water will then be pumped to the elevated service reservoir & distributed by gravity thro' stand posts and house connections

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Thank you for listening

Questions??