

CHLORINATION

Bactericidal & moderately Virucidal but NOT sporicidal • Polio virus NOT sensitive to disinfection by chlorination

- Used for purification of highly polluted water on large scale • Action of Chlorine •

$H_2O + Cl_2 \rightarrow HCl$ (Hydrochloric acid) + $HOCl$ (Hypochlorous acid)
 $HOCl \rightarrow H^+$ (Hydrogen ion) + OCl^- (Hypochlorite ion) •

Hydrochloric acid is neutralized by alkalinity of water

- Disinfection action of chlorine is mainly due to Hypochlorous acid & to a small extent due to Hypochlorite ion

- Chlorine disinfects best when pH of

water is 7

- When pH exceeds 8.5-chlorine is unreliable as a disinfectant because 90% of Hypochlorous acid gets ionized to Hydrogen & Hypochlorite ions (most water have pH between 6-7.5)
- Most effective water treatment method in rural areas is chlorination of water
- Hydrochloric acid neutralized by alkalinity of water
- Hypochlorous acid (main disinfectant action)

PHASES OF

CHLORINATION

- Phase I - Formation of chloramines
- Phase II - destruction of chloramines
- Phase III - appearance of breakpoint
- Phase IV - accumulation of residual chlorine

Methods of Chlorination

- Chlorine gas • Chloramine • Perchloron / High Test Hypochlorite (HTH)
- Chlorine demand
- Amount of chlorine needed to destroy bacteria & to oxidize all organic matter &

ammoniacal substances

- Chlorine demand is the difference between amount of chlorine added to water & amount of residual chlorine remaining at the end of specific period of contact (usually 60min) at given temperature & pH of water
- Break point • at which chlorine demand of water is met & if further chlorine is added beyond the break point, free residual chlorine (HOCl) begins to appear in water
- Contact period
- Presence of free residual chlorine for a period of at least 1 hour is essential to kill bacteria &

viruses

- Free Residual Chlorine
 - Recommended level of Free Residual Chlorine in water ($1\text{mg/L} = 1\text{ppm}$)
 - Drinking water $>0.5\text{mg/L}$ (after 1 hour)
 - Post disaster water bodies $>0.7\text{mg/L}$
 - Swimming pool $>1\text{mg/L}$
 - Post epidemic • Piped supply 0.5mg/L Well 1mg/L • Tankers 2mg/L
- Residual germicidal

effect

- chlorine Provides margin of safety against microbial contamination, which may occur during storage or distribution. Only chlorine has got the residual germicidal effect whereas UV radiation & Ozone gas DON'T have residual germicidal effect

- Breakpoint Chlorination • Addition of chlorine to water produces chloramines

- if chlorine dose is increased, a reduction in residual chlorine occurs, d/t destruction of Chloramine by added chlorine.

- This causes fall in residual chlorine with further increase in chlorine dose & after a stage, residual chlorine begins to increase in proportion to the added dose of

chlorine.

- This point at which the residual chlorine appears & when combined chlorine is completely destroyed is breakpoint & dosage is breakpoint dosage

- Super Chlorination • Super chlorination is followed up with dichlorination • It is the addition of large doses of chlorine to the water & removal of excess of chlorine after disinfection This method is applicable to heavily polluted waters on large scale

- Instruments used in Chlorination

- 1. Horrock's apparatus - chlorine

demand estimation

- 2. Chlorinator/Chloramine mixing of chlorine

- 3. Chloroscope - measuring residual chlorine

- Tests for Free Residual Chlorine

- 1. Orthotolidine test (OT)--Determines both free & combined chlorine in water

- 0.1 ml reagent (Orthotolidine in 10% HCl) is added to 1 ml of water containing chlorine

- It turns yellow, whose color is matched against a colored

demand estimation

- 2. Chlorinator/Chloramine mixing of chlorine

- 3. Chloroscope - measuring residual chlorine

- Tests for Free Residual Chlorine

- 1. Orthotolidine test (OT)--Determines both free & combined chlorine in water

- 0.1 ml reagent (Orthotolidine in 10% HCl) is added to 1 ml of water containing chlorine

- It turns yellow, whose color is matched against a colored

disc

- OT reacts with free chlorine instantaneously but more slowly with combined chlorine

- So, it's essential to take reading within 10 seconds to estimate free.

- INSTRUCTIONS • chlorine because color produced after 15-20 minutes is due to the action of both free & combined chlorine

- 2. Orthotolidine Arsenite test (OTA) For Free & Combined Chlorine separately

- Errors caused by presence of Nitrites, Iron & Manganese (as they also give