National Symposium

on

Safe Water and Disinfection/ Chlorination Initiatives

Venue

Date

Organised by

SPM-NIWAS

Evidence Action, EAS Advisors & Development Innovation Lab (DIL)

Contents

Contents

Background

1) In partnership with the National Jal Jeevan Mission (NJJM), the Nobel Laureate Prof. Dr. Michael Kremer and his team, "Evidence Action," have undertaken a structured pilot study to conduct a comprehensive evaluation of in-line chlorination (ILC) technologies suitable for implementation in both Single Village Scheme (SVS) and Multi Village Scheme (MVS). The pilot study was carried out in three States i.e., Andhra Pradesh, Madhya Pradesh, and Rajasthan.

2) The pilot study assessed three categories of devices within the SVS, encompassing
   - tablet-based passive in-line chlorination devices (Easol PureALL 100 - recommended by the Standing Committee of the Department of Drinking Water & Sanitation);
   - non-electric liquid chlorine dosing devices (HiSafe Chloritron – recommended by the Technical Committee of the Department of Drinking Water & Sanitation); and
   - electric liquid chlorine dosing pumps (from the market).

3) To disseminate the outcome of the pilot study, a "National Symposium of Safe Water and Disinfection/ Chlorination Initiatives" was held on 02.02.2024 at SPM-NIWAS, Kolkata.

4) All the States/ UTs and Professor Chair from IIT Kanpur & IIT Guwahati were asked to submit a presentation on Safe Water and Disinfection/ Chlorination Initiatives implemented by them.

5) The Symposium was attended by officials from various States/ UTs, Professor Chair from IIT Kanpur & IIT Guwahati, academic institutions, private sector players, research organizations, and WASH community organizations.

India Safe Water Program & ILC Implementation

National JJM Symposium
Kolkata, West Bengal
February 2nd, 2024

India Safe Water Program

India Safe Water Program

01 About EAII India Safe Water

Worldwide, limited access to safe water is one of the biggest public health problems, affecting 2.2B people

2.2B

people don't have access to Safe Water sources in the world.

81M

estimated DALYs from diarrheal disease

<15%

of countries have sufficient financial resources to implement their national WASH plans

Children under 5 are particularly affected by unsafe water

- Globally, there are **more than 1.5M deaths per year from diarrheal disease**, with many of them attributable to unsafe water
- Diarrhea is **particularly consequential in children under 5**
- **Unsafe water is linked a range of health conditions** including typhoid, cholera and hepatitis A

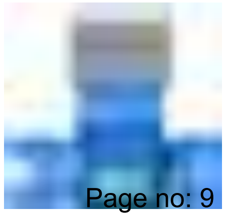
Source: Water Quality: [Guidelines, Standards, and Health.]

Chlorine is one of the most effective solutions to delivering safe water, and Evidence Action has two programs that do it

- New evidence shows that water treatment via chlorine may be one of the most effective ways to help save the lives of children under five (U5s)
- Michael Kremer and co-authors analyzed multiple RCTs to conclude that **safe water treatment reduces the odds of all-cause U5 mortality by about 30%**

- Evidence Action has operated chlorination programs across East Africa since 2013
- To support the program, we've developed extensive in-country supply chains (chlorine, parts) and a large volunteer network.

- We've **developed a complementary technology, In-Line Chlorination (ILC)** that is installed directly into a waterpoint's pipes, **automatically chlorinating all water** that passes through
- ILC enables us to reach new peri-urban and urban communities, which is critical for the Indian context.



TIMELINE OF THE ILC PROJECT

Jun 2022

Dr. Kremer's visit to India to talk about water quality.

Jan 2023

Evidence Action proposes a pilot to National JJM

Mar 2023

Beginning of the pilot to evaluate water chlorination at scale.

Sept 2023

Evidence Action presents its pilot recommendations on ILC for SVS sites, as well as its scale up plan.

Oct 2023

Release of National JJM's National Advisory.

PRESENT

Different concurring processes:

1. Recruitment.
2. Vendor contracting.
3. Engagement with AP and MP.
4. Continued pilot implementation.

India Safe Water Program

02 Pilot Key Results and Findings

In March 2023, Evidence Action began a pilot to evaluate water chlorination at scale

Devices were installed at 18 sites across the states of AP, MP and RJ

- Across the 18 sites, **contexts and technologies were varied** where possible, including:
  - Different chlorination technologies
  - Scheme type (some sources serve only a single village, while others serve more than one)
  - Different tank and pipe specifications
  - Where possible, various geographic and climate factors

Our learning objectives were primarily focused on operational factors

Target metrics included:

Installation feasibility: Complexity and amount of effort and time required for the installation

Operational feasibility: Operating, refilling, and basic operator-level maintenance of the technology

Efficacy: Consistency of correct chlorine dosage in household supply

Summary of the pilot

52 Devices

Installed in 14 districts across 3 States: Andhra Pradesh, Madhya Pradesh and Rajasthan.*

34,000 Households

Estimated to reach close to 1,00,000 individuales across 114 villages.*

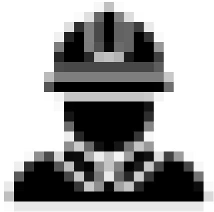
4 Technologies

Tested in different areas, such as scalability, costs, user-friendliness, and adaptability to different SVS sites. These technologies are:

1. Tablet-based passive in-line chlorination device.
2. Electric liquid chlorine dosing pump.
3. Electrochlorinator.
4. Non-electric liquid chlorine dosing.

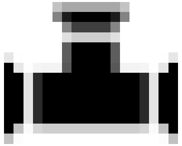
* These numbers are preliminary as we continue to install more devices.
** Our pilot is the only source of these figures.

Before initiating the pilot, we conducted a comprehensive technology landscape analysis and infrastructure survey to understand the opportunity



Infrastructure survey

- Surveyed 151 water points across 9 Indian states
- Identified three promising intervention points:
  - Single Village Schemes (SVS) tanks – groundwater based systems that service only a single village and are infrequently treated
  - Multi-Village Schemes (MVS) intermediaries – MVS service more than one village and are often treated centrally. Schemes can run hundreds of miles and may require ‘topping up’
  - MVS tanks – MVS often have a village-level tank with similar infrastructure to SVS tanks



Technology landscape analysis

- Rigorous process, including reviewing JJM approved technologies, hiring a local water technical consultant, and interviewing partners and academics
- Ultimately recommended chlorine due to its strong evidence base and ability to procure suitable devices that are “Made in India”

Since March 2023, we've been piloting three different water chlorination technologies across Madhya Pradesh

We've conducted a 7 site pilot across 3 districts

- We installed devices in 7 sites across the state across 3 different districts
- We tested three different technologies as part of the pilot to ensure we'd find a scalable solution
  - Tablet-based dosers are a simple, low maintenance technology
  - Electric liquid chlorine dosing pumps support large systems and have a robust existing supply chain
  - Non-electric liquid chlorine dumps are a blend between the other two technologies

List of site installations by village

District	Block	Village
Bhopal	Fanda	Barkheda Bondar
Bhopal	Fanda	Kanhasiya
Shivpuri	Shivpuri	Khari
Shivpuri	Shivpuri	Bhada Bawadi
Shivpuri	Shivpuri	Gangora
Vidisha	Ganjbasoda	Udaypura
Vidisha	Ganjbasoda	Bareth

In May 2023,we began testing water treatment via chlorination at 6 different SVS sites across AP

Since May 2023, we've been conducting a pilot across 6 different sites

- We installed devices in 6 sites across the state across 4 different districts
- The initial goal of the pilot was to **assess potential to scale Safe Water across the state**, focusing on operational factors, like ease of installation and daily operations, as well as device efficacy
- As part of the pilot, we wanted to **test the various contexts** the program could work in, including different waterpoint infrastructure as well as different geographic factors

List of site installations by village

District	Block	Village
NTR	Ibrahimpatnam	Kotikalapudi
Eluru	Dendulur	Gopannapalem
Eluru	Eluru	Madipalli
Bapatla	Kollur	Donepudi (device 1)
Bapatla	Kollur	Donepudi (device 2)
Guntur	Prathipadu	Thummalapalem

During the pilot, we tested 4 technologies and found the following 3 are scalable

Non-electric liquid chlorine dosing pumps

Tablet-based passive in-line chlorination device

Electric liquid chlorine dosing pump

Recommendations: The pilot yielded recommendations on three key topics

Device scalability

- All three types of devices have the potential for scalability
- While each device is viable, they all have trade offs

Holistic contracting

- Preferencing 'turn-key' contracts that include device, installation, and maintenance reduces complexity

Contracting vendors

- Using similar contracts and vendor structures to those used in ISAs and 3PAs will enable seamless handover between Evidence Action and the government

EAII is currently working to scale up the current pilot in Andhra Pradesh and Madhya Pradesh, implementing the lessons learned during the pilot.

India Safe Water Program

03 Chlorination & Water Quality
Water Disinfection through In-Line Chlorination

Chlorination: an effective water quality intervention

Chlorine is one of the most widely used and effective solutions to delivering safe water

Evidence suggests that chlorine **reduces the odds of all-cause U5 mortality by about 25%**

- Unsafe water is a leading cause of diarrhea, which causes millions of deaths worldwide, especially in children under 5
- Chlorination helps kill the bacterial agents that cause diarrhea

- Nobel Laureate Michael Kremer and co-authors analyzed multiple RCTs to conclude that **safe water treatment reduces the odds of all-cause U5 mortality by about 25%**

Chlorination is widely used globally and is **endorsed by the World Health Organization**

- Chlorine is **officially endorsed by the World Health Organization** and is included in the Guidelines for Drinking Water Quality (GDWQ)
- Water treatment via chlorination is widely used in treatment plants across the globe
- Evidence from Nobel Laureate Michael Kremer* and colleagues suggest that chlorination is **more than 45 times as cost-effective as the WHO's threshold** for "highly cost-effective interventions"

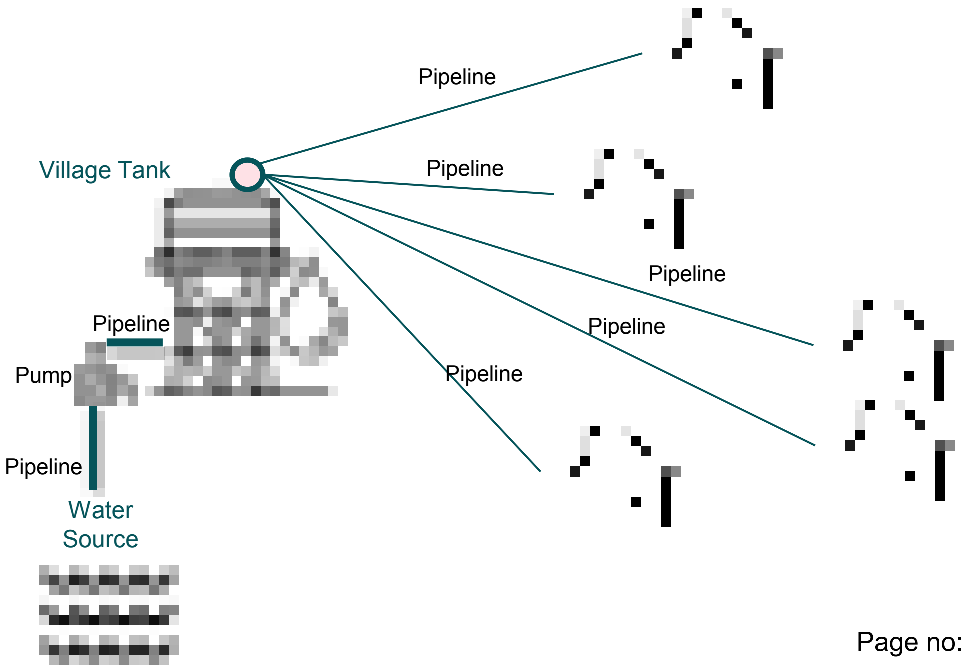
*Source: Water Treatment and Child Mortality: A Meta-analysis and Cost-effectiveness Analysis

In-line Chlorination (ILC) technologies enable simple, consistent chlorine dosage to piped water points

- In-Line Chlorination devices are installed directly into a waterpoint’s pipes and automatically chlorinate all water that passes through
- Many of the designs are simple and can be used for extended time without necessary maintenance
- The technology is commonly used worldwide, with award-winning research backing up its efficacy by Amy Pickering and co-authors

Single-Village Schemes (SVS) are commonly used and provide a platform for chlorination devices

- Single-Village Schemes are central water schemes that serve one village
- Sites are typically groundwater-based and not treated at a central facility
- **Technologies that work on SVS infrastructure include:**
  - Tablet-based passive in-line chlorination devices
  - Non-electric liquid chlorine dosing devices
  - Electric liquid chlorine dosing pumps



As previously mentioned, Evidence Action found the following three technologies to be scalable for SVS sites

Non-electric liquid chlorine dosing pumps

Tablet-based passive in-line chlorination device

Electric liquid chlorine dosing pump

Based on the pilot learnings, Evidence Action thinks the tablet-based devices are the most efficient option. Further detail on this will be provided.

Technologies: Tablet-based passive in-line chlorination devices provide a low-cost way to reach SVS

- Tablet-based passive in-line chlorination devices are electricity-free, low-maintenance devices that use stable chlorine tablets to dose water supply
- Benefits
  - Low cost with stable, long-lasting consumables
  - Simple design, low maintenance & no electricity required
  - Easily controlled dosing with open-source designs & no pipe corrosion
- Drawbacks
  - Limited large-scale producers for tablets & cartridges
  - Proprietary cartridges for Easol PurAll dosers

Technologies: Electric liquid chlorine dosing pumps build on existing manufacturing and supply chain capabilities

- Electric liquid dosing pumps are similar to pumps used for a wide range of industrial purposes, ensuring a robust, diversified supply chain for device manufacturing and refills. We anticipate the private sector is already capable of meeting demand.
- Benefits
  - Low cost & well-established mass market
  - Ability to dose liquid sodium hypochlorite
  - Positive private sector response anticipated
- Drawbacks
  - Requires established sodium hypochlorite supply chain & electricity. Currently evaluating different supply chain methods
  - Most moving parts among the options, increased risk of breakage
  - Requires manual operation and installation challenges in metal piping

Technologies: Non-electric liquid chlorine dosing pumps share attributes of the other two groups of devices

- Non-electric liquid chlorine dosing devices are electricity-free devices that leverage the force of the water to apply chlorine dosage
- Benefits
  - Fewer moving parts, reduced breakage risk
  - Easily controlled dosing & no electricity required
  - Potential compatibility with bleaching powder and water mixture
- Drawbacks
  - Requires established sodium hypochlorite supply chain. Currently evaluating different supply chain methods
  - Installation challenges in metal piping to avoid corrosion

The tablet-based doser device was found to be the most cost effective and scalable

- Low cost with stable, long-lasting consumables.
- No moving parts.
- Easily controlled dosing with open-source designs.
- No pipe corrosion.
- Simple design.
- Low maintenance.
- No electricity required.

The evidence from our pilot endorses the fact that ILC devices are an **effective way** to chlorinate water

There are different benefits from chlorine residuals

They are scalable across geographies, water points and water quality.

They are incredibly cost efficient.

They can reach thousands of people.

Simplified design makes operations and management easier to implement.

WHO and the Indian Government endorsed this practice for microbiological contamination

About Water Disinfection through In-Line Chlorination (Tablet Based Dosers)

About Tablet based dosers

- Tablet-based dosers are simple In-Line Chlorination (ILC) devices, capable of treating 2,00,000 liters of water daily
- EAII recommends a design heavily based on the open-source CTI-8
- The technology has no mechanical moving parts and doesn’t require electricity
- The devices store chlorine tablets inside the device and are installed at the bypass line of waterpoints

Tablet-based dosers can be **easily and quickly constructed** using commonly available parts

- Construction requires only cheap and widely available parts like PVC, UPVC, and Acrylic
- Devices can be built within 4-6 hours
- Assembly can be led by a relatively low skilled plumber or fitter
- Necessary tools simple, such as cutting tools and PVC glue

Some considerations for installation of tablet based dosers

- Device enclosures are metal mesh cages with an opaque roof that enclose the entire device
- The enclosure will be securely fixed to the ground
- The roofing is constructed to protect the devices from the weather, including direct sunlight and rain
- The devices will have a lockable gate to ensure secure and easy maintenance

Chlorine Tablets: Tablet-based dosers use standard, round chlorine tablets that meet standard guidelines

- **Composition:** NaDCC/ TCCA make, Slow dissolving Chlorine Tablets
- **Size and Weight:** 3 inches and 200 gram tablets
- **Drinking Water Safe:** NSF ANSI 60 approved and or/tested and approved for BIS 9825:2003 (up to date amendments)
- **Appearance:** Shall be white/ off white with chlorines odor and uniform in size.
- **Purity:** Minimum 90%

Installation method will vary by site conditions but will be installed at site bypasses

Key variables include:

- Type of Water reservoir (Sumpwell or Overhead Tank)
- Material and size of mainline water pipes
- Pumping power and system
- Capacity and Height of the water tank
- Existence of Pumphouse/Enclosed Shed

The tablet-based doser device was found to be the most efficient

Dose Calibration: To ensure community adoption, chlorine dosage should be gradually increased

Target Free Chlorine Residuals

≤1.0 PPM at the closest household to the waterpoint

≤1.0 PPM and **≥0.4 PPM** at the furthest household from the waterpoint

These Free Chlorine Residuals are completely safe and ensure community adoption

- Chlorine typically can't be tasted in the water supply below a threshold of ~1.0 PPM, so keeping FCR below that ensures community adoption
- Chlorine provides its lifesaving effects **starting at roughly 0.2 PPM**, so targeting 0.4 PPM ensures sufficient cushion
- As per the World Health Organization, chlorine is safe up to at least 5.0 PPM, so these targets ensure optimum community health*

Source: Chlorine in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality

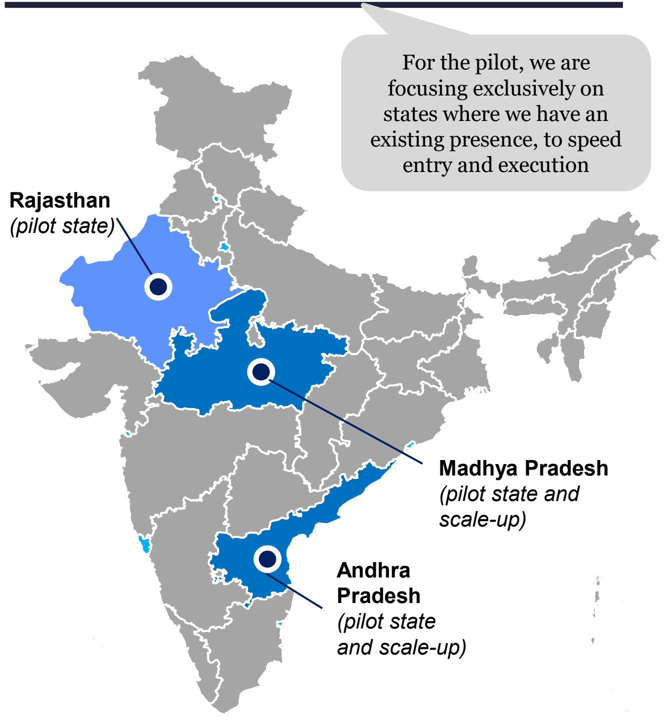
India Safe Water Program

04

- Program scale up plan
- Program Contracting Model
- Importance and Impact of an Implementation Contractor

Our current scale up plan

Generating learnings and quick wins from an initial tightly-focused pilot will serve as a launchpad for large-scale expansion



Pilot phase

- Test the ***effectiveness, applicability and operational feasibility*** of appropriate water treatment technologies
- Based on the pilot results, ***make recommendations and provide technical assistance*** to GoI on what solutions / technologies to scale, and how.

Scale-up Phase 1

- Scale up successfully piloted technologies across two pilot states –***AP and MP***, over 2 years, providing technical assistance to national and state governments
- Provide safe water access to up to ***1M people*** in rural India through installing 800 devices.

Scale-up Phase 2

- Build off momentum from initial scale-up and leverage JJM's funding, resources, and platform to hand over the project to the State Governments, who will follow a similar process to install thousands of devices, ***reaching millions of people*** with safe water.

Program Contracting Model

Implementation Contractor (IC)

Key Activities:

One-time
- Procurement
- Transportation
- Installation

Recurring
- Maintenance
- Resupply

Third Party Agency (3PA)

Key Activities:

Confirms

Monitors

Reports to

SW Program team

Implementation Support Agency (ISA)

Key Activities:

Community Sensitization and Management
- 2 pre-installation sessions.
- 1 post-installation session.
- As-needed engagement (e.g. after a significant malfunction).

Monitoring Firm

Key Activities:

- Data collection for baseline, mid-point, end-line surveys.
- Performance monitoring.

Private Entity

EAII/EvAc Entity

Based on our pilot's lessons, EAII decided to engage one Implementation Contractor through a turn-key contract.

This will allow us to effectively manage our contract system while pursuing the following goals:

- Create model & proof points for implementation of safe water activities
- Expand implementation model and proof point to new states
- Private market for chlorine implementers expands.

Specific advantages of a turn-key contract

01.
Economies of scale

02.
More efficient and agile contract management

03.
Positive spillovers on the ILC devices market in India

04.
Easier to transfer to Government when needed

This means the Implementation Contractor will play a critical role in the project

EAII is thrilled to engage an Implementation Contractor to play such a critical role and look forward to receiving your questions and bids.

Provide communities with safe water.

Help local leaders and governments build capacities

Improve the chlorine and ILC device markets in India and potentially abroad.

Promote economic growth in India both directly and indirectly.

LIST OF ABBREVIATIONS

ANSI - American National Standards Institute
CTI-8-Compatible Technology International 8
DALY - Disability-Adjusted Life Years
EAII - EAII Advisors Private Limited
EvAc - Evidence Action
FCR - Free Residual Chlorine
IC - Implementation Contractor
ILC - In-Line Chlorination
IM - Monitoring Firm
ISA - Implementation Support Agency
GDWQ - Guidelines for Drinking Water Quality
JJM - Jal Jeevan Mission
MVS - Multi-Village Scheme
NaDCC - Sodium dichloroisocyanurate
NSF - National Sanitation Foundation
PPM - Parts Per Million
PVC - Polyvinyl Chloride
RCT - Randomized Controlled Trial
SVS - Single-Village Scheme
SW - Safe Water
TCCA - Trichloroisocyanuric Acid
TPA - Third Party Agency
UPVC - Unplasticized Polyvinyl Chloride
U5 - Under Five (Years Old)
WHO - World Health Organization

Thank you.

For more information, visit evidenceaction.org

Any questions, please
email Bimlesh Kumar
bimlesh.kumar@eaiiadvisors.in

Safe water & Disinfection/Chlorination

Chlorine is a powerful disinfectant, that is, a substance which may kill or inactivate Microorganisms. Chlorination is a process where chlorine is added to drinking-water to kill or inactivate microorganisms, including harmful pathogens. Although chlorine is an effective disinfectant, chlorine does not kill all harmful microorganisms

Disinfection

- Objective

    to understand the principles of chlorination, and the factors that influence its efficiency in the disinfection of water.

How do you test for disinfection

- Objective

    make sure water is potable to end-users

(c) The relative effectiveness of chlorine against microorganisms

The effectiveness of chlorine against different types of microorganisms is illustrated in Figure 1.

In general, chlorine is most effective against bacteria*, is less effective against certain viruses and is least effective against certain protozoa.

Protozoa may survive for long periods in the environment by forming a type of durable shell called a cyst or oocyst. This is an important consideration for the supply of safe drinking-water, as chlorine has little practical effectiveness against these resistant protozoa (e.g. Cryptosporidium). Other drinking-water treatment processes may be required to effectively remove or inactivate protozoa, such as filtration or disinfection by ultraviolet (UV) light.

Figure 1. The relative effectiveness of chlorine against different types of microorganisms

Source: WHO, **ISBN:** 978–92–9022–536–2

DISINFECTION

"The removal of Pathogenic micro-organisms from Water"

AIM: to produce SAFE drinking water
i.e. < 1 Coliform/100 ml

Standards: 1984 & 1993 WHO Guidelines
1980 EEC Drinking Water Directives
2012 IS 10500 Drinking water (BIS)

Treated water ENTERING Distribution system must conform
Treated water IN distribution system should never have coliforms and *E.coli* /100 ml

Therefore must maintain RESIDUAL disinfectant in Distribution System to control growth or contaminant bacteria.

Disinfection Methods

PHYSICAL

(1) Boiling - Household use, temporary, expensive, emergency measure.
- Kills bacterial, viruses + other microorganisms.

(2) U-V light - effective for bacteria + viruses if Turbidity is low

(a) Simple storage in glass containers - effective but not very practical

(b) Tubular, jacketed, u-v lamps
- Need power supply
- Used in operating theatres + isolated communities.

(c) storage Reservoirs

CHEMICAL METHODS

Mostly Oxidising Agents and metal ions such as silver, copper, cobalt, nickel with significant bactericidal properties

Large Scale:

Oxidising agent such as chlorine, potassium permanganate, halogen other than Cl such as Iodine (hypoiodous acid: HOI/bromine—costly

Ozone (O_3)
Breaks down to O_2 and nascent oxygen—powerful oxidising and germicidal agent
Superior bactericidal property than chlorine
Does not provide offensive taste, odour, toxic substance
Problem: High cost, inability to produce residual protection against recontamination

Criteria of good disinfectant

- Be capable of destroying pathogenic bacteria and not unduly influenced by the physicochemical parameters of water
- Should not leave product of reactions that produce toxic compound
- Property of leaving residual contamination
- Can be easily detected to control disinfection process

Chlorine/Chlorination

Source: WHO, **ISBN:** 978–92–9022–536–2

What Happens to Chlorine After it's Added to Water ?

Oxidizes organic acids (making DPBs)

Reacts with organic nitrogen (making Chloramines = Combined Chlorine)

Oxidizes inorganics (e.g. Iron and Manganese)

Free Chlorine

HOCl

OCl⁻

The undissociated HOCl is 80-100 times more potent as a disinfectant than the OCl ions

CHLORINE DEMAND

The difference between the amount of chlorine added to water and the amount of residual chlorine after a specific contact period is defined as chlorine demand

- Chlorine Reacts with:
  - Ammonia
  - Organic Matter
    - Dissolved, colour
    - particulate
  - Metal ions
    - pipe materials
    - from source water

Chlorination

(1) Free Chlorine

Chlorine Gas i.e. Cl_2 + Pure water

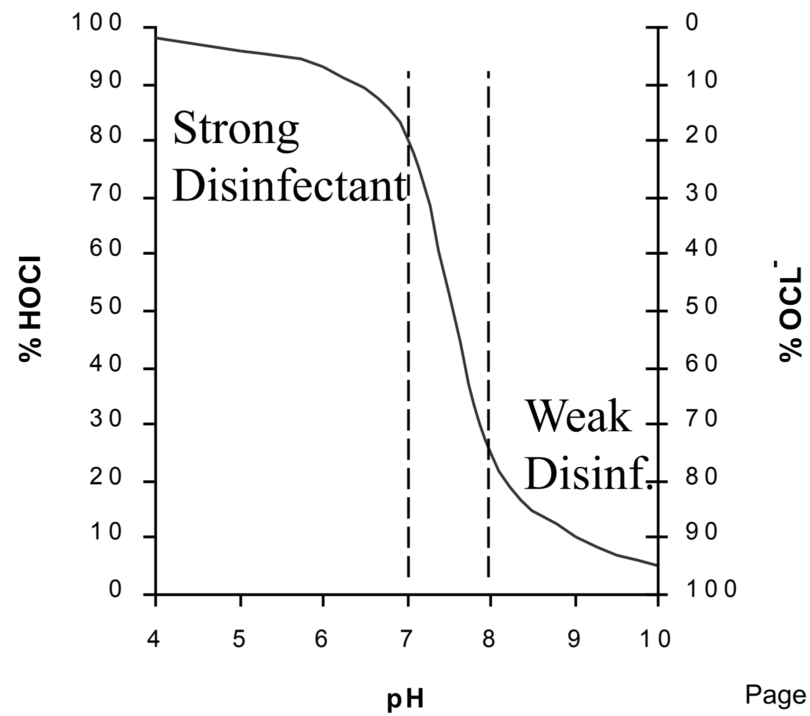
(a) Hydrolysis $Cl_2 + H_2O \rightleftharpoons HOCl + HCl$

(b) Ionisation $HOCl \rightleftharpoons H^+ + OCl^-$ ***(Free Chlorine Residuals)***

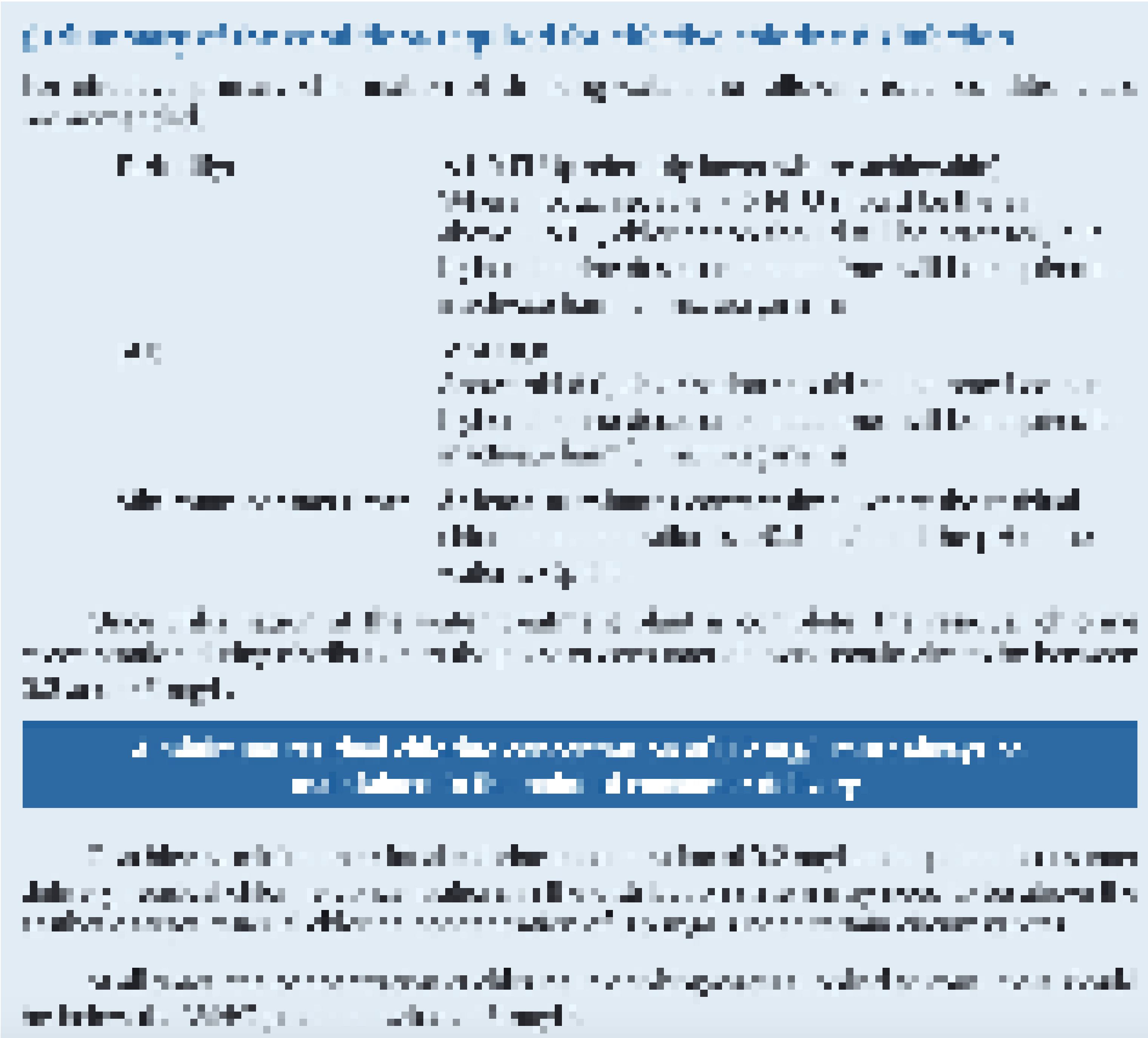
Hypochlorous Acid → Hypochlorite Ion

Depends on many factors: e.g., pH

WHO recommends that a minimum residual chlorine concentration of 0.2 mg/L is maintained to the point of consumer delivery



Source: WHO, ISBN: 978–92–9022–536–2

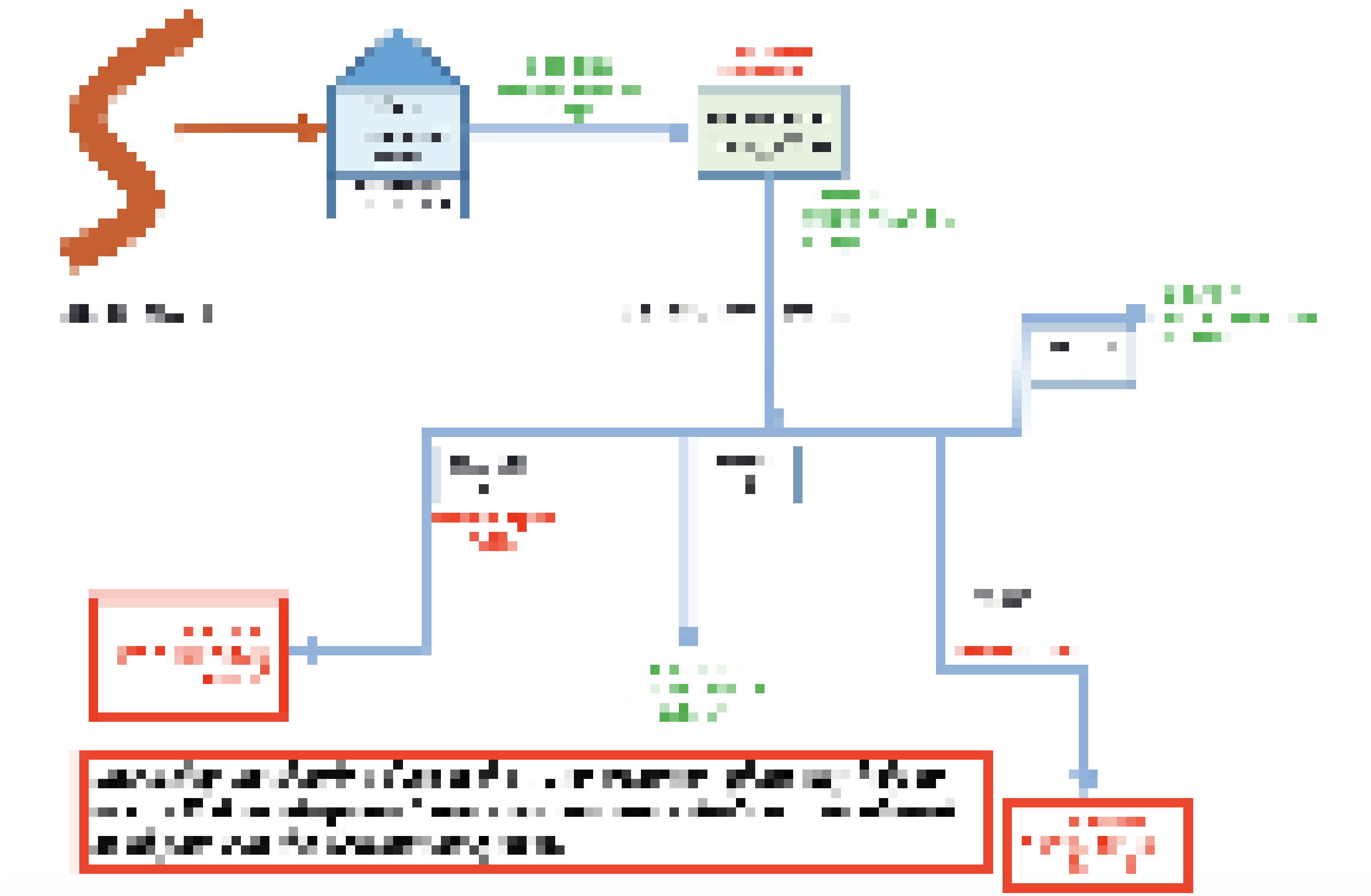


Summary of WHO recommendations

Source: WHO, **ISBN:** 978–92–9022–536–2

Chlorination Practice: The importance of decay

Chlorine decay means the decrease (or reduction) in the concentration of chlorine in drinking-water as it passes from the water treatment plant through to the end of the distribution system.



Branch A: Unclean pipes

Branch B and C: Clean pipes with no leakages

Branch D: Low usage of water in this area, which results in a long water age (i.e., old or stagnant water).

Source: WHO, **ISBN:** 978–92–9022–536–2

Chlorine monitoring?

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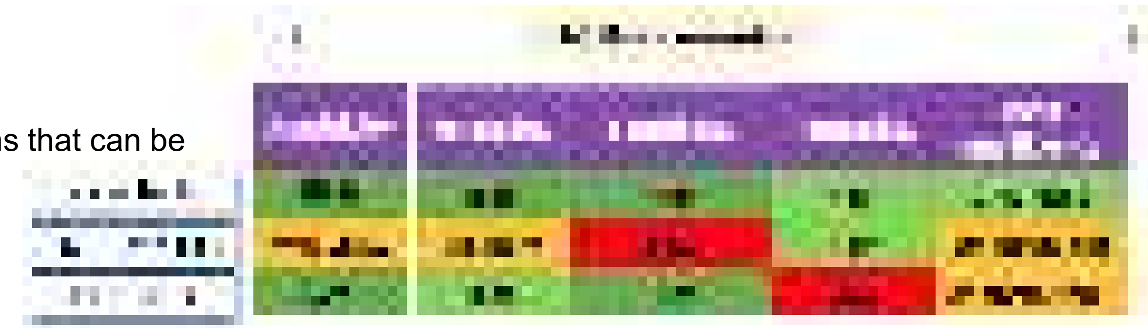
Source: WHO, **ISBN:** 978–92–9022–536–2

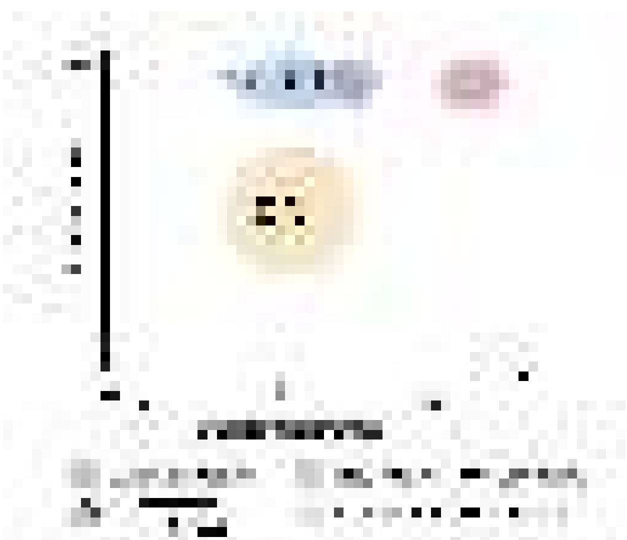
Technical advantage over existing products

Absence of E.coli (H_2S test kits/ enzyme-substrate best test kits)

- Detection of E. *coli* at 1CFU/100ml
- On-site use with easy handling instructions that can be followed by anyone
- Low-cost
- Long shelf life / cold chain not needed



Illustrative cost – accuracy trade-off



Sensitivity: *The detection limit of E.coli..*

Reliability: *ability to consistently generate comparable and accurate results based on the test.*

Specificity: *How targeted it is towards E.coli.*

Portability: *ability to apply the tests without any logistical challenges and as close to the point of intended use of the water at its last mile*

Data intelligence: *extract water quality intelligence from the test results to manage data in a single window platform*

Useful resources

- Principles and practices of drinking-water chlorination: a guide to strengthening chlorination practices in small-to medium-sized water supplies. ISBN: 978-92-9022-536-2
- Manual of water supply and treatment, Central Public Health & Environmental Engineering Organization, 3rd Edition

Source: WHO, **ISBN:** 978–92–9022–536–2

WATER DISINFECTION TECHNOLOGIES

Prof. Mihir Kumar Purkait, Professor Chair, JJM

Department of Chemical Engineering, IIT Guwahati

Performance of Pathogen Removal Technologies

Treatment Process	Microorganism Removal	Type
Screening	10-20%	Physical Removal
Grit Removal	10-25%	Physical Removal
Primary Sedimentation	25-75%	Physical Removal
Chemical Precipitation	40-80%	Physical Removal
Activated Sludge	90-98%	Physical Removal
Electrocoagulation	95-99%	Disinfection
Chlorination	**98-99%**	**Disinfection**

Disinfection techniques for drinking water

- **Disinfection** refers to removing pathogenic organisms from water.

e.g.: Bacteria, Viruses, Protozoa, Worms, and Larvae

- **Conventional techniques**
  - Ozonation
  - UV lamps
  - Chlorination

- **Emerging techniques**
  - Photocatalysis
  - Electrochemical disinfection
  - UV-LED disinfection

DISINFECTION AND CHLORINATION

Wastewater Treatment Plant

Chlorine + Water ⇨ Hypochlorous Acid + Hydrochloric Acid

$$Cl_2 + H_2O \Rightarrow HOCl + H^+ Cl^-$$

Sodium Hypochlorite + Water ⇨ Sodium Hydroxide + Hypochlorous Acid + Hypochlorite- + Hydrogen

$$2NaOCl + 2H_2O \Rightarrow 2NaOH + HOCl + OCl^- + H^+$$

Calcium Hypochlorite + Water ⇨ Calcium Hydroxide + Hypochlorous Acid

$$Ca(OCl)_2 + 2H_2O \Rightarrow Ca(OH)_2 + 2HOCl$$

Sodium Dichloroisocyanurate (NaDCC)

$$NaCl_2(NCO)_3 + 3H_2O \leftrightarrow 2HOCl + NaH_2(NCO)_3$$

Chlorine Dioxide (ClO_2) Chemistry

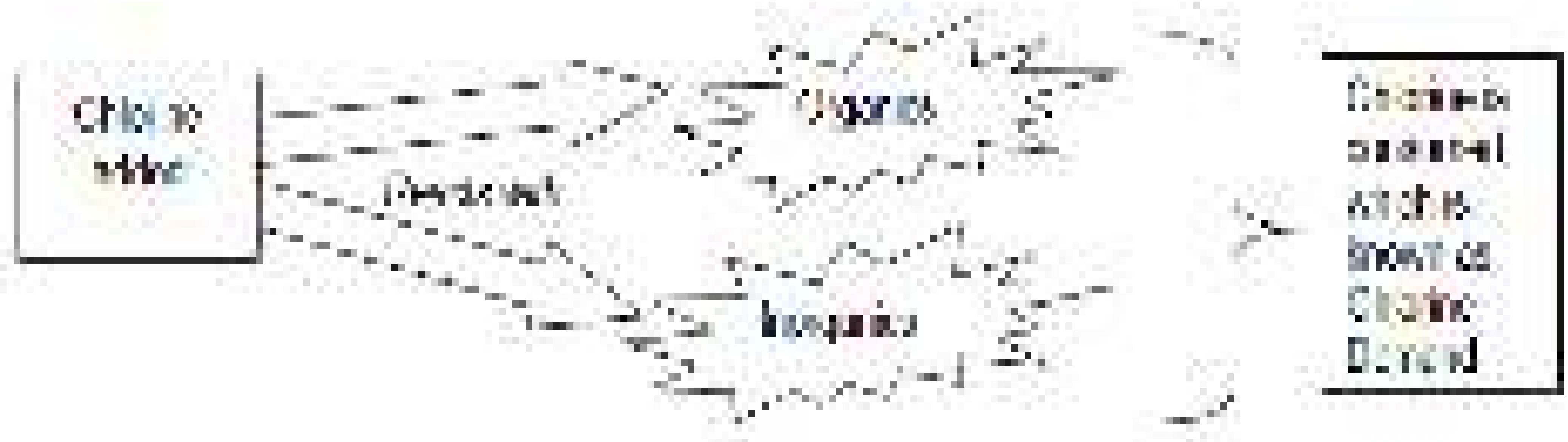
Sodium Chlorite + Chlorine ⇨ Sodium Chloride + Chlorine Dioxide

$$2NaClO_2 + Cl_2 \Rightarrow 2NaCl + 2ClO_2$$

Chlorine dioxide + Water ⇨ Chlorate Ion + Chlorite Ion + Hydrogen Ion

$$2ClO_2 + H_2O \Rightarrow ClO_3^- + ClO_2^- + 2H^+$$

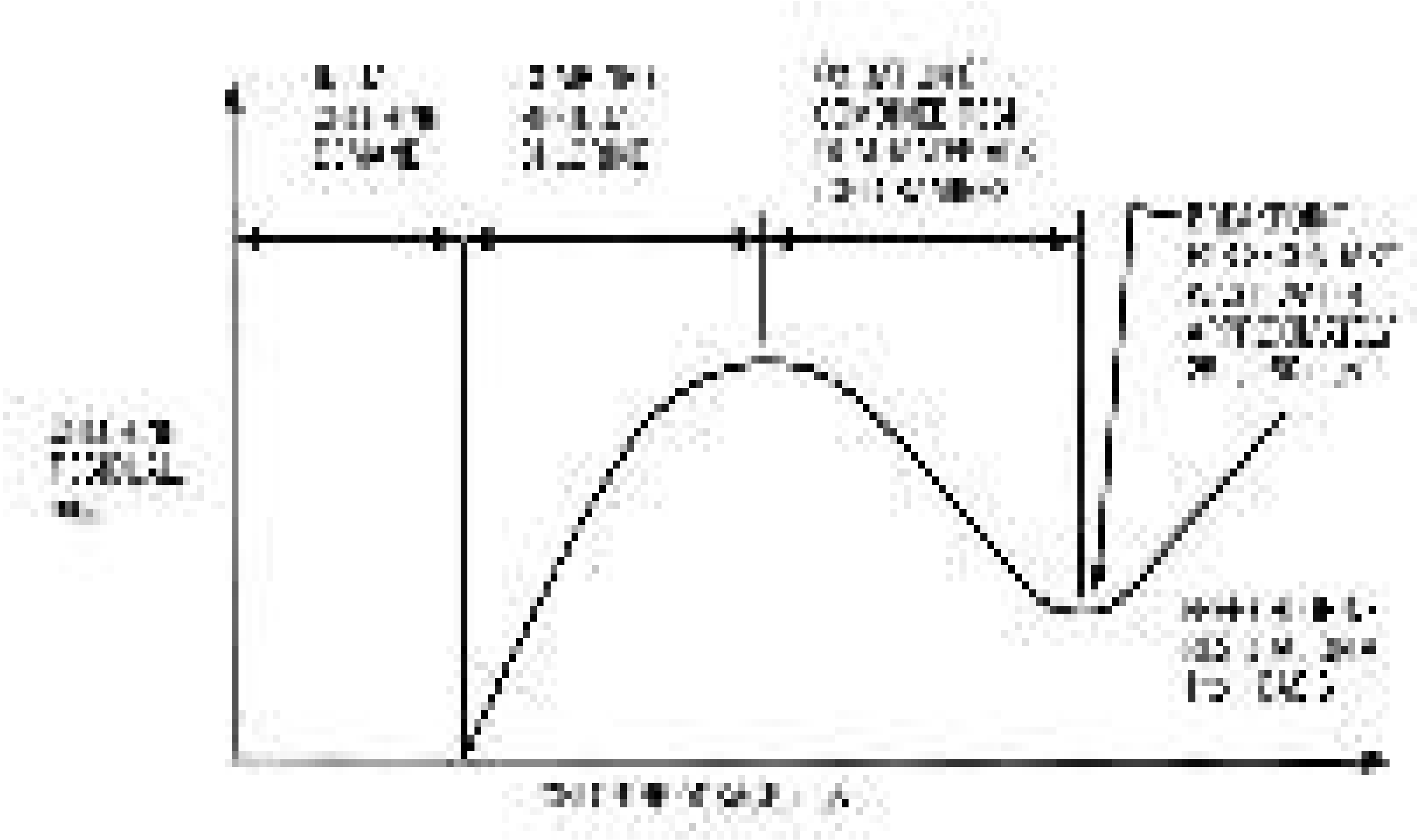
Chlorine Demand



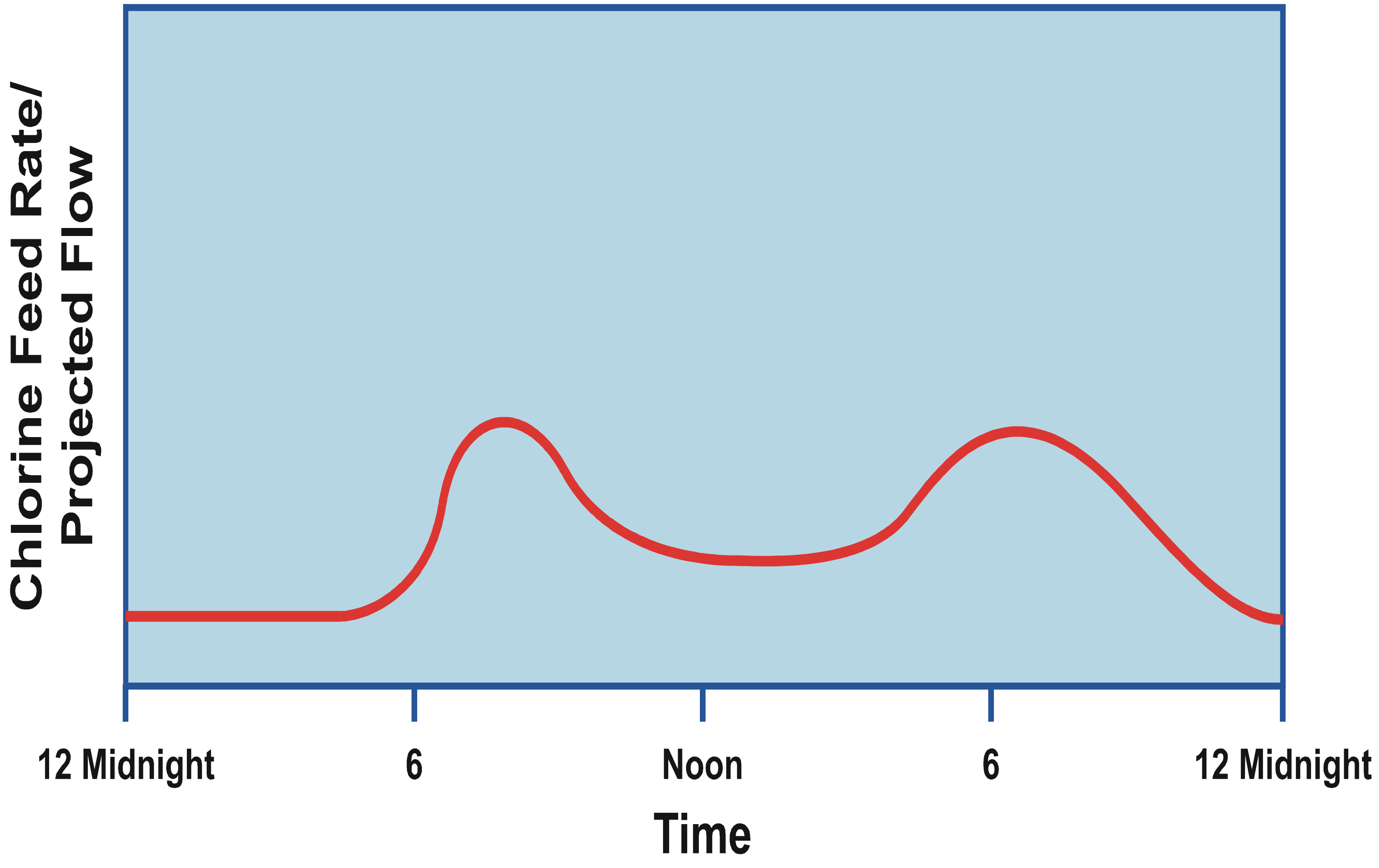
Chlorine Residual

Chlorine Dose = Chlorine Demand + Chlorine Residual

Breakpoint Chlorination Curve



Timed Program Control



Physiological Response to Chlorine Gas

[illegible]

Chlorine Leakage Incident

Sl.No.	Incident/Industry	Date of Accident	Source	Death/Injury/Missing; Losses
1.	GACL, Vadodara, Gujarat	05.09.2002	Chlorine gas Explosion	4/20/nil
1.	IPCL, Gandhar, **Gujarat**	20.12.2002	Chlorine gas Explosion	Nil/318 /nil
1.	Orient Paper Mills, Amla,	13.10.2003	Liquid Chlorine	Nil/88/nil
1.	Chemplast, Mettur, **Tamil Nadu**	18.07.2004	Chlorine leak	Nil/27/nil
1.	Kanoria Chemicals and Industries Ltd. Renukoot, Sonebhadra, **Uttar Pradesh.**	29.03.2006	Chlorine Release	6/23/nil
6.	Muwailah Industrial Area, **Muscat**		Chlorine leak	Nil/42/nil
7.	Transport Depot, **Chandigarh, India**	18.05.2016	Chlorine leak	Nil/5/nil
8.	Jordon Docked Ship		Chlorine Release	13/265/nil
9.	Industry in Europe		Liquified Chlorine Leak	
10.	**Mumbai Port, India**	2010	Chlorine leak	nil/120/nil

Presentation on experiences with water disinfection methods & controlling bacterial contamination

RWW&S Department, AP

Water Quality related Issues

- Less than 30% Chlorination occurs in the villages as per functionality assessment by GoI
- Residual chlorine @ 0.2ppm not visible at last households across villages (FRC)
- Common manual chlorination and irregular disinfection practices
- Chlorination (bleaching powder) is a cumbersome process as reported by many pump operators, to climb to OHSR of 12-18 meters height on daily basis and their safety is much concerned.
- Bleach products with lower or unspecified hypochlorite concentrations may not be effective for disinfection
- Issues of over dosing and under dosing with bleaching powder
- Loss of chlorine level in reaching middle and tail end villages in Centralized Liquid or Gas chlorination under CPWS schemes
- Unstable /in-effective bleaching powder usage by operators
- Lack of regular cleaning of tanks/sumps with quality chemicals
- Challenges for effective control of biological contamination

Water Quality Access – Current Status

- Residual Chlorine (RC) found in 48% of samples

- Incidence of waterborne diseases “Zero” - National average 2%
- HH level purifying water access before drink 79% - National average 57%

- Villages usage of FTKs 39% - National average 30%
- Villages with a chlorination mechanism 21%- National average 21%

Source: Functionality Assessment by GoI

Water Quality Initiatives in the State

- Functional Inline Chlorinators in **156 villages across the State** (Tablet and Hypochlorite based) in partnership with Evidence Action, TATA Trusts & Vnkane tech
- Piloted ILC technologies in different agro-climatic regions in the state (Electrical & Non-electrical) – Mashelkar committee & Scientific advisor, GOI
- IoT initiated to monitor daily service delivery on pilot basis in one village
- Wider dissemination of Water quality importance through Swachh Jal Se Suraksha campaign - State obtained 2nd rank in 2022-23 under this campaign
- 112 water testing laboratories function including 13 NABL accredited laboratories and 69 Sub-division Laboratories recognized by NABL for water testing

Water Quality Initiatives...contd

- 4 Advance Laboratories functional (Testing for toxic heavy metal & pesticides)
- Water quality surveillance, Field test kits have been provided to all the Gram panchayats
- Special focus on contamination zones/areas including floride affected pockets
- Trained 5 women in every village to conduct periodical testing pre and post monsoon season
- Engaged ISAs (NGOs) for support and facilitation for implementation of JJM
- SPMU and DPMUs have been engaged for project monitoring and for providing management support to state and districts
- Skill trainings to local youth and SHGs (women) on multi skills at grassroot level - Electrical, Plumbing and Masonry etc

Challenges

- Lack of knowledge and capacities at community level on “Disinfection” importance
- Non-viable technologies (high costing, establishment, operation and maintenance)
- Manual operations and maintenance of water infrastrcutre assets
- Inadequate skilled professionals (plumbing, welding and electricity) at the sites
- Power fluctuations/issues (single & three phases)
- Less knowledge on Auto-chlorination and technologies among VWSC & Panchayats
- Local access of dry chlorine tablets and standard liquid hypochlorite
- Dual/multiple motors and direct pumping to OHSR than the existing inlet system which may hinder uniform disinfection

Chlorination Challenges in Rural Areas & Advantage of ILC Innovation

Challenges

- Manual & Daily Preparation in OHT or GWR
- Energy Intensive
- High CAPEX
- High OPEX and not affordable to VWSC
- Requires skilled human resource for installation

Solution

- Online System with minimal human intervention
- Works without Power
- Minimal CAPEX as made locally from Local available materials
- Minimal OPEX
- Easy installation and can be done by a local plumber

Innovative Solutions Implemented

- **Auto chlorination technologies recommended by Mashelkar committee (Easol, Hisafe etc) & Scientific Advisors, GOI**
- **Simple tablet based Inline chlorination (Non-electrical, assembled with locally available material and easy of operation) fixed to inlet system-TATA Trusts model**
- **Sensor based (FRC) chlorination by adjusting dosage (super chlorination) in MVS scheme**
- Using NSK/ANSI certified dry chlorine which is patented used in Easol Purall100
- Trials are in progress on functional auto dosing system with usage of standard bleaching powder and chlorine tablets
- **CTI8 (Compact Technology International) device trials in progress – Device placed at inlet tank and outlet distribution system**

Additional Considerations for ILC technologies

Device scalability

- All three types of devices have the potential for scalability
- While each device is viable, they all have tradeoffs

Corrosion risk

- There are multiple methods for reducing contact between corrosive sodium hypochlorite and metal piping. We continue to evaluate methods

Dose stabilization

- Dosing should start low and gradually increase to ensure that chlorine doesn't affect taste and smell
- Target for Free Chlorine Residual at the last household is 0.2 ppm

Holistic contracting

- Preferencing 'turn-key' contracts that include device, installation, and maintenance reduces complexity

Contracting vendors

- Using similar contracts and vendor structures to those used in ISAs and 3PAs will enable seamless handover to Government

Local capacity for operations

- There is sufficient local capacity to conduct daily device operations without significant training

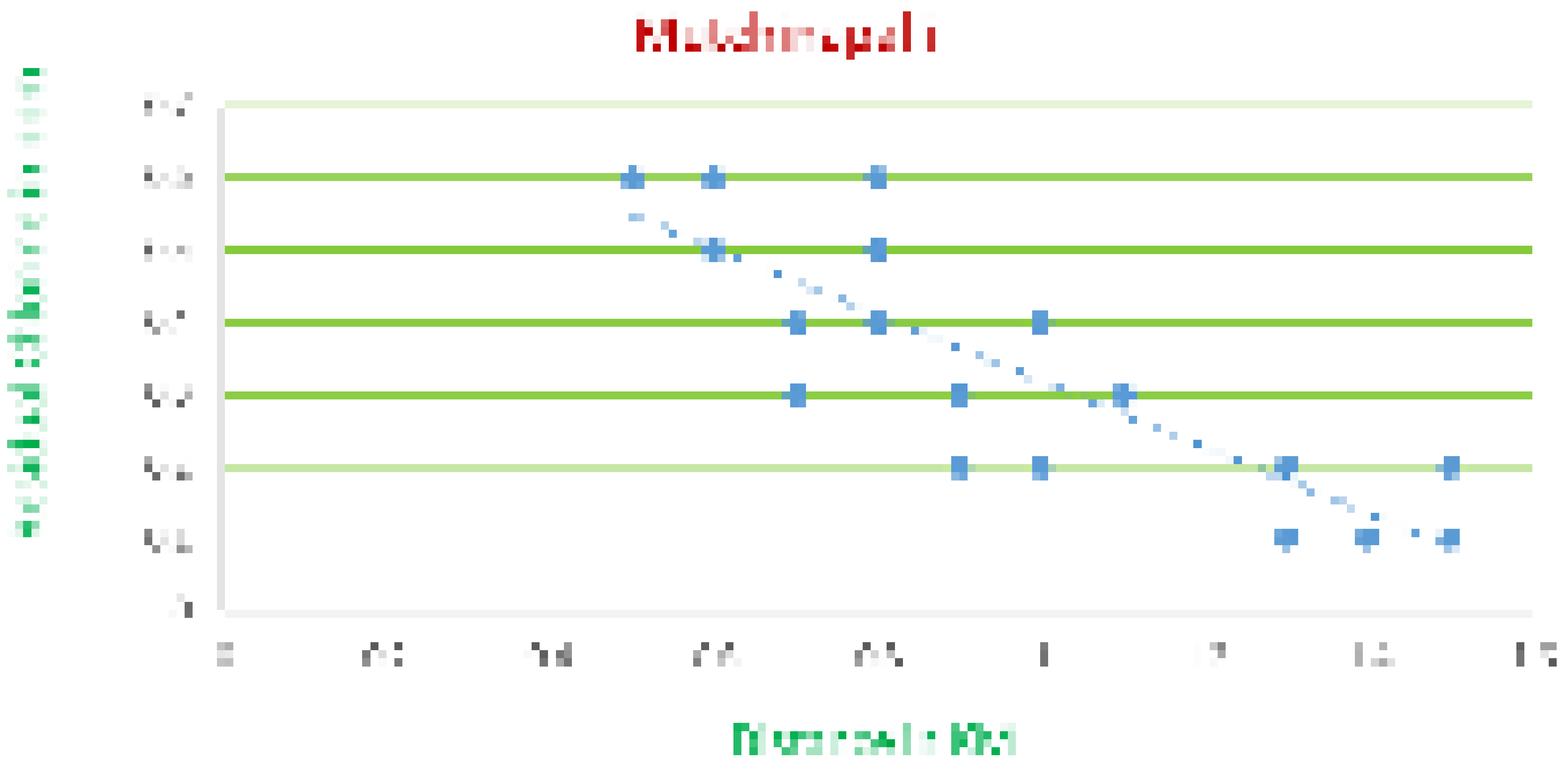
Community sensitization

- Creating and leveraging local champions increases uptake and community buy-in

Dose Stabilization Process

- Check existing Chlorine Levels at water tank and households (before ILC installation)
- Inline Chlorination device established at inlet system/near pump house
- Ensure usage of certified dry chlorine tablets and Sodium hypochlorine liquid
- Dosage set at tank level (Total chlorine @1ppm) with required standard
- Collect random sampling water in 3 households (ensure range 0.7ppm to 0.2ppm) viz., First, Middle and Last households
- First two weeks dosage standardization takes place (Considering random sampling at Households covered in different vavle system)
- Ensure required Chlorine levels at HH with digital device and FTK kit sampling
- Maintain dosage records as first hand evidence
- Sensitize pump operators or VWSC on importance of required FRC level
- Conduct periodical testing of chemical and biological parameters

Performance of ILC –FRC vs distance(for e.g.)



Learnings and Insights

- People not aware on Auto/ILC importance, yet to percolate knowledge
- Over dose (smelling) and under dose (likely contamination) issues not yet percolated
- Assumptions on higher costing and maintenance of technologies including access quality supply chain
- Observation of positive perception and outcome on supply of chlorination water in PWS scheme
- Issues of multiple inlet system on maintaining required dosing at tank level
- Observed paramters of supply water PH, Turbidity, TDS & bacterial load may likely chanage FRC level, hence dosing adjustment

Comparative analysis of different types of Chlorination methods

Parameters	Manual	IOT based	Capsule based	Chlorine Liquid based	Gas Based	Prototype (Inline Chlorinator)
CAPEX Cost	Nil	High	Moderate	High	High	Low
OPEX Cost	High	Moderate*	High	Low	Moderate*	Low
Ease in Installation of Unit	NA	Moderate	High	High	High	High
Ease in O & M	Low	Moderate***	High	Moderate**	Moderate***	High
Type of human resource required	Skilled	Semi-skilled	Semi-skilled	Semi-skilled	Semi-skilled	Semi-skilled
Efficiency at point of use	Low	High	High	High	High	High
Ease in raw material (Chlorination agent) availability locally	High	Moderate	Low	Moderate	Low	High

*requires electricity; ** requires safe handling of the chlorination agent; ***Need sensor maintenance, calibration and replacement

Feedback from Villages

- The initiative has received positive feedback from both VWSC members and villagers, indicating their satisfaction with the improved water quality
- The positive reception suggests a high level of acceptance and appreciation for the innovative solution
- Taste of water is good,' reduced in occurrence of ill health issues, 'we can see chlorination is happening
- The In-line chlorination system has positively impacted the well-being of pump operators, reducing physical strain and exposure to strong bleaching smells
- The slow release of chlorine tablets over an extended period ensures consistent disinfection without adverse effects on water taste and smell

…….**health related issues yet to be monitored properly**

Inline Chlorination devices by “Evidence Action Inc”

Non - Electrical Devices

Hi Safe Chloritron

Kotikalapudi village, NTR District

Easol PurAll 100

Gopannapalem Village, Eluru district

Electrical Devices

AC 6 Dosing

Madepalli Eluru District

Proton 6

Eelaprolu village, NTR District

IE Neo6

Sunnampadu, NTR District

Pristine Dosing

Rangapuram village, Eluru District

Inline Chlorination devices by "Evidence Action Inc"

VP ECHO DOSING PMUP

Kothavalasa – Parvathipuram District

IE ORP

Nunna, NTR District

RITE WATER ELECTRO

Thotapalli, Vizianagaram District

CTI8 – Compact Technology International (Trial version)

Gosala, NTR District

Vanukur, NTR District

Agraharam, YSR Kadapa District

CHODAVARAM MANDAL, ANAKAPALLI DISTRICT
INLINE CHLORINATION SYSTEMS by TATA Trusts

Lakshmipuram

Ankupalem

Exhibition –Working models






THONDUR MANDAL, YSR KADAPA DISTRICT
INLINE CHLORINATION SYSTEM By VNKANE

MALLELA Village



Community Awareness on Inline Chlorination


NJJM Team Visit

Display of water quality reports @ GP level

Way forward…

- Standard Operating Procedure(SoP) is being drafted
- The success of the project from AP serves as a model for other communities facing similar water quality challenges in AP and India
- The innovative and sustainable approach can be replicated in various regions, contributing to nationwide efforts to improve rural water disinfection.

https://photos.app.goo.gl/VrCj6C7fu2gSwK8BA

THANK YOU

Inline Chlorination

To

Provide safe water to community in Andhra Pradesh

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Arunachal Pradesh
Dr. Binod Pokhrel
Chief Chemist

Water Quality Initiatives Overview

1. State Level Laboratory	**01**
2. District level laboratory	**25**
3. Sub-division level Lab	**23**
4. Mobile Lab	**02**

22,287 nos. of women have been trained for FTK use under JJM till date.

State WQT LAB

<u>Water Quality Profile in Arunachal Pradesh:</u>

- Major contamination found in foothill region is iron with highest recorded 7.0 mg/L (BIS Limit 1.0 mg/L).
- There were 364 WQ affected (iron) habitation before JJM execution.
- Total iron affected habitations in Arunachal Pradesh are 224 nos. All have been covered during FY 2020-24.
- Arunachal Pradesh faces heavy rainfall during monsoon season. Landslide, soil erosion, accumulation of humus and waste by running water through gravity and finally mixing into surface water body, causes very high turbidity (As high as 800 NTU).
- Drinking water supply is jeopardized due to prolong settling time of suspended particles and use of excess alum during purification process.

Water Quality Initiatives Overview

Addressing Water Quality Problem in Arunachal Pradesh:

Iron Removal Process:

1. For multivillage schemes the most common method for iron removal from water is oxidation followed by sedimentation and filtration. The process involves oxidation by aeration, oxidation by using MnO_2, coagulation, flocculation and sand filtration. Disinfection by chlorine dosing at CWR.

2. For single village schemes with lesser population, pressure filters are used. The Iron treatment media used are MnO_2, Katalox, Purolite, Anthracite and treated sand.

Turbidity Removal Process:

A. The treatment processes for removal of turbidity involve the following

- **Presetling or desilting tank**: Detention period of ½ hour to 3 hours and surface loading of 20 to 80 cum/sqm/day for removal of coarse and rapidly settling silt is recommended for the Pre-sedimentation tank. It allows bleeding of coarse objects and small pebbles automatically.
- **Chemical treatment:** Alum is used for coagulation. The dose of coagulant varies from 5 to 40 mg/L depending on turbidity, colour, pH value of raw water etc.
- The process is followed by flocculation, settling and slow sand filtration.

B. Roughing filters:

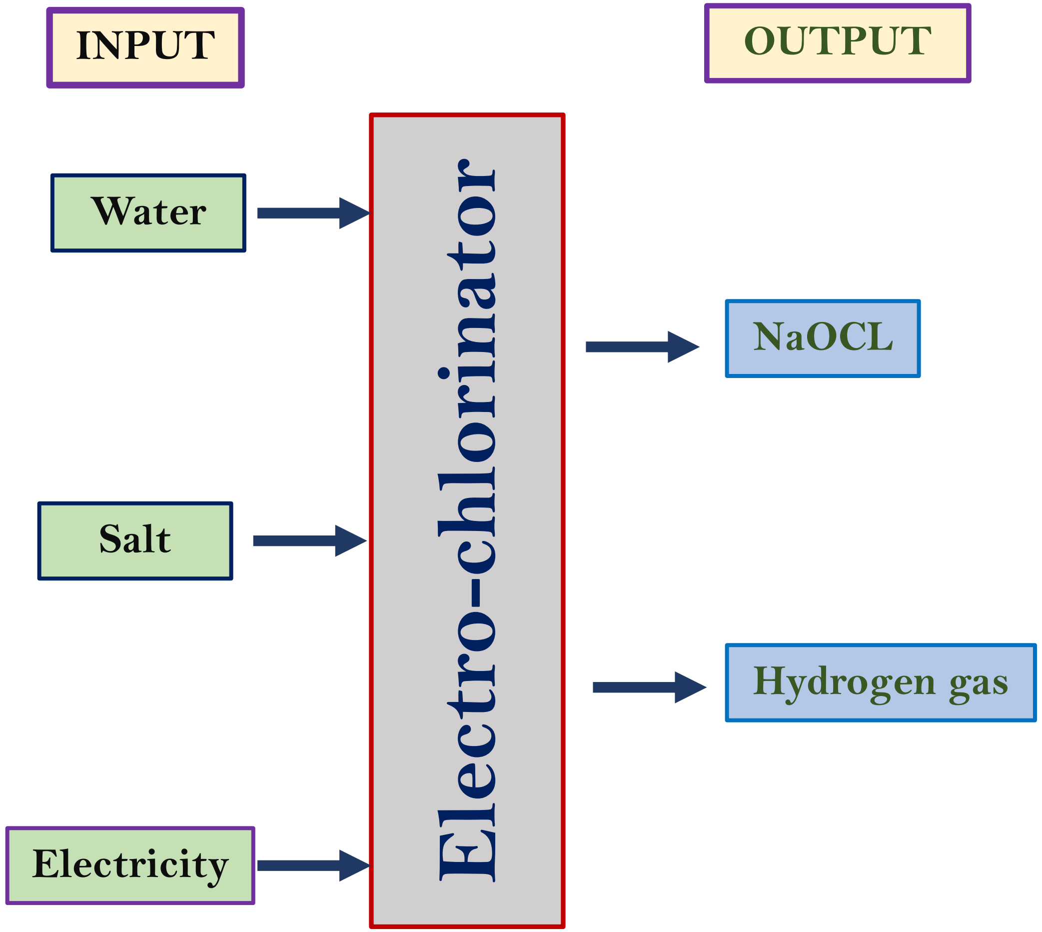
- Vertical (upward & downward) and horizontal roughing filters are employed to effectively separate fine solid particles. They are usually placed at the treatment plant site and operated in combination with other pretreatment units such as sedimentation tank. Roughing filters precede final treatment processes, such as slow sand filtration and chlorination.

Challenges Faced

- Bacterial contamination often seen during monsoon season. Pre-monsoon and post-monsoon season also need careful attention due to turbidity issue.
- Generally, chlorination is done in batch manner keeping the residual chlorine greater than 0.2 ppm.
- However, constant monitoring is problematic controlling the dosage.
- As a demo basis, two schemes have been installed with electro-chlorinator and observed the progress.
- Presently, 1734 new schemes are being installed with electro-chlorinator.

INTRODUCTION TO ELECTRO-CHLORINATOR

Electro-chlorination is the process of producing Sodium hypochlorite by passing electric current through salt water. This dis-infects the water and makes it safe for human use, such as for drinking water. Sodium hypochlorite (NaOCl) is an effective disinfectant and can be used as a substitute for chlorine gas or Calcium Hypochlorite (solid chlorine granules). The production of NaOCl is onsite generation basis. Generation of NaOCl requires salt, water and electricity (direct current type). In these systems, salt is dissolved and used for electrolysis. Hydrogen gas, a by-product, is generated when electrolysis occurs on the brine solution.



$$NaCl + H_2O + ENERGY \rightarrow NaOCl + H_2$$

Innovative Solutions Implemented

FEATURES OF ELECTRO-CHLORINATOR INSTALLED AT YUPIA

1) Manufacturer	: Green Works Engineering.
2) Electro-chlorinator model No.	: BTE 25.
3) Reaction tank capacity	: 50 Litres.
4) Batch of hypochlorite generation	: 8 Hours.
5) Total Dissolved hypochlorite generate	: 36 litres.
6) Concentration of hypochlorite	: 0.60 %.

DETAILS OF WATER TREATMENT PLANT WHERE ELCTROCHLORINATOR IS INSTALLED

1) N/Work	: P/W/S to Yupia-III.
2) Source of water supply	: Surface Source (Debra Nallah – IV).
3) Water Requirement	: 0.03 MLD (30000 liters per day).

Innovative Solutions Implemented

Dosing Rate Fixation Chart				
N/Work: PWS to Yupia-III				
SL No	Date	Dosing Rate (in percentage)	Residual Chlorine (in ppm)	Remarks
1	2/8/2023	40.00%	1.20	Dosing rate is high
2	3/8/2023	30.00%	0.70	Dosing rate high
3	4/8/2023	20.00%	0.30	Required dosing rate
4	5/8/2023	20.00%	0.28	Required dosing rate
5	7/8/2023	20.00%	0.25	Required dosing rate
6	8/8/2023	20.00%	0.27	Required dosing rate

Innovative Solutions Implemented

Dosing Rate Fixation Chart

N/Work: PWS to Yupia-III

The required dosing rate of the dozer for desirable residual chlorine at delivery point = 20 % dosing.

Dozer capacity	=	6.00	L/Hour
Required per hour dosing	=	1.20	L/Hour (i.e. 20% of the dozer capacity).
Quantity required per day	=	28.80	L/Day
Capacity of the electrochlorinator	=	36.00	L/Batch (in 8 hours)
Time required to empty the dissolved hypochlorite tank	=	30.00	Hours

Technical Details of Chlorination Initiatives

S. No.	Name of Chlorination Initiative	Total no. of plants installed	Total no. of HHs served	Chlorine consumption per month
1	Initiative 1 (Electrochlorinator 5 gm/h Cap.)	1135	20986	1634.4 Kg
2	Initiative 2 (Electrochlorinator 15 gm/h Cap.)	510	34307	2203.2 Kg
3	Initiative 3 (Electrochlorinator 25 gm/h Cap.)	89	22991	640.8 Kg
	TOTAL	1734	78284	4478.4 Kg

Financial Details of Chlorination Initiatives

**All amounts are in Rs.*

S. No.	Name of Chlorination Initiative	Capital Expenditure (One time cost in Rs.)		Operational Expenditure (Annual recurring cost)	
		Cost of device	Installation cost (materials, plumbing etc)	Operations and Maintenance cost	Cost of Materials (Chlorine resupply)
1	Initiative 1 (Electrochlorinator 5 gm/h Cap.)	1,54,759.00	92,855.00	12,381.00	365.00
2	Initiative 2 (Electrochlorinator 15 gm/h Cap.)	1,94,059.00	1,35,841.00	11,643.00	1095.00
3	Initiative 3 (Electrochlorinator 25 gm/h Cap.)	2,15,594.00	1,91,640.00	14,373.00	1825.00

* Data given is per unit cost

Learnings and Insights

FIELD OBSERVATION
(I) The following advantages of electro-chlorinator is found:
1. On-site chlorine production.
2. Enhance water disinfection.
3. Reduced chemical handling and transportation risk.
4. Simple operation.
5. Cost effective.
6. Raw material available.
(II) The few disadvantages may be found in using electro-chlorinator:
1. Required constant electricity.
2. Risk in stealing of the platinum electrode.

PHOTOGRAPH OF ELECTRO-CHLORINATOR INSTALLED AT YUPIA-III

Thank You

Experiences with water disinfection methods & controlling bacteriological contamination

State: Assam
Name of officer: Nasimul Haque
Designation: Chief Engineer(Water), PHED, Assam

Agenda

- *Water Quality Initiatives*
- *Challenges faced*
- *Innovative Solutions implemented*
- *Learning & insights*

Water Quality Initiatives Overview

Identified the contamination in water sources by laboratory and FTK testing

Water Quality Initiatives Overview

Identified and awarded the best performing 5 member women FTK group

Water Quality Initiatives Overview

Conducted Special Bacteriological testing drive from 10th July to 9th August 2023

Various samples collected during SBT drive

Special Bacteriological Testing (SBT) drive

Water Quality Initiatives Overview

Awarded the best performing laboratory each month

Challenges faced

01

Maintaining residual chlorine at 0.2 ppm at terminal points of distribution pipelines.

02

Unwillingness for testing by some existing FTK women groups

03

Frequent resignation by contractual laboratory personnels

04

Lack of proper infrastructure in microbiological laboratories

05

Overloading of work on departmental officials often delay taking remedial actions on time.

Innovative Solutions Implemented

Village Level

- ***One FT***
  school c
- *Re-orien*
  users
- *Observe*
  every m
- ***Jal Do***
  testing

Innovative Solutions Implemented

Monthly Evaluation & Awards

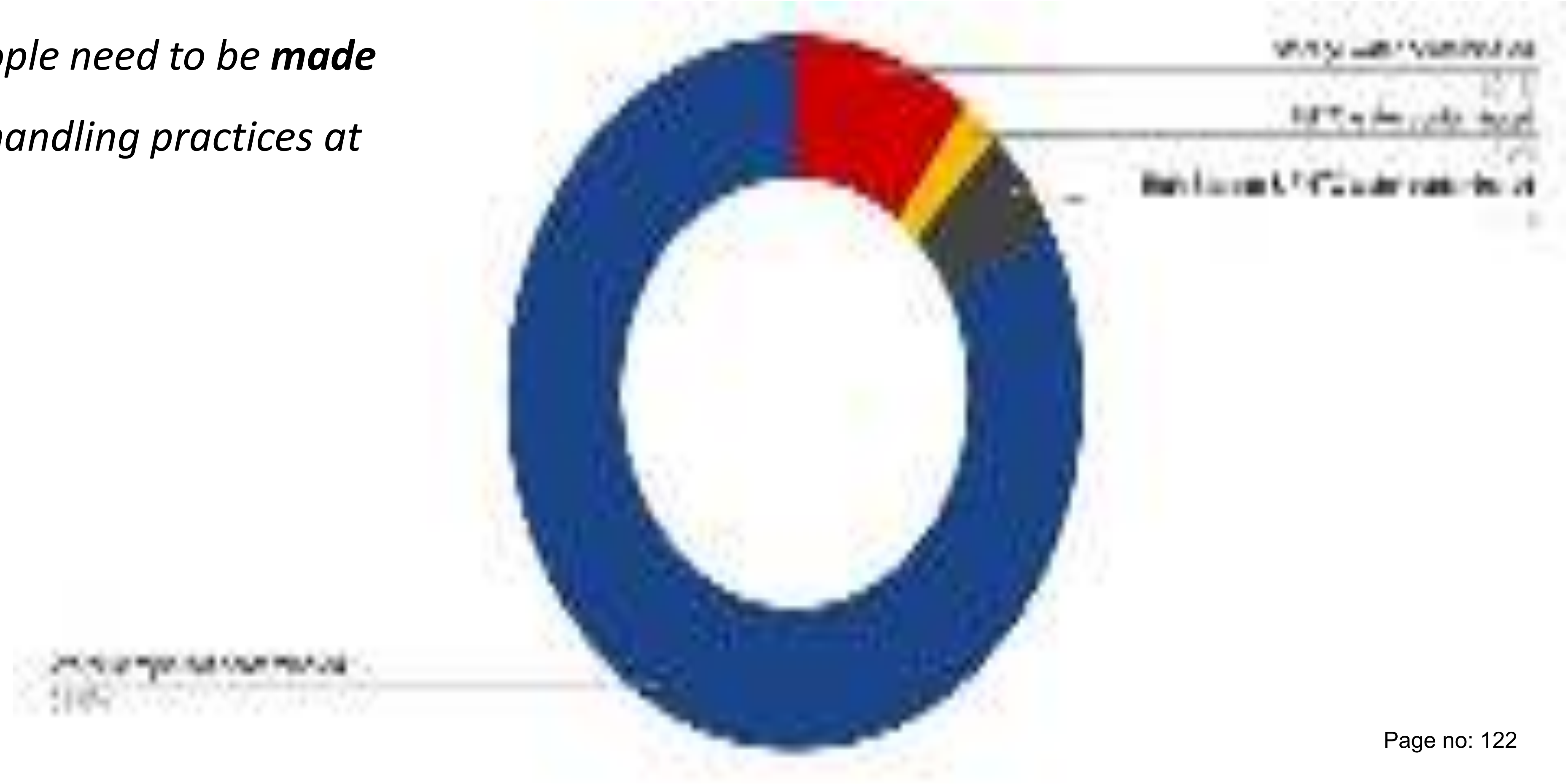
Other Ini

Jal Kosh QR code.

Learnings and Insights

- *The SBT conducted in **89,075 households covering 25 households** in each of **3563 no of PWSS** through out the State showed that, bacteriological contamination is more at **household storage water (10.1%)** rather than FHTC supplied water (2.2%).*

- *This shows that the people need to be **made aware about safe water h**andling practices at household level.*



Learnings and Insights

*The low level of bacteriological contamination in FHTC may be due to usage of **chlorine doser in each PWSS***

*NABL Accreditation has facilitated in **improvement of detection, evaluation and mitigation** of bacteriological issues*

*Data from the initiative will help **identify and adopt remedial actions***

Distribution of NaDCC tablets during emergency

Technical & Financial Details of Chlorination Process

S. No.	Name of Chlorination Initiative	Total no. of plants installed	Total no. of HHs served	Chlorine consumption per month
1	Chlorination with bleaching powder in PWSS	10,796	51, 03, 264	122.0 MT (approx.)
2	Distribution of NaDCC tablets during emergency	-	Flood affected areas	50 Lakh Tablets during FY 2023-24.

S. No.	Name of Chlorination Initiative	Capital Expenditure (One time cost)		Operational Expenditure (Annual recurring cost, FY 2023-24)	
		Cost of device	Installation cost (materials, plumbing etc)	Operations and Maintenance cost	Cost of Materials (Chlorine resupply)
1	Bleaching powder	Rs. 47,000.00 (each)	All inclusive	Electricity cost	Rs. 3.4 Cr
2	NaDCC tablets	0	0	0	Rs. 0.67 Cr

Maintenance & supply chain for Bleaching Powder

- *Department has opted for Rate Contract with redundancy option that* ***if L1 fails to deliver, then L2 can be approached to supply at L1 rate.***

- *The rate contract is* ***valid for 1 year only****, so that any requirement from the field can be accommodated.*

- *Requirement keeps on changing depending on different factors like* ***season, severity of flood, turbidity of the raw water*** *etc.*

- *Rates are discovered for* ***all distribution centres*** *so that department do not face logistical issues in supply.*

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Bihar

Name of the Officer: David Kumar Chaturvedi
Designation:Joint Director

Water Quality Initiatives Overview

- PHED, GoB has implemented "Har Ghar Nal Ka Jal" under Mukhymantri Nischay to provide safe & adequate potable water with tap connection to each house hold including quality affected area.
- Water supply scheme has been established in all 114651 Ward in which 30207 ward is quality affected.
- Recognizing the risks, water quality-affected habitations are accorded priority in the implementation of Har Ghar Nal Ka Jal Nishchay.
- Similarly water quality monitoring & surveillance activities are prioritized.
- 01 State Level Water Testing Lab, 38 District Water Testing Labs and 76 Sub Divisional Water Testing Labs established. (11 District labs are NABL accredeted)
- 268 Positions of Chemists, Assistant Chemists and Lab Assistant sanctioned to strengthen the functioning of laboratories.
- A Cell constituted to monitor the water quality activities by creating positions of Superintending Engineers, Executive Engineers, Assistant Engineer & Junior Engineer at Head Quarter level.

Water Quality Initiatives Overview

- PHED Bihar has successfully addressed all three water quality issues by installing treatment unit in those area. Details of treatment unit with chlorination installed in quality affected area are as follows:

Water Quality Issue	No. of Schemes with Treatment Unit Installed
Arsenic	4709
Fluoride	3789
Iron	21709
	Total - 30207

- PHED has installed all water Supply scheme with Chlorination Unit and planning to install chlorination unit in PRD Schemes.
- PHED has developed a protocol for Operation & Maintenance and Reject Management Protocol for Arsenic, Fluoride and Iron treatment Units in September 2019.

Water Quality Initiatives Overview

- Disinfection of drinking-water supplies with chlorine is widely regarded as one of the most significant public health interventions, reducing the incidence of waterborne disease.
- Chlorination is a very popular method of water disinfection that has been used for many years. It has shown to be effective for killing bacteria and viruses but not for some protozoan cysts. Hence for these resistant protozoa water treatment process like filtration or disinfection by UV Light is used to effectively remove protozoa.
- Bacteriological test facilities available in State Referral Lab.
- Through FTK (8 parameter water quality test) and H_2S vial (bacteriological) testing is done at Gram Panchyat level.
- Total sample tested through H_2S vial till date – 42775 Nos. (as reported on WQMIS)

Challenges Faced

- Lack of trained pump operator. (what chlorine dose is required to ensure effective disinfection and an adequate residual chlorine concentration in the drinking-water supply.) need to understand.
- Due to unpleasant taste & odour people is not accepting easily.
- Allergic reactions in some individuals.
- Limited effectiveness against some parasites and viruses.
- Community not taking interest in O & M of water supply scheme (for effective disinfection and monitoring chlorine demand of water).
- Lack of awareness of safe handling of chlorine.
- Lack of awareness among people about importance of safe water.

Innovative Solutions Implemented

- After dosing of chlorine in supply water testing of Residual chlorine at tail end point.
- Regular Capacity building of Man Power (Pump operator, Chemist, Lab Assistant and JE).
- Skill training of Pump Operator through ITI/PRANJAL (Training Centre).
- IEC activity at District/Gram Panchyat level.
- Maintenance of water Supply scheme on regular basis and ensuring immediate repair of leakage through panchyat level repair team.
- “Har Ghar Nal Ka Jal” Seva Vahan is being operated to provide training about plumbering skill to pump operator & willing youth.
- Three tier Grievance Redressal System (At Pump House, District Control Room and CGRC)
- Spreading awareness about water quality through monthly **Jal Chaupal** in villages.
- **H_2S vial Provided to all Gram panchyat** for Bacterial contamination testing.
- **Water test report register** is maintained at each pump house and exhibited to benefeciaries for their satisfaction.
- **Transect walk** to ensure functionality of scheme.

Learnings and Insights

- FTK and H2S vial should be available in GP level to identify contamination at primary level.
- Trained Man Power at pump House to operate Chlorinator, FTK, H2S vial etc.
- Disinfecting chemicals should be available at site.
- Awareness generation among the community about benefit of chlorination and safe drinking water.

Photos of the initiatives

Photos of the initiatives

Photos of the initiatives



Chlorination

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Gujarat

Water Quality Initiatives Overview

Multi-layered approach for sampling and testing

- The state has adopted multi-layered arrangement for quality sampling and testing
  1. 80 Laboratories (76 NABL accredited): 1 at State level, 33 at District level and balance at Block level
  2. Service contract at 80 field offices for sample collection (payment per sample)
  3. Self testing using FTKs by 13,442 VWSCs at village level
  4. Smart quality analyzers in bulk network: pH, chlorine and turbidity sensors (data collected every 15 min)
- In FY2023-24, so far more than 4 Lakh tests have been conducted at Labs and by VWSCs
- Target for next FY will be ~8.5 Lakh

Water Quality Initiatives Overview

- TPI for Functionality Assessment: Appointment of TPIs for functionality assessment, identification of deficiencies and corrective actions in tribal districts.
- Training women to use FTKs: 87,820 women have been trained so far to use FTKs. Overall, 17,564 villages have been covered under the training program.
- Chlorination is done at WTP of respective MVS and bleaching is done at village level storage structures prior to distribution
- Rigorous IEC campaigns conducted by WASMO

Challenges Faced

- In Gujarat, water supply is ensured through multi-village schemes owing to lack of perennial local sources
- Water is supplied from MVS to the village level storage. Gram Panchayat/ ULB is responsible for further distribution of water to all households
- There is skill gap at local institutions especially in GPs
- Lack of awareness in VWSC members and beneficiaries with regard to the importance of disinfection or bacteriological contamination

Innovative Solutions Implemented

- State has appointed agency via service contract at 80 field offices to strengthen testing and surveillance (in addition to other mechanisms)
- FTKs procured and distributed regularly to the Pani Samitis (VWSCs) to enable self testing at village level (local sources and household level)
- IoT initiative: Smart sensor based quality analyzers have been installed across the MVS network: pH, chlorine and turbidity sensors (data collected every 15 min)
  - This data is available at the Central Monitoring & Command Centre at state level for surveillance and quick response
  - The system is equipped with SLA based alert generation feature (SMS/ Email/ System display)

Learnings and Insights

- Rigorous IEC campaigns are essential at village level
- Deployment of skilled personnel at GPs will help in ensuring supply of safe drinking water
  - Also, train local operators in the aspect of water quality management

Photos of the initiatives

Photos of the initiatives

Women led management of water supply

FTK use by trained women for household level testing

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Himachal Pradesh
Name of the Officer:
Designation:

Water Quality Initiatives Overview

- Providing safe and sufficient potable water to every household to enhance the ease of living of citizens is 1st priority of Jal Shakti Vibhag, Himachal Pradesh.
- Provision of safe and adequate water also leads to reduction in water borne diseases leading to better public health outcomes.

Initiative to ensure quality of drinking water :

- Proper chlorination is ensured in all water supply schemes.
- Regular testing is done through established network of water testing laboratories and through FTK at Panchayat level/Village level.
- 70 water testing labs have been established including 1State lab with State of Art facilities ,14 District labs, 55 Sub-divisional labs.
- 62 labs are NABL accredited / recognized.
- Field Test Kits have been distributed in all villages, Govt. High Schools and Govt. Sen. Sec. Schools.
- 69860 women trained for water quality testing using FTKs in 17816 villages.
- Regular Sanitary Inspection of drinking water sources is done to identify and evaluate factors associated with drinking water that may pose a risk to health.

Challenges Faced

- Presently State uses chlorine for disinfection of water supply by way of gaseous chlorination and bleaching powder. Gaseous chlorination is being used in major water supply schemes of the State in urban and rural areas with automatic dozing. Bleaching powder is used by mixing manually in the main storage tanks.
- Due to the scattered population and complex distribution system in the hilly areas it is an uphill task to maintain minimum prescribed residual chlorine level of 0.2 PPM at the tail end. This often results in high residual chlorine level to the houses near the storage tank and often leading to bad taste and smell in water.

Innovative Solutions Implemented

To ensure clean and potable drinking water supply in the state SOP has been adopted with highlights as under:

- All the vulnerable schemes to be identified.
- Use of bleaching powder to be replaced with the Gaseous Chlorination System in schemes with capacity greater than 1.0 MLD.
- Slow sand filter to be constructed on all percolation based schemes with chances of contamination.
- UV/Ultra-filtration/Ozonisation disinfection system to be installed in case of detection of viral contamination.
- The IoT based turbidity and residual chlorine to be installed at Main Distribution Tank on identified schemes.
- Surface water based schemes to be fitted with auto doser based hypochlorite system.

Innovative Solutions Implemented

Chlorination based Disinfection System:

- In light of SOP, 9551 schemes have been identified in the State for installation of (446 Gaseous Chlorination,2270 Liquid Chlorine/ Sodium Hypochlorite, 6835 bleaching powder).
- Firms empanelled and work being allocated to the Firms.

Sensor based real time monitoring system (IoT) :

- IoT system are being installed on the selected Schemes to monitor the regular quality and quantity of water.
- loT up to village level in 39 Multi Village Schemes for monitoring Flow, Turbidity, Chlorine residual, pressure etc. in 13 Blocks.
- Basic loT in 250 schemes on Main Distribution Tank for monitoring 3 parameters at single point of Multi Village Schemes i.e. Flow, Turbidity & Residual chorine in 10 districts.

Learnings and insights

Learnings :

- In past few incidents of water born diseases (diarrohea, jaundice, gastroenteritis etc.) has been noticed in the State necessitating the proper and effective flow of information between Water Supply Department, Health Department and the Community for speedy remedial actions.

Insights:

Development of Web based GIS Dashboard for monitoring of Water Borne Diseases in collaboration with Health & Family Welfare Department:

- GIS based dashboard is being developed through Aryabhatta Geo-informatics & Space Application Centre (AGiSAC) Shimla for reporting & monitoring of water borne diseases in coordination with Health & Family Welfare Department.
- Detail of already identified hot spots of water borne diseases along with Water Supply Schemes supplying the water to the area has been uploaded on the dashboard.
- New identified hot spot, detail of water supply scheme can also be uploaded by the concerned field officers/officials in case of outburst of water borne disease.
- SMS will be sent to all concerned officers of JSV and Health Department wherever incidence of water borne disease is detected for taking prompt remedial action.

Photos of the initiatives:



Water Quality Testing in Labs and by Community



IoT based Monitoring Instrumentation System

Photos of the initiatives

Water Treatment Plant

Chlorination based Disinfection System

Thank You

Presentation On Experiences With Water Disinfection Methods & Controlling Bacterial Contamination

Name of the UT: Jammu &Kashmir
Name of the Officer: Er.Jan Masood Ahmad
Designation: Asstt. Ex, Engineer-Chemical (PHED, Jal Shakti Department, Kashmir)

Water Quality Initiatives Overview

- Water Quality challenges in Jammu & Kashmir.
- Risks associated with bacterial contamination in water.
- Primary goals of water disinfection.
- Importance of water disinfection and the importance of controlling bacterial contamination for public health.

Water Quality Initiatives Overview

Bacterial Contamination:

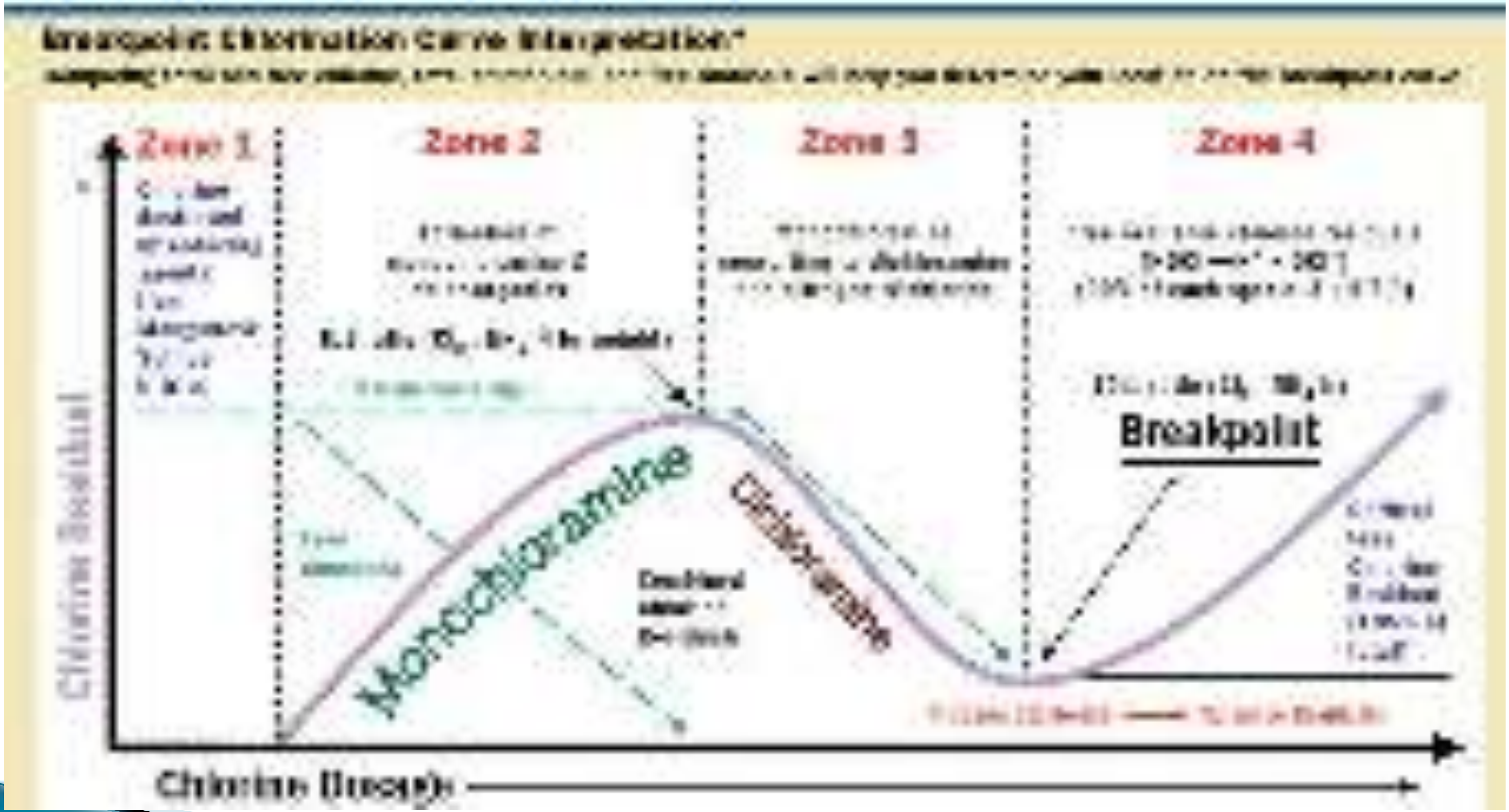
- Bacterial contamination is a prevalent issue in water supplies worldwide, resulting from the presence of various microorganisms in water sources.
- Sources of contamination include industrial discharges, agricultural runoff, sewage discharges, and natural environmental factors.

Common Waterborne Bacteria:

- Some of the most common waterborne bacteria include Total Coliform, Escherichia coli (E. coli),fecal coliform, Salmonella etc
- These bacteria can enter water supplies through fecal contamination, contaminated soil, or untreated sewage.

Water Quality initiative Implemented

In order to control the bacteriological contamination in drinking water,various water treatment plants have been made properly functional. In jammu and kashmir where various water treatment chemicals like Alum,PAC,Activated carbon and chlorine is being used properly.the testing of water samples is done at inlet and outlet points in order to ensure the quality drinking water to the customers.


Zone 1
Zone 2
Zone 3
Zone 4
Breakpoint
Monochloramine
Dichloramine
Chlorine Residual
Chlorine Dosage

Challenges Faced

Health Risks Associated with Waterborne Bacteria:

- Exposure to waterborne bacteria poses significant health risks, especially when the pathogens are ingested or come into contact with the skin.
- Health risks include gastrointestinal infections, diarrheal diseases, stomach cramps, nausea, and in severe cases, life-threatening illnesses.
- Vulnerable populations, such as children, elderly individuals, and those with compromised immune systems, are particularly at risk.

Waterborne Diseases:

- Waterborne bacteria are known to cause diseases such as cholera, dysentery, typhoid fever, and gastroenteritis.
- The severity of the diseases varies depending on the type of bacteria and the concentration present in the water.

Impact on Public Health:

- The contamination of water supplies with bacteria can lead to widespread outbreaks of waterborne diseases, affecting communities and straining healthcare systems.
- Proper water disinfection methods are essential to prevent and control bacterial contamination, safeguarding public health.

Learnings and Insights

Key Learnings:

- **Diversity of Approaches:**
  - One major insight is the diversity of approaches to water disinfection and bacterial contamination control.
  - Different regions and projects necessitate tailored solutions based on unique challenges and resources.
- **Integration is Key:**
  - Successful strategies often involve integrating various disinfection methods.
  - Combining traditional and advanced technologies creates synergies that enhance overall effectiveness.
- **Community Involvement Matters:**
  - Community engagement is crucial for sustainable water quality management.
  - Informed communities play a proactive role in maintaining and monitoring water hygiene.

Learnings and Insights

- *Insights from Case Studies:*
- **Innovation Yields Results:**
  - The successful implementation of innovative solutions has consistently resulted in improved water quality.
  - Innovative technologies and practices showcase the potential for transformative change.
- **Monitoring for Proactive Action:**
  - Real-time monitoring is a powerful tool for proactive intervention.
  - Swift response to changes in water quality helps prevent outbreaks and ensures continuous improvement.
- **Education is a Pillar:**
  - Educational initiatives significantly contribute to behavioral change.
  - Increased awareness about the importance of water hygiene fosters a culture of responsibility within communities.

Challenges and Opportunities:

- *Challenges:*
  - Persistent challenges include the formation of disinfection by-products and the need for environmentally sustainable practices.
  - Ensuring universal access to safe water remains a global challenge.
- *Opportunities:*
  - Advances in technology present opportunities for more sustainable and efficient water disinfection.
  - Collaborative efforts can drive policy changes and facilitate the implementation of innovative solutions.

Drinking Water Initiatives In Jammu and Kashmir

- **Jal Jeevan Mission (JJM)** a centrally sponsored scheme is being implemented in Jammu and Kashmir for provisioning a portable water supply to every rural household of the UT of J&K by 2024.so far as more than 75% FHTC has been covered under the scheme. Under this scheme the new innovative have been implemented in which awareness among people, establishment of paani samities,training and awareness among general masses, establishment of water testing labs etc have been done properly and involment of public under JJM has been the star feature of the scheme.

United Nations Development Goal (SDGs) 2030

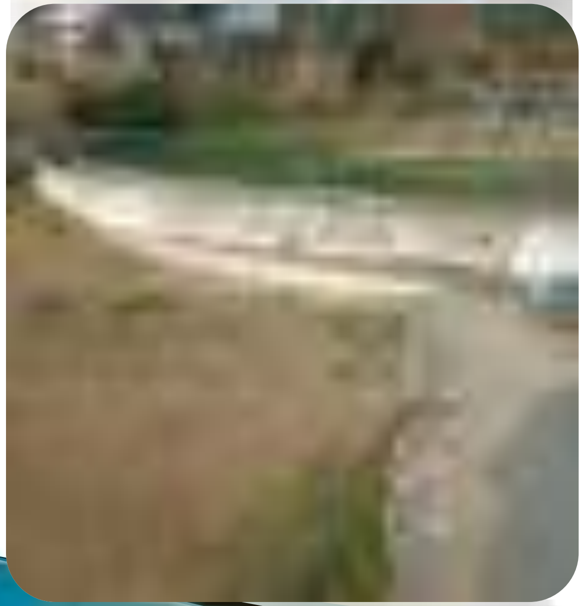
Safe and clean water is essential to meet all the targets effectively

WATER TREATMENT PLANT RANGIL,SRINAGAR-KASHMIR

Water Filtration Plant,Sitlee,Jammu








Photos of the initiatives

Our Achievement in J&K

1. Total number of WQ Labs established in Jammu and Kashmir under Jal Jeevan Mission=98
2. Total number of labs NABL Accredited=12
3. Total number of samples tested in Labs:207737
4. Total number of samples tested through FTK:32915
5. Total number of 5women trained for ftk : 5667
6. Total number of schools tested: 22817
7. Total number of Anganwadi centers tested:24107
8. Total number of villages where 3 households tested: 5667
9. Total number of sources tested:11689

Thank you…….

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Jharkhand

Name of the Officers: Er. Shishir Kumar Soren & Er Anil Prasad

Designation: Chief Engineer, DWSD, Jharkhand

Water Quality Initiatives Overview

- **31** total number of water quality testing laboratories
- **30** number of NABL accredited water quality testing laboratories
- **03** number of NABL accredited water quality testing laboratories in Microbiology

  (State lab Ranchi Hinoo, District lab Jamshedpur and Hazaribagh)
- **241** human resources for water quality monitoring and surveillance
- **179** human resources are trained through Quality Council of India on sustainability of NABL labs and disinfection methodologies
- **29595** Village level front worker – Jalsahiyas have been trained on water quality testing using FTKs and H2S vials

Water Quality Initiatives Overview

- **533910** water samples have been tested through FTKs and H2S vials
- **159182** water samples tested through labs for chemical and bacteriological parameters
- **350** manpower of Implementation Support Agencies (ISAs) on water quality monitoring and surveillance activities for awareness generation on importance of potable water among communities.
- **1.47** lakh women at villages have been trained on water quality issues
- **315430** source for which sanitary survey has been done and appropriate measures taken for source protection to avoid bacteriological contamination.
- **29595** villages where water quality testing parameters boards have been installed for community awareness

Challenges Faced

- ❑ Gravel Packed Tubewells in collapsable areas causes bacteriological contamination that cannot be easily identified.
- ❑ Leakages of water pipe lines may cause contamination as redressal gets delayed due to other utilities such as permission from Road and Electricity Departments.
- ❑ Water –logging areas in the rainy seasons causes bacteriological contamination, especially in flood zone areas such in Sahebganj district.
- ❑ Lack of sensitization among communities on the management of grey water

Innovative Solutions Implemented

- Installation of decontamination technology (electro-chlorination) at Rukka Water Treatment Plant
- Disinfection by chlorine gas for all MVS schemes.
- Silver ionization method for bacterial removal installed at Murchu SVS scheme, Ranchi District
- Chlorination through Nacl (salt)

Learnings and Insights

- Periodical chlorination at gravel packed tub well sources is mandatory and testing of water is necessary
- In case of road crossing or near electric polls, casing pipes over main pipelines is required
- Awareness on water quality monitoring and surveillance at village level
- Preparation and implementation of Disaster management plan in the flood areas to address the issues of bacteriological contamination.
- Pre and Post monsoon water quality testing of bacteriological parameters is mandatory for affected sources

Photos of the initiatives



Chlorination of clear water through chlorine gas at Rukka water treatment plant

Photos of the initiatives

Chlorination through Nacl (salt) in the Ulihatu water supply scheme, Khunti District

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State:Karnataka

Name of the Officer:Mr. Aijaz Hushin
Designation:Chief Engineer RDW&SD

Water Quality Initiatives Overview

- In providing safe water to rural household, the State of Karnataka depends on two natural system of water 1) Ground water 2)Surface water
- The State of Karnataka has planned to have sustainable water coverage of the villages by MVS (Multi Village Scheme) utilizing surface water as a source.

Total No of Functional MVS	Village Covered	No Of Ongoing MVS	Village planned to be covered
492	6923	138	13803

- The State of Karnataka has 32 district Laboratories & 48 taluk level laboratories to analyze water quality. Out of which 27 district laboratories are NABL Accreditated and 39 taluk laboratories are NABL recognized.
- In case of Microbiological parameters, 34 Laboratories are proposed of which 7 are functional and 20 more microbiological Laboratories are in the process of getting established .
- Presently RDW&SD has empanelled private laboratories for bacteriological testing across karnataka.
- For Ground level water quality monitoring 5 VWSC Members +SHGs Group members+ Water person are trained frequently to use FTK &H2S Vials by the Department.

Challenges Faced

- Irregular Cleaning of water storage system like OHT,GLSR,MWS.
- Improper maintenance of documentation on cleaning and disinfection.
- Establishment of microbiology labs with required specification.
- Chlorination of water.
- NSF Certified technology for safety and durability of technology (water in contact with material and durability of material)
- O&M of the material installed and its safety aspects.
- Usage of FTK and H_2S Vials by Registered FTK Users and entry into WQMIS portal.

Innovative Solutions Implemented

- SOP (standard operating procedure) for chlorination process and disinfection of over head tanks and reservoirs.
- Electrochlorinator with 5 years of maintenance is planned and a pilot study is under progress.
- In case of MVS, the primary chlorination and post chlorination are carried out to maintain required residual chlorine.
- Water supply system cleaning activity is documented by ground level staffs, monitored by taluk level staffs and supervised by Zilla panchayath level officers.
- As immediate remedial action activity, Karnataka has installed 18500 R O based water purification plants across Karnataka.

Learnings and Insights

- O&M and safety of R O based Water purification plants
- O&M and safety of Chlorination system

Post Chlorinator at MVS

Chlorinator housing under OHT connected ground water

Electrochlorinator system for ground water

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State/UT: Ladakh

Name of the Officer: Sh.Urgain Nurboo
Designation: Chief Chemist

Water Quality Initiatives Overview

- Capacity Building of Lab Staff
- Infrastructure Development for Lab
- Introduction of Non-Electric Auto Chlorinator
- Laboratories Open to Public
- Women Trained in 100% Villages (FTK)
- IEC Campaign To Raise An Awareness Among Villagers

Water Quality Initiatives Overview




Challenges Faced during implementation of Disinfection in UT Ladakh

Challenges Faced during implementation of Disinfection in UT Ladakh

Innovative Solutions Implemented

No Power/Electricity Required

Easy to Install and Use

No Regular Monitoring

Innovative Solutions Implemented

Learnings and Insights

- Uses of Pressure Head for Dosing of Chemical
- Energy Efficient System
- Auto Dosing of chemicals
- Avoid Excess Dosing of Chemicals

Learnings and Insights

Thank You

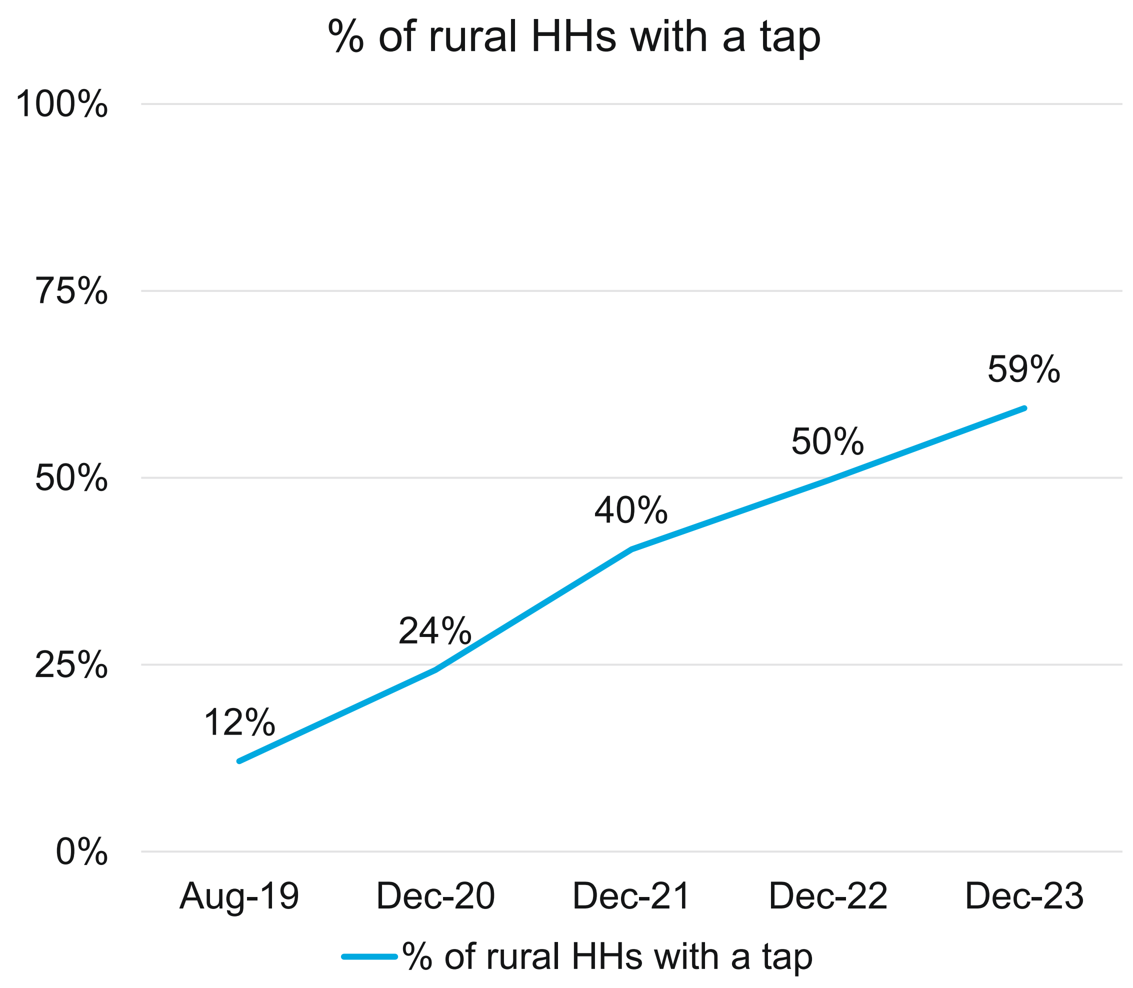
Madhya Pradesh chlorination pilot

February 2, 2024

Madhya Pradesh has more than quintupled its number of households with a tap since 2019

We’ve installed 53 lakh rural taps since 2019

- We now reach 66 lakh households (89%), an increase of 53 lakh households since 2019
- Total rural population with a household tap has more than quintupled over that time period
- Progress continues, with additional installations planned for 2024



Source: % of HHs taken from JJM data from August 2019 and December of each other year
https://ejalshakti.gov.in/jjmreport/JJMIndia.aspx

Since March 2023, we've been piloting three different water chlorination technologies across the state

We've conducted a 7 site pilot across 3 districts

- We've installed devices in 6 SVS sites across the state across 3 different districts
- Since the original pilot, we've installed
- We tested three different technologies as part of the pilot to ensure we'd find a scalable solution
  - Tablet-based dosers are a simple, low maintenance technology
  - Electric liquid chlorine dosing pumps support large systems and have a robust existing supply chain
  - Non-electric liquid chlorine dumps are a blend between the other two technologies

List of site installations by village

Type	District	Block	Village
Original pilot	Bhopal	Fanda	Barkheda Bondar
	Bhopal	Fanda	Kanhasiya
	Shivpuri	Shivpuri	Bhada Bawadi
	Shivpuri	Shivpuri	Gangora
	Vidisha	Ganjbasoda	Udaypura
	Vidisha	Ganjbasoda	Bareth
Pilot Expansion	Shivpuri	Shivpuri	Bhada Bawadi
	Shivpuri	Shivpuri	Gangora
	Shivpuri	Shivpuri	Khari
	Vidisha	Ganjbasoda	Bareth
	Vidisha	Ganjbasoda	Udaypura

Technologies: Tablet-based dosers provide a low-cost way to reach Single-Village Schemes

Easol PurAll device in Barkheda Bondar, Fanda, MP

- Tablet-based dosers are electricity-free, low-maintenance devices that use stable chlorine tablets to dose water supply
- **Benefits**
  - Low cost with stable, long-lasting consumables
  - Simple design, low maintenance & no electricity required
  - Easily controlled dosing with open-source designs & no pipe corrosion
- **Drawbacks**
  - Limited large-scale producers for tablets & cartridges
  - Proprietary cartridges for Easol PurAll dosers

Technologies: Electric liquid chlorine dosing pumps leverage strong existing manufacturing and supply chain capabilities

AC 6 Mechanical Dosing pump device in Kanhasiya, Fanda, MP

- Electric liquid dosing pumps are similar to pumps used for a wide range of industrial purposes, ensuring a robust, diversified supply chain for device manufacturing and refills. We anticipate the private sector is already capable of meeting demand.
- **Benefits**
  - Low cost & well-established mass market
  - Ability to dose liquid sodium hypochlorite
  - Positive private sector response anticipated
- **Drawbacks**
  - Requires established sodium hypochlorite supply chain & electricity. Currently evaluating different supply chain methods
  - Most moving parts among the options, increased risk of breakage
  - Requires manual operation and installation challenges in metal piping

Technologies: Non-electric liquid chlorine dosing pumps share attributes of the other two groups of devices

HiSafe Chloritron device in Pachama, Nasrullaganj, MP

- Non-electric liquid chlorine dosing devices are electricity-free devices that leverage the force of the water to apply chlorine dosage
- **Benefits**
  - Fewer moving parts, reduced breakage risk
  - Easily controlled dosing & no electricity required
  - Potential compatibility with bleaching powder and water mixture
- **Drawbacks**
  - Requires established sodium hypochlorite supply chain. Currently evaluating different supply chain methods
  - Installation challenges in metal piping to avoid corrosion

Based on the pilot's success, we're preparing to scale up the program to 9,200 villages across the state

Year	Number of people reached	Number of villages
2024-2025	1,80,000	173
2025-2026	5,40,000	502
2026-2027	49,00,000	4,600
2027-2028	99,00,000	9,200
2028-2029	99,00,000	9,200

Note: Years are ending March 31

We estimate the program to reach 99 lakh people by 2028

- We estimate that, by 2028, we'll have a presence in a 19 districts, 37% of the total districts across the state
- The University of Chicago's Development Innovation Lab estimates that the program could save up to **19,500** U5 lives over the next 7 years
- This program will integrate well into existing governance structures and create jobs across the state

Based on pilot learnings, we plan to use tablet-based dosers but continue exploring other technologies

We learned a lot about technology over the course of the pilot…		…that have informed our recommendation to proceed with tablet-based dosers
Suitability of different technologies to different infrastructures: Dosing pump-based devices may not be the right fit for metal pipe-based schemes due to risk of corrosion	→	**Continue evaluating technology landscape:** Dosing pump-based devices shouldn't be used in systems with metal pipes, and we should continue evaluating other solutions that work
Need for simple, scalable solutions: Devices need to be cheap, reliable, and fit in a variety of different systems	→	**Recommend using tablet-based dosers:** Tablet-based dosers are the simplest and cheapest technology available and work at most waterpoints
Limited existing supply of tablet-based dosers: The tablet-based doser market is nascent though developing quickly	→	**Creating incentives to attract new vendors:** Tablet-based dosers are a simple technology that many manufacturers can produce. We're working to build the market to attract new entrants

Questions?

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Maharashtra

Name of the Officer: Mahesh Patil
Designation: Superintending Engineer, SWSM Maharashtra.

Water Quality Initiatives Overview

- Maharashtra has become a pioneer state in implementing uniform & advanced chlorination systems for providing safe water to the communities
- Electro Chlorination Plants is being implemented across 33000+ SVS

Unique Onsite Hypochlorite Generator

Works on the proven concept of “Electro Chlorination”

Safest method of chlorine generation

An Ideal solution for disinfection of water supply schemes

Simple & Proven technology for generating Chlorine

Based on principle of Electrolysis of brine (salt water)

NaCl — Converts ordinary salt into sodium hypo chlorite (Electro Hypo)

Applied on site, at the point of application

$NaCl + H_2O + energy \rightarrow NaOCl + H_2 \uparrow$
(Salt) (water) (Electro-Hypo)

- **Electro Hypo contains 0.7% to 1% chlorine**
- **Below 1% , hypo is a non-hazardous chemical**
- **pH < 7.5 - High Stability (30 days)**
- **High disinfection quotient**

Water Quality Initiatives Overview

Advantages of Electro Chlorination

Generation is as and when

No deterioration of chlorine during storage

No raw material needed other than salt

Compact & Fully Automated

Eliminates hazards of handling Gas Chlorine

Eliminates deterioration of chlorine occurring in Bleaching Powder & Hypo Chlorite

Not dependent of Suppliers of chemicals

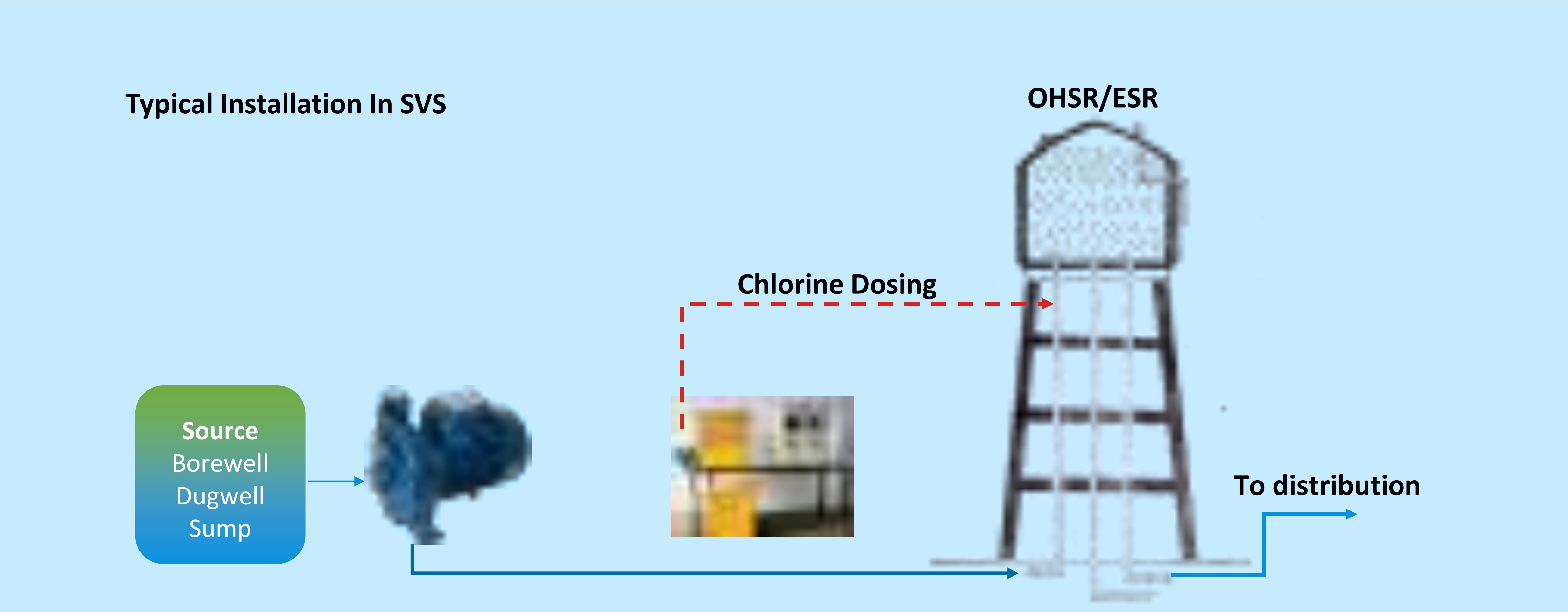
Eco Friendly Solution to water disinfection

Challenges Faced

Following challenges were being faced for chlorination in rural water supply schemes:

- Inconsistency in chlorination during supply of water
- Often reporting of Human errors in chlorination (No chlorination, very low or very high quantity usage).
- Ineffective dosing bleaching powder across villages
- Loss of chlorine strength during storage of bleaching powder, commercial hypochlorite solution
- Difficulty in dosing exact dosages
- Difficulty in adding chemical to ESRs
- Possibility of pandemic outbreaks during rainy season.

Innovative Solutions Implemented



- Chlorine dosing is given in inlet of ESR to provide sufficient contact time for effective chlorination
- Chlorine dosing system can be synchronized with the pump for auto dosing of chlorine

Innovative Solutions Implemented

EC project SOP Followed in Maharashtra

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
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Learning and Insights

- Specialized agencies appointed for disinfection work for installation & commissioning of EC plants across SVS
- Comprehensive Maintenance for 5 years is included in the scope of contract to ensure that systems runs smoothly for longer period.
- Monthly cost for consumables i.e. salt is ~₹150-200/month which can easily be borne by gram panchayat
- Training is being provided to all Jalsurakshaks to run the plants
- Third Party Inspection of commissioned units. Repository is being created for all documentation.
- Information board & flow chart installed in the switch room at all locations for easy understanding. Information booklet cum operations manual in local language (Marathi) is provided at each place.

Photos of the initiatives

Principal Secretary, WSSD along with CEO ZP reviewing the Electro-chlorination Systems

Photos of the initiatives

Future Perspectives

- The state is planning to adapt an innovative idea of real time E.coli. contamination detector system in future. Discussion about the same with global technical innovative solution companies is in progress.

- The state has taken all 34 district level water testing laboratories for biological NABL accreditation certification as per the NJJM guidelines.

Thank You

PRESENTATION ON EXPERIENCES WITH WATER DISINFECTION METHODS & CONTROLLING BACTERIAL CONTAMINATION

Name of the State: Mizoram
Name of the Officer: Elizabeth Chonghlut
Designation: Chemist

Water Quality Initiatives Overview

- **Water - a necessity for life, without it, no life would exist**.
- **Objectives of PHED, Mizoram -**
  - Facilitates all Urban & Rural population to have access to adequate safe drinking water and use appropriate sanitation facilities.
  - Ensuring all schools & anganwadis has functional toilets, urinals and access to safe drinking water.
  - Enabling rural communities to monitor and keep surveillance on their drinking water quality and managing sanitation.
  - Ensuring sustainability of drinking water sources and systems.

Water Quality Initiatives Overview

- Laboratories setup- 1 State, 8 Districts & 18 Sub-div Labs.
- All laboratories- well equipped with advance instruments and competent technicians to analyse specific or newly emerging water quality problems.
- Daily/Hourly monitoring of supplied water(incoming phases+reservoirs)-RC, Chemical & Bacteriological.
- Monitoring water quality-laboratory test, FTKs & sanitary survey.
- Monitor and ensure timely data updation on WQMIS.
- Regular quality testing-sources, households, schools & anganwadis.
- Closely monitor hotspots, field visits to quality-affected areas.
- Monitor any quality grievances, ensuring remedial actions are taken.

Challenges Faced

- Lack of publicity on accessibility of laboratories
- Lack of confidence in people to drink directly from tap
- Community unaware of quality importance & impact
- Lack of community ownership on water quality testing
- Lack of innovative technology to monitor quality of water supplied
- Limited grievance redressal measures
- Non-availability of water quality data in public domain
- Institutional and functional gaps

Innovative Solutions Implemented

- ❖IEC activities-Signboards, Media awareness programme
- ❖Chlorination and Re-chlorination at zonal/distribution tanky
- ❖Frequent cleaning of zonal/distribution tanky
- ❖Community awareness-water quality and associated health risks
- ❖Community engagement with honorarium-sample collection
- ❖Training-5 women in every village(FTKs, sanitary inspection,data uploading)
- ❖Customer care-grievance redressal
- ❖Daily water quality report-highlighted on media,##Citizens Corner##
- ❖Occasional Review Meeting-Institutional framework, Reporting system & its functionality.

WQMIS DATA as on 26/01/2024

- Total no. of Villages tested-604/633 (95.41%)
- Total no. of Sources tested-1576/1660 (94.93%)
- Total no. of Schools tested-1770/2327 (76.36%)
- Total no. of Anganwadis tested-1358/1545 (87.9%)
- Total no. of Villages(at least 3 HHs tested)-578/642 (90.03%)
- Total no. of Villages(women trained)- 560/642 (87.22%)
- Total no. of contaminated samples reported-2025
- Total no. of remedial action taken-1899 (92.45%)

Learnings and Insights

- ❖IEC activities-more customers and visitors frequent the lab for water quality testing.
- ❖Quality importance-FSSAI mandates water quality test report for licensing-food processing, packaged drinking water plant, hotels, restaurants, health centres.
- ❖Grievance redressal-lab team on rapid action-spot verification and action(disinfection)-epidemiological measures-mobile lab in process.
- ❖Community participation-benefits of active participatory seen in many villages.
- ❖Frequent disinfection of storage tankies led to 0.2ppm RC at consumer end.

FINANCIAL DETAILS OF CHLORINATION INITIATIVES

Sl. No.	Name of Chlorination	Capital Expenditure (onetime cost)		Operational Expenditure (Annual recurring cost)	
		Cost of Device	Installation cost (Materials, Plumbing, etc.)	Operations and Maintenance cost	Cost of Materials (Chlorine resupply)
1.	Electrochlorinator SEACLOR MAC 1000, 500, 300, 100, 50	11.97 to 47.84 lakhs	Included in SITC	1 – 1.5 lakh per unit	1 lakh (200 – 250 kg of Sodium Chloride required per unit per month)
2.	NADCC Tablet	-	-	-	500/Kg

Technical Details of Chlorination Initiatives

Sl.No.	Name of Chlorination Initiative	Total No. of Plants installed	Total No. of HHs served	Chlorine Consumption per month
1.	Electrochlorinator SEACLOR MAC 1000, 500, 300, 100, 50	45	60,000 in city, 6000 in District, 500 – 3000 in villages	51.1 Kg to 217 Kg depending on the capacity of Chlorine generated by each model
2.	NADCC Tablets (Sodium Dichloroisocyanurate) 7gm → 2000 – 2500L		642 Villages	200 – 500 tabs/villages

Photos of the initiatives

Photos of the initiatives





Thank You

PRESENTATION ON EXPERIENCES WITH WATER DISINFECTION METHODS & CONTROLLING BACTERIOLOGICAL CONTAMINATION

NAME OF THE STATE: **PUNJAB**

NAME OF THE OFFICER: **ER. RAJESH DUBEY**

DESIGNATION: **SUPERINTENDING ENGINEER, DWSS**

WATER QUALITY INITIATIVES OVERVIEW

Laboratory Network:

- Three tier network of NABL Accredited labs.
- Network includes 1 State, 6 Regional,17 district-level and 7 block-level Water Testing Laboratories.
- Two Mobile water testing labs.

Sophisticated Equipments:

- Inductively Coupled Plasma Mass Spectrophotometer (ICPMS) for heavy metals .
- Ion Chromatograph (IC) for cations and anions.

Process Efficiency:

- Use of a Laboratory Information Management System and QR codes.
- Structured Water Quality Monitoring Protocol.

WATER QUALITY INITIATIVES OVERVIEW

Robust Chlorination Systems

- Chlorination of water to mitigate the risk of biological contamination.
- 5172 more chlorinators are being installed on Water Supply Schemes by the Department, where chlorinators were not installed or were non functional. This will result into 100% chlorination of all water supply schemes.
- Hub and spoke model implemented with 14 Hypochlorite storage facilities jointly by the Department of Water Supply and Sanitation and Punjab Water Supply & Sewerage Board.

Benefits

- Catering both urban and rural areas.
- Easy Availability.
- Reliable quality.
- Cost effective.
- Monitoring of usage of disinfectant.

CHALLENGES

- **High Altitude Requirements:** Water supply schemes in certain regions, such as in Kandi area, operate at high heads, need a high head of dosing pump for effective chlorination. Conventional chlorinators are often designed for lower heads, necessitating manual chlorination.
- **Electricity Issues**: In Kandi area water is pumped and stored in UGSR's on the top of the hills, so as to supply water through gravity. In few cases electricity is not available so need manual chlorination.
- **Natural Calamities:** Water supply schemes face additional challenges during floods and natural calamities. These events disrupt the regular chlorination processes, leading to potential contamination risks and difficulties in ensuring water quality. In emergency situations, ensuring the continuous and effective chlorination of water supply becomes more complex. Rapid response and adaptability are crucial so far.
- **Community Awareness:** Most of the water supply schemes are managed by Gram Panchayats (GPs), which often lack knowledge about chlorination and this lack of awareness may result in improper water usage practices, diminishing the overall effectiveness of chlorination efforts.
- **Short lifespan of chlorinator:** The short lifespan of chlorinators leads to frequent breakdowns and malfunctions, causing interruptions in the chlorination process. Frequent breakdowns and the need for regular maintenance contribute to elevated operational costs.
- **Insufficient stock:** Insufficient stock of Sodium Hypochlorite during emergencies poses a serious risk, as the absence of this disinfectant could compromise water safety during critical situations.

INNOVATIVE SOLUTIONS IMPLEMENTED

- Established Decentralized Sodium Hypochlorite Storage Facilities:
  - Successfully implemented storage units in 14 districts across Punjab, ensuring a consistent and accessible supply of Sodium Hypochlorite to address the unavailability issue.
    - **7 No. Storage facilities by Department of Water Supply & Sanitation, Punjab.**
    - **7 No. Storage facilities by Punjab Water Supply & Sewerage Board.**
- Installation of chlorinators with (O&M) :
  - Department has proactively undertaken an initiative to install chlorinators with a dedicated 3-year Operation and Maintenance (O&M) period, strategically addressing the recurring breakdowns experienced with the current chlorination systems.
  - Department is overseeing the installation of **5172** additional chlorinators across multiple water supply schemes, each accompanied by a comprehensive **3-year O&M** commitment.
  - This strategic approach is designed to guarantee timely maintenance, fostering the uninterrupted and efficient provision of potable water to the villagers.
- IoT based Chlorination system for Real Time Monitoring:
  - Govt. of Punjab has initiated to take up Sensor Based Remote Measurement & Monitoring System using IoT Applications (SBMMS) in phased manner. In 1st phase, project to cover 346 multi-village water supply schemes has been proposed. This IoT (Internet on Things) system will enable the monitoring of Measurement of availability of Chlorine at tail end of each village, so that every household should get safe and quality water.

INNOVATIVE SOLUTIONS IMPLEMENTED

- Launched Training Manual:
  - Developed and launched training manual for operators in which the process of chlorination is included , ensuring widespread accessibility to comprehensive training for consistent knowledge transfer.
- Trainings:
  - Regular trainings and awareness are being given to the Social staff for improvement in water quality related issues, Disinfection methods & controlling bacterial contaminations through disinfection.
  - Daily monitoring on JJM portal is also being done regarding chemical as well as bacteriological contaminations and accordingly remedial measures has been taken.
  - Also under Nal Jal Mitras programme training are proposed to be given to all Pump Operators to strengthen their knowledge about the contamination and disinfection of the water supply schemes.
  - Implemented emergency reserves of Sodium Hypochlorite in key locations, enabling swift responses to unforeseen circumstances. Formed rapid deployment teams for efficient distribution during emergencies, ensuring a robust emergency management system.

These successful implementations showcase our commitment to overcoming challenges and ensuring a resilient and efficient water disinfection system throughout Punjab.

LEARNINGS AND INSIGHTS

- Strategic Transition from Gaseous Chlorine/ Bleaching Powder to Sodium Hypochlorite Solution:
  - Department has made a strategic decision to transition from using gaseous chlorine/ bleaching powder to liquid chlorine in the chlorination process for water supply schemes. The decision appears to be based on several factors, including the critical nature of handling gaseous chlorine and the associated risks, especially in rural water supply schemes.
  - The advantages of switching to liquid chlorine, specifically in the form of Sodium Hypochlorite solution, are highlighted. These advantages include the solution's effectiveness in water treatment, ready availability, and cost-effectiveness. Sodium Hypochlorite is a common disinfectant used for water treatment due to its ability to kill bacteria and other harmful microorganisms.
  - The decision to adopt Sodium Hypochlorite solution reflects a commitment to ensuring a safe and efficient water treatment process. It's important to note that the choice of water disinfection method depends on various factors, including the characteristics of the water source, infrastructure considerations, and safety concerns.
  - By making this switch, the Department aims to maintain water quality standards while addressing the challenges associated with handling gaseous chlorine, especially in rural settings. It also aligns with a trend in the water treatment industry where alternative disinfection methods are explored to enhance safety and operational efficiency.
  - Previously, the Department utilized the Silver Ionization method to disinfect the water supply schemes. However, due to cost considerations, the department decided to discontinue this practice.

LEARNINGS AND INSIGHTS

- Benefits of own Sodium Hypochlorite Facilities:
  - **Continuous Water Treatment Operations**
  - **Emergency Preparedness**
  - **Cost Savings Through Bulk Purchases**
  - **Flexibility in Procurement**
  - **Customization of Stock Levels**
  - **Reduced Dependence on External Suppliers**
  - **Improving conventional approach from bleaching powder to sodium hypochlorite**
  - **Availability in remote towns**
- Human Capital Investment:
  - **Formulated a training manual and conducted sessions, emphasizing the importance of investing in personnel to operate advanced systems effectively.**

LABORATORIES INFRASTRUCTURE AT A GLANCE

State-cum- Referral lab - Mohali

Regional Lab Amritsar

Inductively coupled Plasma Mass Spectrophotometer (ICP-MS)

Ion Chromatograph

LABORATORIES INFRASTRUCTURE AT A GLANCE

Modern Infrastructure in Labs (Regional Lab Mohali)

Regional Lab Moga

SODIUM HYPOCHLORITE FACILITIES & CHLORINATORS

Sodium Hypochlorite Centre, Patiala

Sodium Hypochlorite Centre, Amritsar

Sodium Hypochlorite Centre, Moga

Chlorinator

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Rajasthan

Name of the Officer: Mrs. Seema Gupta

Designation: Chief Chemist

Water Quality Initiatives Overview

- Rajasthan has become the Pioneer state in water quality monitoring alongwith one state Lab, 06 Regional Lab, 26 District Lab, one Mobile Lab & 20 Mobile Lab (out sourcing) in districts, Establishment of Block Level Labs is under process.
- In Water Quality checking after disinfection of drinking water, bacteria & micro-organism are destroyed thus providing safe drinking water to public keeping them away from water borne diseases.
- Chemical used for disinfection are called disinfectants. some of them are Bleaching Powder, Chlorine gas, Chlorine dioxide, UV Rays, Ozone, Potassium Permangnate etc.
- Mostly disinfection is done by chlorine gas & Bleaching Power.

Water Quality Initiatives Overview

- As per the status of water quality checking under JJM project in Rajasthan, 17677 villages in 33 districts of the state are quality affected. Out of which 4439 villages are affected by high fluoride, 946 villages are affected by high nitrate and 12291 villages are affected by high salinity. Remedial measures are taken by department.
- 1728 water samples found Bacteriologically contaminated in rural area of Rajasthan during the year 2023-24 (upto 22.01.2024). Remedial action of 98.3% water samples has been taken & for remaining under process.
- In 251 Urban Towns of Rajasthan chlorination is done by Chlorine dioxide, Bleaching Powder, Chlorine Gas & Electro-chlorinator. Water quality in most of the urban towns are satisfactory.

Challenges Faced

- It has been observed that chlorination is the best method, as residual chlorine can be measured at consumer water supply end.
- The main challenge is to maintain residual chlorine level up to the end point of each supply area's on the regular basis.
- Sustaining residual chlorine in the Clear Water Reservoir (CWR) is essential to ensure it reaches the intended endpoint.
- Due to intermittent water supply adopted, a loss of pressure in the water distribution systemleads to a fall in hydraulic integrity. Because of this contaminants can enter the water supply distribution network. **So the main challenge revolved around ensuring the continuous chlorination on a 24x7 basis.**
- A big challenge for laboratory is lack of permanent man power.

Challenges Faced

- The factors affecting effective disinfection are Time, Temperature, Concentration of disinfectant, Concentration of organism, nature of the disinfectants
- Desinfection of water necessitates individuals who are either dedicated or trained for the task.
- Each type of Raw water / Drinking water has different chlorine demand depends upon water quality.
- Proper chlorination must be used for desinfection which includes proper Does of required Chlorine Demand.

Innovative Solutions Implemented

- Continuous monitoring at the main pump house should conducted using geotagged photographs shared through a WhatsApp group.
- Installation of sensor based devices at service reservoirs to monitor pH, TDS, Turbidity, Residual Chlorine and Dissolved Oxygen (DO) Which can be accessible by mobile phones or at a centre point by computer.
- Installation of automated disinfectant dosing system at service reservoirs.
- Development of a transparent and responsive system with technological innovations such as sensor-based IoTs which provide automatic data on water supply quantity, quality and regularity. The data accessible to GPs /VWSCs, local community and PHED alike is to be used to address any grievances, monitor the water supply and test water regularly evaluate factors that can pose a health risk and thereby enable preventive / remedial action to ensure portability of water.

Innovative Solutions Implemented

- In rural area for chlorination by bleaching powder in overhead tank service reservoirs(SR), a simple method (jugad technology) was observed in which a plastic tub with a valve in a vertical pipe welded with the horizontal pipe line going toward SR. Chlorinated water is poured in the tub & a lid coveres the tub. Valve is so much open that dropwise chlorinated water goes in the drinking water going towards the SR. Thus in fields, helpers may use a simple method for chlorination of drinking water. Photo enclosed.

Photos of the initiatives

Jugad Technology for on line Chlorination by Bleaching Powder for overhead Tank.

Photos of the initiatives

Chlorination by Electrochlorinator

Residual Chlorine Checking by OT solution.

Photos of the initiatives

Chlorination by Chlorine Gas Cylinder at WTP Surajpura

Photos of the initiatives

Chlorination by Micro Slay

Learnings and Insights

- Automation and close monitoring system will be helpful in monitoring and controlling outbreaks.
- To strengthen water quality monitoring and surveillance with a road map and collective vision of improving public health.
- Water quality testing tools are to be used for deciding safety of drinking water: at the source; within a piped distribution system; or at the delivery point.
- Extention of water qualiyty monitoring activities up to Gram Panchayats (GPs) and Water and sanitation Committee (VWSC) involving Panchayati Raj Institutions (PRIs)/ community and empowering community on water quality monitoring and surveillance issues.

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Sikkim

Name of the Officer: Sanjiv Rai
Designation: PCE-cum-PD (JJM)

Water Quality Initiatives Overview

- State level laboratory and one district level laboratory has been set-up
- Field Water Testing Kit has been provide in every village
- District Planning Officer (DPO) has been trained to oversee the Water Quality aspect of their respective district
- Junior Engineers has been appointed for every Gram Panchayat
- Plumbers has been appointed and trained in every Gram Panchayat
- Village Water and Sanitation Committee (VWSC) has been formed and trained
- Women for WQM&S has been trained
- Distribution of Household water filter by state government

Challenges Faced

- Location of sources in difficult terrain makes it challenging for testing
- Open spring water sources makes it prone to contamination
- Bacteriological contamination of water sources

Innovative Solutions Implemented

- Regular testing of water at all levels
- Chlorination of drinking water
- Cleanliness drive
- Sensitization of stakeholders

TRAINING OF PLUMBERS ON WQM&S

TRAINING OF WOMEN ON WQM&S

TRAINING OF VWSC MEMBERS

SENSITIZATION OF STAKEHOLDERS

CHLORINATION

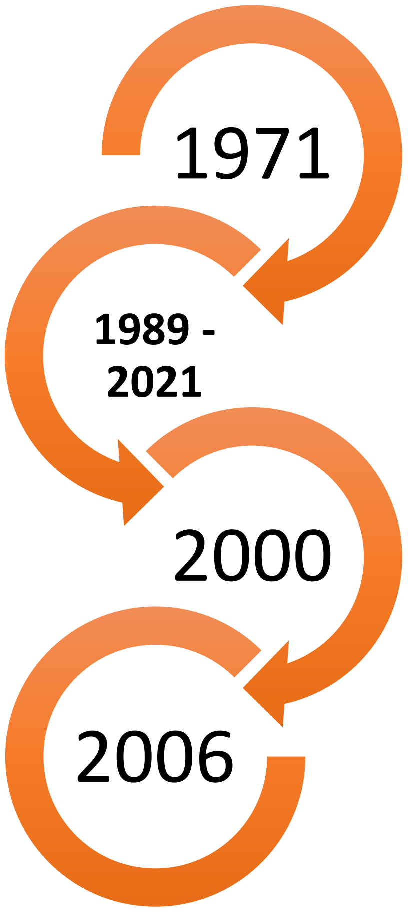
Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: Tamil Nadu

Name of the Officer: Er. P.Vasanthi
Designation : Joint Chief Engineer (PM)

Water Quality Initiatives Overview



- ✓ Water Quality Monitoring and Surveillance activities in Tamil Nadu was entrusted to Tamil Nadu Water Supply and Drainage Board (TWAD Board) during the year 1971 since its formation.
- ✓ Expansion of Labs from 1989 to 2021 : Network of 113 water quality testing laboratory services (1 State level, 31 District-level , 56 Sub District level and 25 Block level) throughout the State help to ensure water safety to the public.
- ✓ During the year 2000, about 36,000 samples were tested for bacteriological contamination in resurvey programme. Construction of platforms at hand pump sources to eradicate bacterial contamination of hand pump sources.
- ✓ During the year 2006, the Field Water Testing kit developed by the State lab is widely used nationwide at the community level, and help to promote awareness of water quality and health impact.

Water Quality Initiatives Overview

1. State Level Water Testing Laboratory (Chennai) – 1 No.

- ✓ **NABL Accredited since 20.10.2016** with the certificate No. NABL TC-No : 7779, complying with ISO/IEC 17025:2017 in conducting tests and measurements.
- ✓ Recognized as State Referral Institute (SRI) for Tamil Nadu by Government of India.
- ✓ Govern the activities of 31 District laboratories

2. District level laboratories - 31 nos

- ✓ All 31 District laboratories are NABL Accredited.

3. Sub District / Block level laboratories - 81 nos

- ✓ 61 Sub-District/Block level labs have NABL recognition .
- ✓ 20 Sub-District/Block level labs are under process for NABL recognition

Challenges Faced

Issues	Solutions
Disease out break @ Thiruvarur in 2019	• Check on source of contamination • Identified at pits were contaminated water seeped in to the pipeline joints • Faecal coliform colonies were found • Stopped the pumping immediately • Scoured the existing water in pipeline • Super chlorination (8 gm per 1000 litre of bleaching powder) • Retesting of bacteriological samples after chlorination to ensure potable supply.
Huge volume of sample testing : 7.74 lakh samples	• Deploying out sourcing staff with relevant qualification. • One week training for the outsourced staff with hands on experience before allocating to districts. • 24X7 testing timeline was scheduled (3 shifts) to test samples round the clock. • VWSC members / SHG women were trained to use FTKs and H2S Vials • All 12,525 Village panchayats are trained and provided with FTKs and H2S Vials

Innovative Solutions Implemented

Disinfection Techniques

Boiling

Ozone gas Treatment

Ultra Violet rays treatment

Chlorination
(Chlorine Gas / Bleaching powder)

Chlorination - Chlorine Gas Cylinder

Innovative Solutions Implemented

Predominantly used method in Tamil Nadu: Chlorination

Chlorine Gas

Used in Treatment Plants (Surface Water)

Liquid Chlorine stored in gas cylinders at (-)34.6 C

Dissolved in raw water as **pre - chlorination**

Dissolved in filtered water as **post - chlorination** at main sump

Bleaching powder

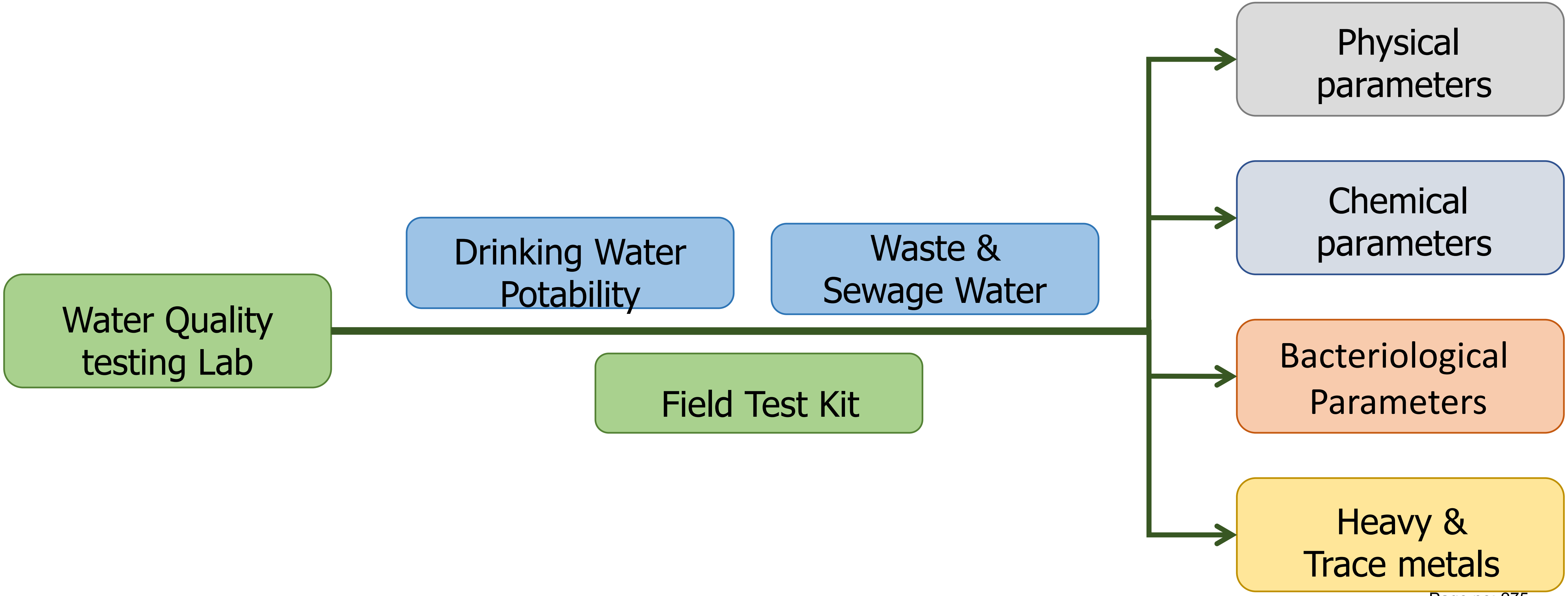
4 gm / 1000 litre
Bleaching powder dissolved locally / in - line chlorination

Bleaching powder mixture is let in to the Over head tank

0.2PPM /0.2mg per litre of residual chlorine at consumer point

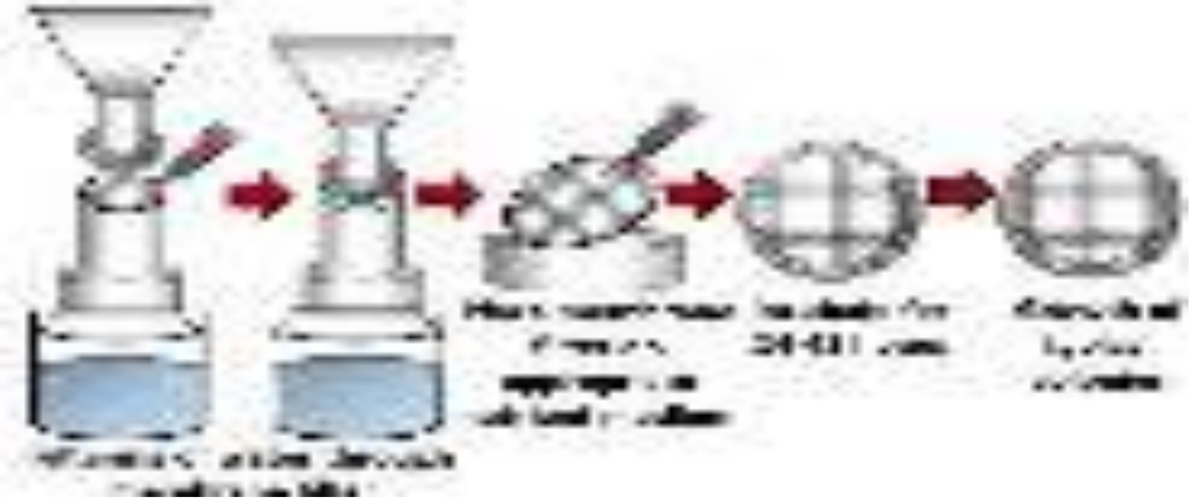
Learnings and Insights

What we do?



Learnings and Insights

Identification methods for Bacteriological Contamination



Membrane Filtration Method

- Standard Plate count
- Total Coliform
- Fecal Coliform
- Fecal Streptococci

BIS 10500 :2012

Shall not be detectable in any 100 ml sample

Photos of the initiatives

Issue

Bacteriological Contamination at water drawl points

Solution

Construction of cement platform at water drawl points to avoid seepage and stagnation of water which leads to bacteriological contamination

Before JJM

After JJM

Photos of the initiatives

Residual Chlorine Test

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

J. Madhu Babu
Chief Engineer, Mission Bhagiratha
Telangana

Water Quality Initiatives Overview

- In Telangana as on date 23,839 rural habitations are being covered with surface treated water except 136 remote/isolated habitations.
- Water is drawn from the Irrigation Reservoirs in Krishna Basin (14 sources) and in Godavari Basin (19 sources).
- 4100 MLD of water is processed in 123 rapid sand filtration units (WTPs) spread over in various places based sources and coverage area.
- All the raw water sources are regularly tested in the laboratories for chemical and biological contaminations required as per IS: 2296 standards.
- Raw water and processed water also tested as per IS:10500 standards at Laboratories located in the WTPs by the O&M Agencies on regular basis as per the frequency specified in the CPHEEO Manual for Water Supply.

Water Quality Initiatives Overview

- All the treatment plants are equipped with chlorination system for disinfection of raw & treated water majorly with gas chlorination system. It is ensured that the turbidity of treated water is below 1 NTU at WTPs.
- The treated water is conveyed through pipelines from WTPs to the service reservoirs located in the habitations on 24/7days basis.
- Gram Panchayat will test the residual chlorine in the incoming water and if necessary, extra bleaching powder is being added to get the minimum residual chlorine at household level as per standards.
- Total 76 WQMS laboratories are spread over in the entire state in addition to the laboratories located in WTPs. Each laboratory is collecting 3600 samples per year in the habitations, 3000 samples are tested for chemical contamination and 600 samples for bacteriological contamination. All the tested samples results are being uploaded in the WQMIS website.
- Also residual chlorine test is being conducted at household taps randomly by District/Sub- divisional laboratories.

Challenges Faced

- In krishna basin raw water turbidity is low however, at times,due to the algae formation in the reservoirs the water colour will be green and has odour. The treatment of such water is crucial in the normal processing WTPs.
- In Godavari Basin reservoirs the turbidity level during the monsoon is very high It will be ranged from 150 NTU to 3000 NTU. The process of reducing turbidity to less than 1 NTU is tedious.
- Training to the village level operation staff for adding of bleaching powder and usage of chloroscope for testing of residual chlorine and testing for bacteriological contamination with H_2S vials.
- Removing of pit taps and prevention of backflow of water to the distribution pipeline

Innovative Solutions Implemented

- Pre chlorination up to 5 PPM is done at WTPs to raw water before clariflocculation to reduce the bacteriological load, remove the colour caused due to the presence of algae and micro organisms in raw water. Post chlorination is done at 2 PPM.

- Earlier Ferric Alum was used, and it was not effective for high turbid raw waters. Now Poly Aluminum Chloride (PAC) is being used for high turbidity removal which is found effective.

- Extensive training and awareness camps were conducted at village level where training was imparted on how to add bleaching powder, conduct tests for presence of residual chlorine and usage of H_2S Vials.

Innovative Solutions Implemented

- To avoid backflow of water from household connection, Flow Control Valve is provided for each and every functional household tap connection.

- The FCV also controls the flow to 5 LPM so that all the households get water equally.

- FCV also stops water when try to draw using suction pumps

Technical Details of Chlorination Initiatives

S. No.	Name of Chlorination Initiative	Total no. of plants installed	Total no. of HHs served	Chlorine consumption per month
1	Vacuum feed Gas chlorination system	1 @ 10 MLD Plant	25000	2100 kg (Approx Rs 22000)
* All the newly constructed WTPs have gas chlorination system by default. The rate is included in the cost of WTP. Above sample calculation is for a 10 MLD WTP.				

Financial Details of Chlorination Initiatives

**All amounts are in Rs.*

S. No.	Name of Chlorination Initiative	Capital Expenditure (One time cost)		Operational Expenditure (Annual recurring cost)	
		Cost of device	Installation cost (materials, plumbing etc)	Operations and Maintenance cost	Cost of Materials (Chlorine resupply)
1	Vacuum feed Gas chlorination system	Rs 12,50,000	Rs 5,00,000	Rs 60000	270000
* Above sample calculation is for a 10 MLD WTP.. With other conventional methods of liquid chlorine or Bleaching powder, it costs about Rs 35 lakhs per annum					

Poly Aluminium Chloride

- PAC (Poly Aluminium Chloride) is a chemical compound used primarily in water treatment and purification processes. It is an inorganic polymer coagulant that is effective in removing suspended solids, organic matter, and other impurities from water. PAC is commonly used in water treatment applications due to its high coagulation and flocculation properties. PAC is available in liquid form also.

Specifications

PAC	
Chemical Formula	$Al_2Cl(OH)_5$
Appearance	white / light yellow (Powder and liquid forms)
Availability	25 kg bags
Manufacurer	Andhra Sugars Ltd, Kovvru, Andhra Pradesh
Cost (Delivery at site incl GST)	Rs 37,105 per MT

PAC Powder (as per IS 15573 : 2005)	
Bulk Density	Minimum of 0.65 gm/ml
pH of 5 % solution	2.5 to 4.5
Al_2O_3 percentage by mass	Minimum 28%
Chlorides (Cl) percentage by mass	Max 33%
Sulphate SO_4^- percentage by mass	Max 10 %
Insoluble matter percentage by mass	Max 1.5 %

Advantages of PAC

- PAC is less corrosive compared to traditional aluminum – based oagulants like aluminum sulfate (alum).
- It has a wider pH range for effective coagulation compared to alum.
- It produces less sludge compared to alum, which can result in lower disposal costs.
- It can be effective in treating a variety of water sources, including industrial wastewater, surface water, and ground water.

Dosage and Application

- PAC can be used as single coagulant or in combination with other coagulant
- The dosage of PAC varies based on water quality (which can be determined by using jar test), desired treatment goals, and the specific type of PAC being used.

Learnings and Insights

- It is observed during the last (4) years that the bacteriological contamination is minimal and there are no GE cases reported during monsoon periods.
- By fixing the Flow Control valves equal distribution was also possible to the households by controlling the flow.
- By using the PAC the turbidity and colour effect is reduced efficiently and the quantity of sludge generated is also reduced considerably.

Disinfection and Usage of PAC at WTPs

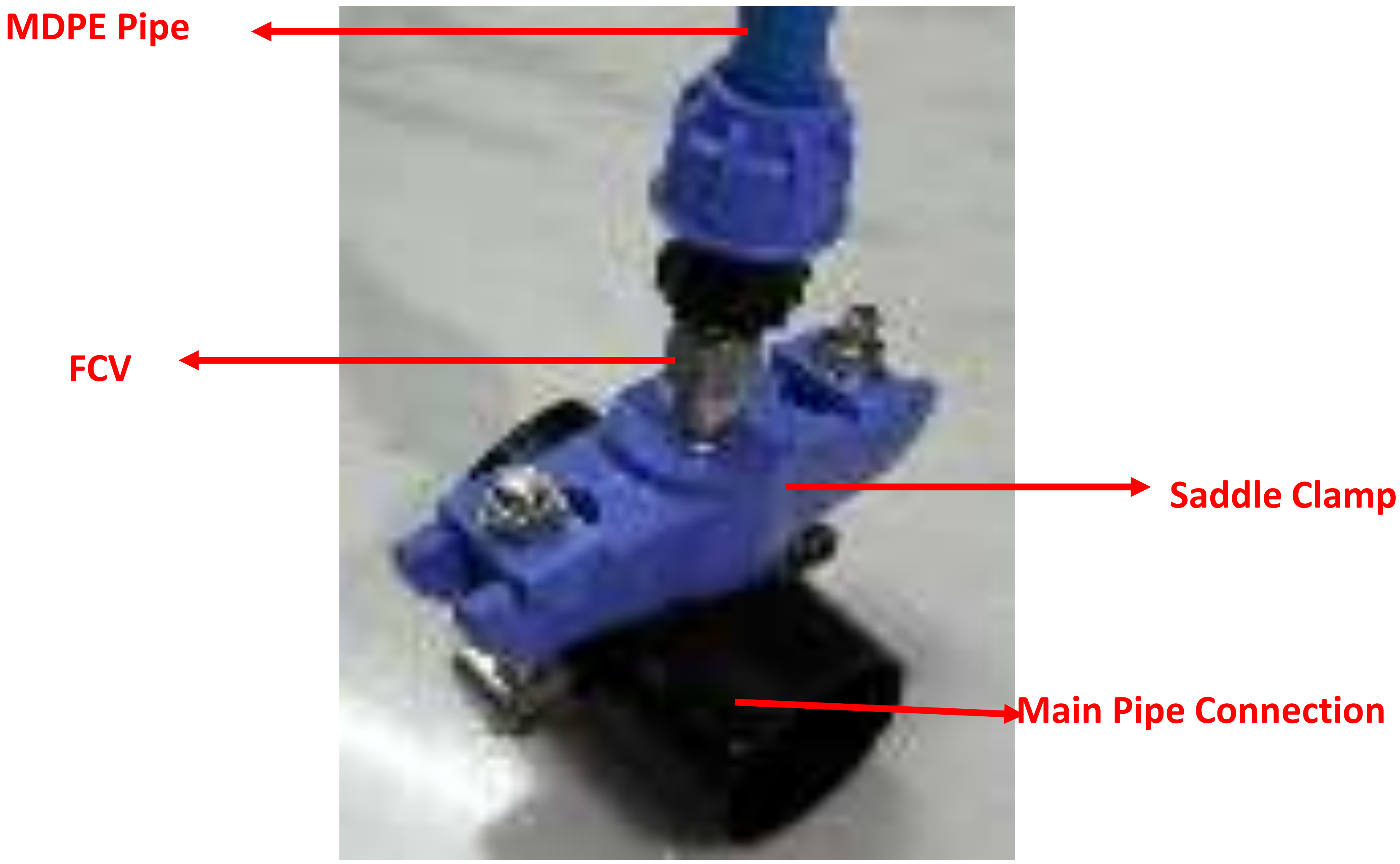
Gas Chlorination equipment at Raghavapur WTP

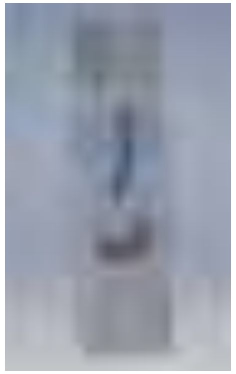
Clariflocculator at Thogudem WTP usage of PAC

Colour difference in flocculation zone/ Clarified Zone

Affect of PAC -Raw Water (3000NTU)and processing water (0.7 NTU)

Flow Control Valve Fixed for Household Connection





Flow Control Valve Usage Results

Water Reaching up to 1st Floor of the House

Measuring the Flow from Taps (5 LPM)

Thank You

Government of Tripura
PWD(DWS)

Presentation on experiences with water Disinfection methods & controlling bacterial contamination

Name of the State: Tripura

Name of the Officer: Er. Rajib Majumder
Designation: Addl. Chief Engineer & Director, WSSO

Water Quality Initiatives Overview

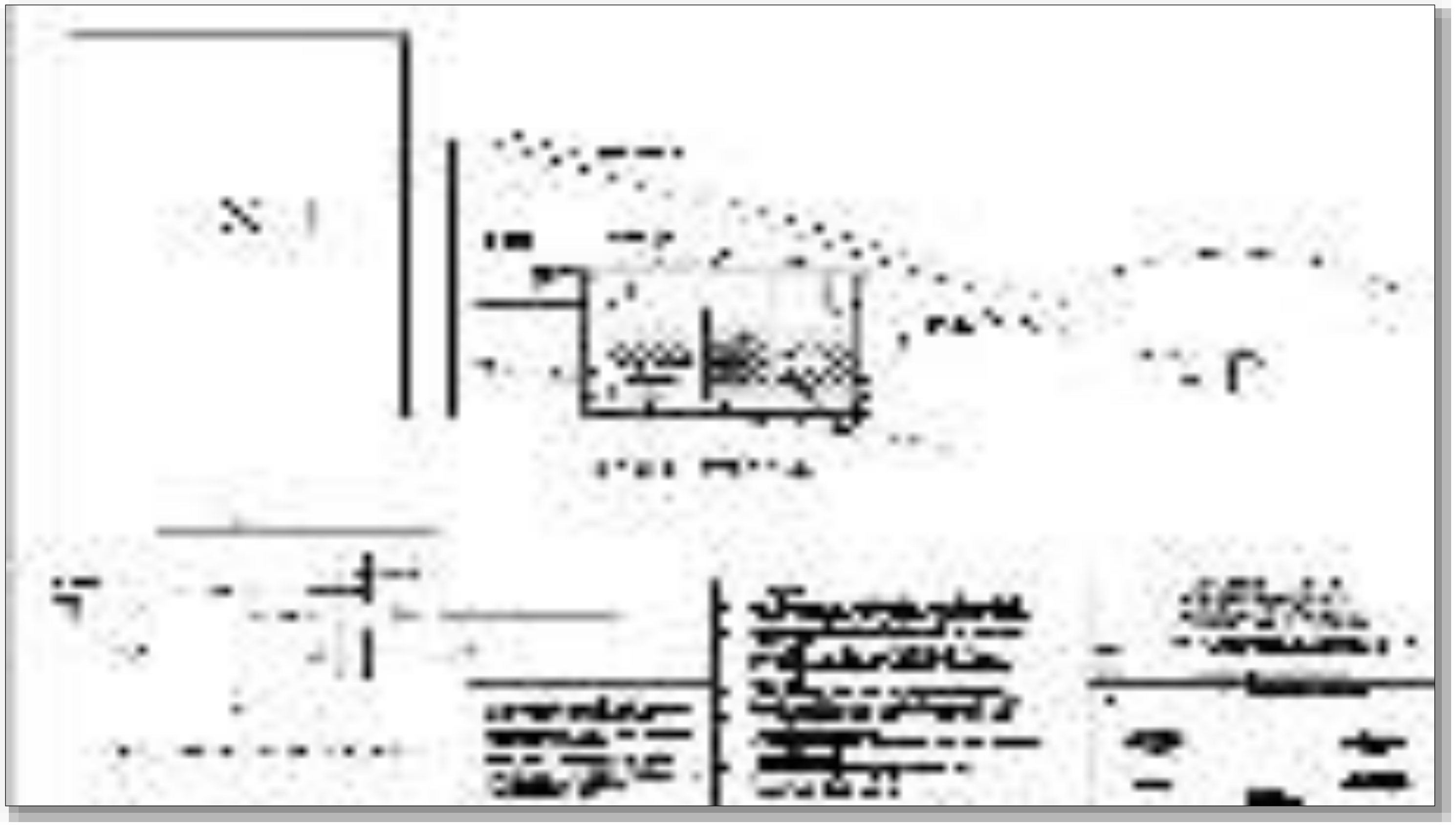
- ❑For drinking water, rural area in Tripura State is mostly dependent on underground water sources.
- ❑Underground water in the State does not contain any other impurities except high level of iron.
- ❑To overcome this problem, the department has adopted the following:
    - ❖Total 1033 Iron Removal Plants (IRP), 35 Ground Water Treatment Plants, 39 Surface Water Treatment Plants, 363 Water Supply Schemes based on Cherra / Spring Water have already been implemented.
    - ❖Presently, 272 habitations are quality affected due to presence of Iron. 72 IRP and 13 Surface Water based Piped water supply schemes are in progress to mitigate the excess iron.
- ❑At present, there are 21 water testing laboratories in the State for day-to-day testing of water samples
- ❑All the laboratories are NABL accredited.
- ❑5 (five) Women group identified and trained in each village for water quality testing by Field Test Kits.

Challenges Faced

- Proper maintenance of residual chlorine at 0.2 mg/L at the tail end of distribution pipelines.
- Low incentive for testing through FTK by 5 Women groups.
- Changes of trained women group, results in loss of trained manpower.
- Overloading of work on departmental officials often delay taking remedial actions on time.

Innovative Solutions Implemented

Gravity Continuous Chlorine Dosing



- Chlorine dosing done continuously through gravity.
- Water for chlorine doser collected from the outlet of the Slow Sand Filter
- Bleaching Powder is used as source of chlorine
- Chlorination is done at the Clear water Reservoir continuously
- Dosing is controlled at the inlet point by control valve.

Innovative Solutions Implemented

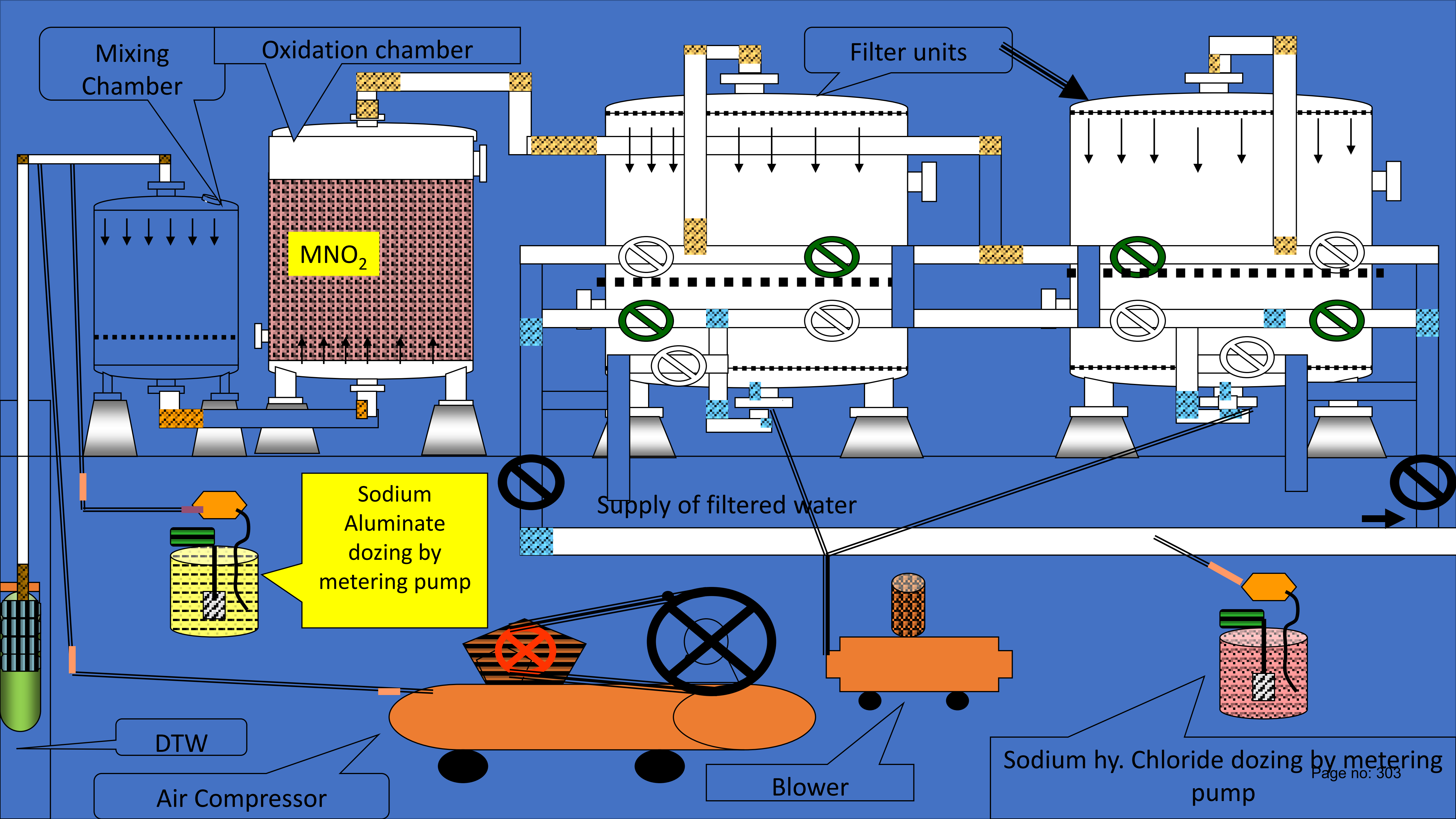
Disinfection by Sodium Hypochlorite solution

[illegible]

Learnings and Insights

- IOT may be installed in all piped water supply schemes for proper monitoring & controlling of minimum residual chlorine in the tail end of distribution system.

- NABL accreditation of water testing laboratories has improved the evaluation of water quality testing, detection and subsequent mitigation for bacteriological contamination through disinfection.


Mixing Chamber
Oxidation chamber
Filter units
MNO_2
Sodium Aluminate dozing by metering pump
Supply of filtered water
DTW
Air Compressor
Blower
Sodium hy. Chloride dozing by metering pump

Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

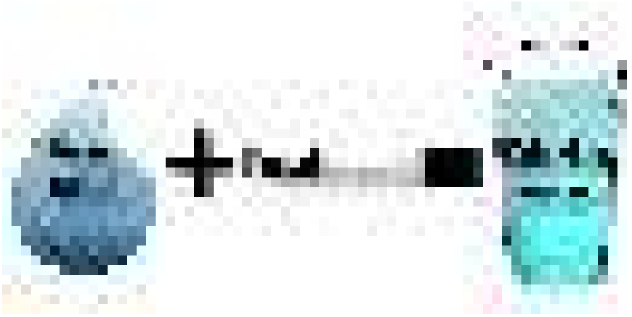
Name of the State: Uttar Pradesh
Name of the Officer: Reetika Rai
Designation: Executive Engineer, State Water and Sanitation Mission, Lucknow, Uttar Pradesh

Water Quality Initiatives Overview

The goal of disinfection of public water supplies is the **elimination of the pathogens** that are responsible for waterborne diseases. The transmission of diseases can be controlled with treatments that substantially reduce the total number of viable microorganisms in the water.

While the concentration of organisms in drinking water after effective disinfection may be exceedingly small, sterilization is not attempted. **Sterilization is not only impractical, it can not be maintained in the distribution system**.

Chlorination is the most widely used method for disinfecting water supplies in the India. The near universal adoption of this method can be attributed to its convenience and to its highly satisfactory performance as a disinfectant, which has been established by decades of use.



Water Quality Overview

DISINFECTION

- Disinfection is the process of killing pathogenic microorganisms and making water potable (safe to drink), usually with the use of chemicals. Water disinfection is needed to prevent the spread of waterborne diseases.

- The exact concentration of disinfectant chemicals used to treat water depends on several factors, including the type of microorganisms present, the quality of the water, and the type of disinfectant used.

- Types of Disinfectants :

Chlorine Gas (Cl2) - Chlorine is one of the most widely used disinfectants. It is very applicable and very effective for the deactivation of pathogenic microorganisms.

Sodium Hypochlorite (NaOCl) - Sodium hypochlorite is used as a bleaching agent and as a disinfectant in solution. The solution generally contains 10–15% of the available chlorine, but rapidly loses its force in storing process.

Electro-Chlorination - Electrochlorination is the process of applying an electrical current to salt water to produce dilute sodium hypochlorite (bleach) and hydrogen gas. The resultant sodium hypochlorite solution contains between 0.7%-1% chlorine. This low concentration is considered non-hazardous to humans yet still destroys viruses, bacteria, and other harmful microorganisms present in the water, making it safe to drink and preventing the spread of diseases.

Water Quality Initiatives Overview

- **Pre-Chlorination** (to control and prevent the growth of Algae & bacterial growth) is being done from the start of treatment process.
- **Chlorine di-oxide(ClO_2)** is introduced instead of gaseous chlorine for pre-chlorination in surface water scheme.
- The usage of raw unblended high strength bleaching powder and calcium hypochlorite is discontinued instead Sodium Hypochlorite is being used.
- NABL accredited **Water quality testing labs** established at districts.
- Water Quality are being checked as per IS 10500 and testing being done as per IS 1622 periodically.
- Distribution of **Field Test Kit(FTKit) by Jal Nigam** and **training** conducted by agency to local village women's(5 nos.) under **Training agency.** Test are being done periodically, and results are uploaded on JJM portal and ejalshakti portal subsequently.
- **Post Chlorination** (to maintain the required amount of residual chlorine) in transmission and distribution network by gaseous & Sodium Hypochlorite in Surface water scheme.

Challenges Faced

- Authenticity of Field test Kit results done by local women.
- Analysis of Lab test results verses Field test Kit results.
- Continuous monitoring & maintenance of minimum residual chlorine at farthest point in distribution system.
- Calibration of Field test Kit.

Innovative Solutions Implemented

- Pre-Chlorination system in WTP upgraded to Chlorine Di-oxide instead of gaseous chlorine.
- System configuration by carefully designed the networks with minimum dead-end mains, optimum size of pipelines, reservoirs and installation of appropriate scour valves. Which reduces the formation of bio films and sediments in piping, which can harbor micro-organisms that consume disinfectants.
- Automatic Chlorination system
- Silver Ionization system

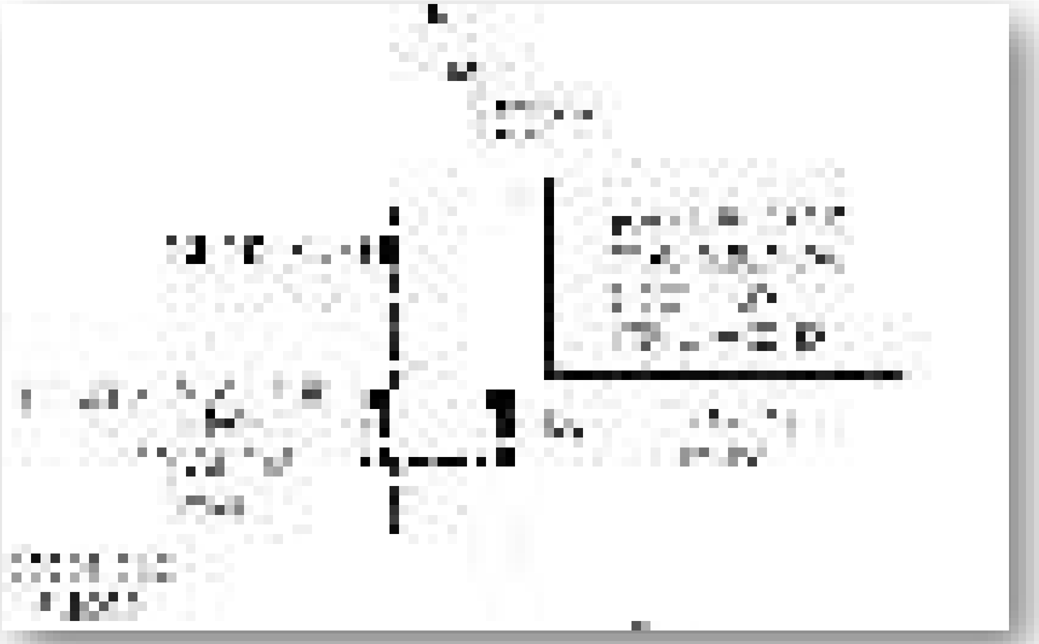
Proposed Innovative Solutions in future

- Sustainable monitoring and compliance mechanism of acceptable residual chlorine concentration upto the consumer end by the following innovative proposals:
  - Assessment of water aging and disinfectant decay along the network using calibrated hydraulic model.
  - Identification of the location for spot flushing, In-line chlorination and the Chlorine sensors.
  - Further proposal of field study about enhancement of monitoring the DBP (Disinfectant Bi products) along the network which is carcinogenic in nature.
  - Automation of the process.

Learnings and Insights

- Use of **Chlorine di-oxide(ClO_2)** to improve the efficiency of pre-chlorination in WTP, which also improves efficiency of coagulation.
- Importance of proper monitoring and controlling of minimum chlorine residual in the distribution system and Re-chlorination arrangement at specific locations.

Photos of the initiatives



Pre-Chlorination by ClO2 (Chlorine Di Oxide) generator in WTP.

Photos of the initiatives

Distribution of FT Kit

Photos of the initiatives

Chlorine Generation & Dozing unit






Thank You

Presentation on experiences with water disinfection methods & controlling bacterial contamination

Name of the State: West Bengal

Name of the Officer: Er. N Sanjeev Kumar
Designation: Superintending Engineer, Planning Circle-I, PHE Dte, GoWB

Water Quality Initiatives Overview

As mid-term mitigation measure for Arsenic & Fluoride contamination, the Department has adopted the following:

- A total of 143 numbers of Arsenic & Iron Removal Plants (AIRP) have been installed in Nadia (73), Murshidabad (31), North 24 Parganas (28) and Malda (11) district.
- In addition, 1392 nos. of Community Water Purification Plants (CWPPs) have been installed in water arsenic and fluoride affected areas of Bankura (19), Birbhum (10), Uttar Dinajpur (77), Malda (315), Murshidabad (397), Nadia (451), North 24 Parganas (118) and Purulia (5).
- Again, 205 nos. of Water ATMs have been installed in schools situated in arsenic affected areas of North 24 Parganas district to serve arsenic safe water to children.

Water Quality Initiatives Overview

- The Department is under the process of covering all water quality affected areas in the state with Piped Water Supply (PWS) as permanent solution to mitigate arsenic and fluoride contamination of ground water by the end of the this year.
- Groundwater based supply schemes attached with AIRPs and CWPPs are being implemented to supply safe drinking water to the community.
- Treated surface water, wherever possible, are being supplied to rural communities residing at quality affected areas of the State.
- Safe piped water are being supplied to each rural household through tap connection.
- Piped water is being chlorinated at the head works site prior to supply.
- Nearest and Farthest Standpost/FHTCs are regularly tested by rural drinking water testing laboratories and Field test kits to ensure supply of potable water.

Challenges Faced

- Chlorination Challenges:
  - The determination of dosage by Junior Engineers has proven challenging, primarily due to adverse feedback from the rural community, particularly households in close proximity to the headwork site. Complaints about the smell of free residual chlorine, even when within permissible limits, have posed a significant obstacle.

Innovative Solutions Implemented

- **Non-Electrical Continuous Chlorinator (Chloritron):**
  - **Brief Description of technology**:
    - Chloritron is installed in various piped water supply schemes for sustained chlorination and re-chlorination to achieve optimal water disinfection..
  - **Technological Advantages**:
    - **Universal Size**: It effortlessly operates under high-pressure conditions, reaching heads of 120-150 meters or more, and demonstrates successful functionality even at 10 kg/cm2 pressure.
    - **Non-Electrical Operation**: Distinguished by a unique intelligent dosing mechanism utilizing the flow of water and meticulously controlled mechanical valves, the system achieves desired chlorine levels in water without any reliance on electricity.
    - **Cost-Effective Manpower and Maintenance**: The system requires only unskilled manpower for the simple task of pouring chlorine solution, leading to substantial cost savings. Additionally, minimal maintenance is needed
    - **Zero Chlorine Wastage**: Activation of the system coincides with the initiation of water flow from the pump, and it ceases operation when water flow discontinues. This design ensures zero wastage of chlorine and eliminates the risk of overdosing.
  - **Installation:** Chloritron installations have been successfully implemented in the piped water supply schemes across multiple districts, including 2 sites in **Nadia**, 2 sites in **North 24 PGS** and 2 sites in **Kalimpong** as an intermediate chlorination to ensure requisite amount of Free Residual Chlorine at consumer end.

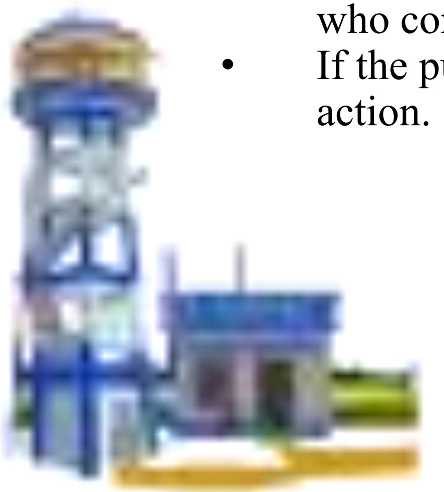
Innovative Solutions Implemented

- **Silver Ionization Water Disinfection System:**
  - **Brief Description of technology**:
    - This electrostatic difference results in an attractive force between the generated silver ions and microorganisms.
    - It plays a crucial role in killing microorganisms by disabling the enzymes vital to their respiratory processes, ultimately leading to their demise.
    - This technology can be installed in schemes having $3m^3$/hr to $800m^3$/hr flow rate.
  - **Unique Features**:
    - Operator not required and No human interference on regular basis.
    - CSIR-NEERI, Nagpur appraised.
    - 6-log reduction of bacteria.
    - Residual effect of silver for more than 48 hours as appraised by NEERI.
    - Can work the same in extreme weather conditions in both summer and winter by busing constant current technology as appraised by NEERI.
    - Instant checking of residual silver using field test kit.
    - Very low power consumption and very well suited for solar pump applications.
    - No smell
    - No change in taste
    - Dosage well within WHO,EPA and BIS limits
    - No corrosion in pumps, pipes and starters, hence longer life
    - Cheap running cost
    - Instant dosage checks using field test kits
    - No movable and wearable part only consumable electrode.

  - **Installation**: Disinfections through Silver Ionization System have been successfully implemented in a Chilkigarh Water Supply Scheme of Jhargram District.

Innovative Solutions Implemented

- **ChlorStock Mobile Application:**
  - **Brief Description of technology**:
    - ChlorStock was developed with a precise objective to assist field engineers in determining the optimal disinfectant dosage for the effective implementation of chlorination in pump houses.
    - It serves as a monitoring tool, enabling engineers to track and manage the daily addition of disinfectant in pump houses.
  - **Unique Features**:
    - It helps to manage disinfectant stock within pump houses, ensuring adequate supplies for the chlorination process.
    - The application supports field engineers by instantly calculating the "volume of disinfectant required" and “Chlorine Dose Rate” upon entry of pre-requisites such as Chlorine demand, Available Chlorine content of the disinfectant, Supply Hours, and pump capacity etc.
    - Once the dosage is determined by the engineer in charge, it is displayed in the panel of pump operators, who confirm the daily addition of the fixed dosage.
    - If the pump operator fails to add chlorine, automatic alerts are sent to the engineer in charge for quick action.



Innovative Solutions Implemented

- **IoT based Monitoring of WQ:**

  - **Features:**

    - A sensor-based Digital Water Supply Monitoring System (DWSMS) using IoT (Internet of Things) has been piloted to monitor critical service delivery parameters (water pressure, residual chlorine, TDS, turbidity, pH and Iron) of drinking water supply at source and consumer end.
    - The sensor is installed in pump houses of Joypur Piped Water Supply Scheme, Amta II, Howrah. Ongoing installations are underway in the Humaipur Piped Water Supply Scheme in Barasat II, North 24 Pgs
    - The WQ data reflected for necessary action.

- **Two Tank Chlorination:**
  - **Features:**
    - Multiple districts in West Bengal have implemented a two-tank chlorination mechanism to enhance the effectiveness of chlorination. This approach ensures the proper mixing of disinfectant in the chlorination tank, contributing to more efficient and reliable water disinfection processes.

Learnings and Insights

- Disinfection of piped water supply by silver-ionization method has been found to be more user friendly than chlorination.
- Disinfection of water by silver-ionization method do not have any residual effect that can be measured on the spot, resulting one has to undertake bacteriological analysis of supplied water to assume it safe.
- Additionally, excess total hardness, chloride, turbidity, TDS may have interference in disinfection process.

Photos of the initiatives

Chloritron

Photos of the initiatives

Silver Ion Technology

Thank You