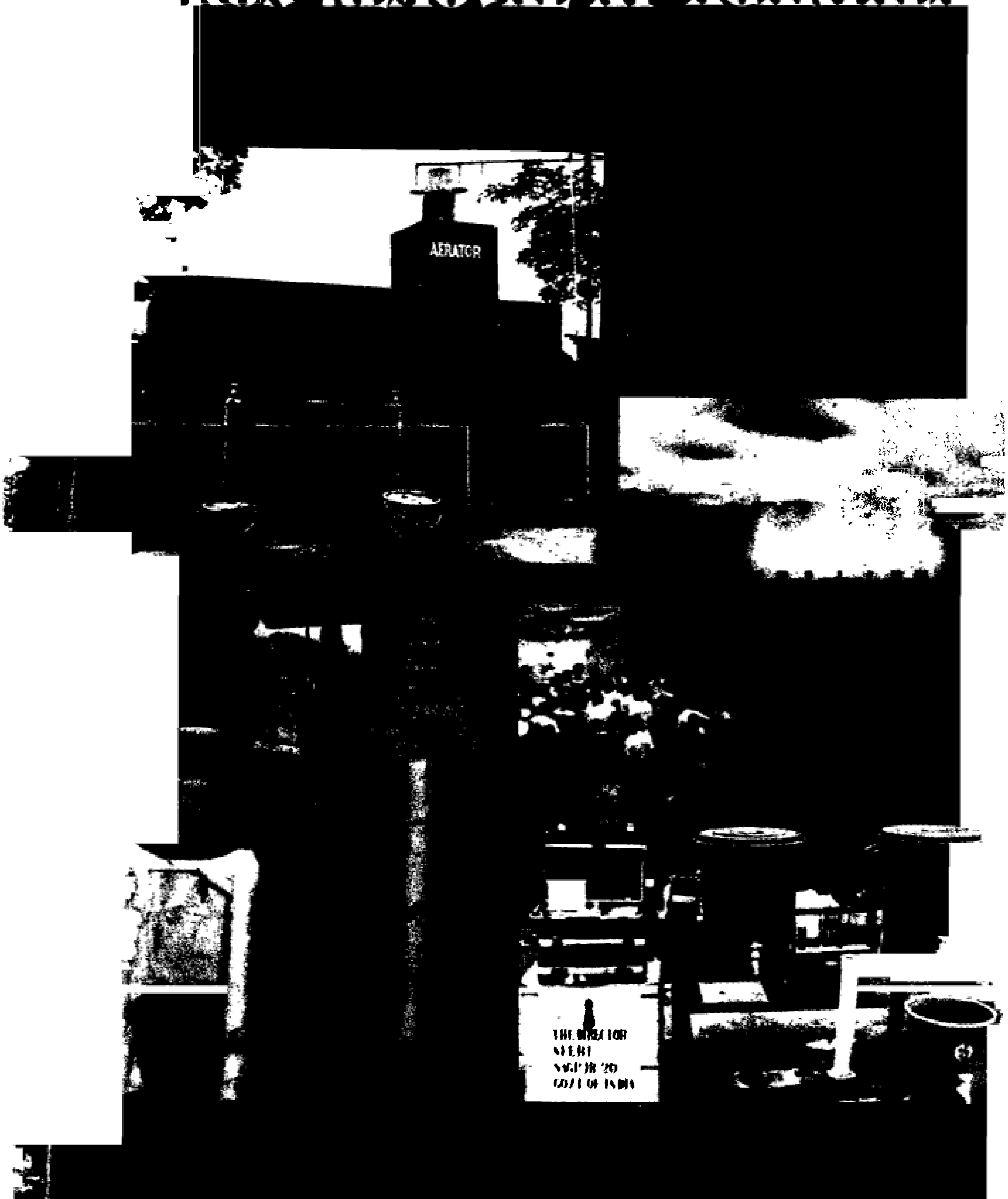
IONAL TRAINING CAMP ON
IRON REMOVAL AT AGARTALA



TECHNOLOGY MISSION ON DRINKING WATER
IN VILLAGES AND RELATED WATER MANAGEMENT

National Camp on Iron Removal at Agartala

REPORT

July 14-18, 1987

NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE
NEHRU MARG, NAGPUR-440 020

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INTRODUCTION

National Environmental Engineering Research Institute (NEERI) under the Council of Scientific & Industrial Research has been identified to impart training for 'Technology Mission on Drinking Water in Villages and Related Water Management' so as to improve performance and cost effectiveness of the on-going programmes in the field of rural drinking water supply so as to ensure the availability of an adequate quantity of drinking water of acceptable quality and to ensure sustained availability of such water on a long term basis. The technologies entrusted to NEERI in recognition of its vast R & D experience include iron removal, defluoridation, slow-sand filtration, disinfection and surface water treatment. The training of involved personnel and demonstration of these technologies have been considered as an essential part of technology transfer.

Iron is present in practically all soils, gravels, sands and rocks, sometimes in considerable amounts, usually in the form of oxides. Rain in percolating through such geological formations acquires iron in addition to other mineral constituents. Iron in surface waters is mostly in insoluble or colloidal form. In ground sources, it is in dissoloved state and exposure to atmosphere results in oxidation of soluble to insoluble or colloidal forms.

States of Assam, Meghalaya, Tripura, West Bengal, Orissa, Bihar, Uttar Pradesh, Maharastra, Madhya Pradesh, Kerala and Tamilnadu have been found to have ground waters bearing iron in varying concentrations requiring appropriate treatment to make them potable. There are an estimated 2900 villages in India, which have a problem of excessive iron. Various practice of iron removal are inter-related and hence must be coordinated in the process concept and in the design.

The Chief Engineer, Irrigation and Flood Control & Public Health Engineering Department (IFC & PHED) Agartala Government of Tripura, readily showed willingness to hold training Camp at Agartala and share its rich experiences on iron removal with other States with iron problem. The State has done considerable work on iron removal and many plants are in operation in Tripura. Hence, NEERI decided Agartala, the capital of Tripura as the venue of the first "National Iron Removal Camp" under the joint auspice of NEERI (CSIR) and IFC & PHED (Government of Tripura).

OBJECTIVES

Iron removal technology is well established and understood. It is known that iron in drinking water is not desired since it causes aesthetic problems besides being responsible for reducing the carrying capacities of the pipes. NEERI made a policy that when its technologies are demonstrated, a special congregation of concerned water supply engineers and the representatives of the rural community are ensured for proper exchange of information at various levels. The other major objectives of the training camp are:

i) To appraise the procedures for sample collection and analysis techniques and their limitations.

ii) How to conduct a few spot tests to identify the nature of dissolved iron species with the assistance of NEERI Kit.

iii) To arrive at an appropriate treatment methodolgy for the specific iron removal problem by on the spot field tests and treatability studies.

iv) To familiarise the all India participants with the various designs available with NEERI on iron removal and to inform them the means to arrive at an optimum system for iron removal for a particular situation.

v) To instal demonstration iron removal plants and to make the participants study their performance, so that such plants in turn may be duplicated by the participants in their respective iron problem areas.

vi) To gather case-studies from the participants and discuss with them pros and cons of different solutions.

Hon'ble Shri Nripen Chakrabarty, Chief Minister, Tripura inaugurating the National Camp on Iron Removal, July 14, 1987

Shri K. R Bulusu, Coordinator, Water Technology Mission in discussion with Hon'ble Shri Nripen Chakrabarty, Chief Minister, Tripura and Hon'ble Shri Baidynath Majumder, Minister for P W D , Power & Transport, Tripura

vii) To assess water quality on the spot of all the potential sources to supplement such information available with the State.

viii) To create awareness among the public and to ensure their participation in iron removal.

VENUE OF THE CAMP - Agartala

One important aspect of iron removal studies is that iron bearing waters are difficult to be prepared in the laboratory and it is imperative that iron removal field camps are held at a place where the ground waters naturally contain iron in solution causing problems to the public and the engineers as well. Agaratala is typically suited for the camp in view of the abundance of ground water with excessive quantities of dissolved iron.

Agartala : The municipal boundries of the city with ten wards cover an area of 16.01 sq.km. and population of 1,31,513 (1981 census). The average rainfall is 2024 mm with an annual rate of evaporation between 62 and 184 mm. The maximum and minimum temperature on an average is 37.6 and 4.2^{o}C respectively. Within the municipal area there is no big industry and outside are mostly agricultural and forest land with scattered but growing urbanised pockets. The ward-wise population of the city is shown in Table 1.

Agartala is divided into service districts for the convenience of water distribution. Zone I comprises Ward No.10; Zone II, Barjala south, Barjala east, Bhatti Abhoynagar, Kunjanban, Nandan nagar, Indra nagar, Chandranagar and Assam Rifles ground; Zone III, Wards from 1 to 7, parts of Wards 8 and 9 and Rajnagar; Zone IV, part of Ward No.8; Zone V Pratapgarh, Anandnagar, Dukli, Amtala, Madhya Badhaghat, Dakshin Badhaghat and Bhattapukur. Zone VI, the entire south-east district and Moufas of Jogeneranagar and Aralia. The projected population of these six service district zones in the year 2011 is 58146, 52448, 147543, 21452, 57975 and 14425 respectively.

TABLE - 1 : Ward wise population

Ward No.	Area in Sq.km.	Population (1981 census)
1.	1.475	14079
2.	0.967	11345
3.	0.780	6514
4.	0.713	6023
5.	1.283	9632
6.	2.203	21882
7.	1.783	10012
8.	2.418	25586
9.	0.967	5879
10.	3.422	20561
	16.011	131513
Other moufas	18.980	57552
TOTAL	34.991	189065

Water Supply to Agartala : The entire municipal district of Agartala receives potable water from two major sources: one from the 6800 m^3 municipal water treatment plant and the other by tapping ground water at a number of locations River Haora is the source of raw water to the 6800 m^3 plant. The river system with its tributaries is entirely rain fed from a catchment area of 477 km^2. The maximum carrying capacity of the river is 170 cusecs.

Muncipal Water Treatment : This comprises aeration, coagulation, flocculation, sedimentation, filtration, disinfection, storage and distribution.

Groundwater Treatment : The ground water with excessive iron is aerated, trickled over locally made charcoal, settled, disinfected and injected into the transmission mains.

Transmission Mains : The·main provides a linkage of the municipal water treatment plant with the overhead reservoirs located at Sizher Vihar and Gandhi School. Each headworks of groundwater source is provided with transmission main to connect to the main distribution system or directly to the overhead reservoirs.

PREPARATIONS OF THE CAMP

A preliminary visit by NEERI Scientists to Agartala on June 10, 1987 was made to plan the Camp particulars with IFC & PHED. Ravindra Bhawan and G.B. Hospital sites were selected to instal the iron removal plants based on NEERI technologies. The plants were fabricated at Agartala and installed under the supervision of NEERI and IFC & PHED engineers. The details of the inauguration, faculty and other inputs were finalised during the initial meeting. All the Camp Training material, demonstration plants, instruments, glassware and chemicals were airlifted by NEERI from Nagpur. The IFC & PHED modernised its laboratory at Agartala to meet with the Camp requirements. The progress of the installation of the NEERI technologies at Agartala was monitored by visiting engineers from NEERI and IFC & PHED so that they stand completed on time for Camp. An advance team of NEERI comprising six scientists reached Agartala on July 10, 1987 for (i) installation of portable demonstration units earlier airlifted from Nagpur, viz. muscle-powered dissolved air floatation units, hand-pump attachable aeration-filtration unit; and domestic chemical treatment unit; (ii) establishment of field water analysis laboratory; (iii) water quality assessment of North Tripura Districts and Agartala city; (iv) calibration of field equipment; and (v) evaluation of full-scale demonstration plants at Ravindra Bhawan and G.B. Hospital prior to the commencement of the Camp.

Participants : NEERI made consultations with CSIR, TM Directorate and CAPART regarding the participants. Requests were sent well in advance in June, 1987 to Chief Engineers and Secretaries of various States and CAPART to depute participants to the first National Iron Removal Camp.

All Camp details with programme particulars were made available to facilitate decision and early communication to IFC & PHED. The CSIR was also requested to depute persons from the various CSIR Polytechnology Clinics. In response to the joint action of NEERI and IFC & PHED, forty participants from Andhra Pradesh, Arunachal Pradesh, Karnataka, Kerala, Manipur, Madhya Pradesh, Sikkim, Mizoram, Tripura, Uttar Pradesh and West Bengal participated in the training programme.

Faculty : The faculty mainly comprised scientists and engineers from NEERI. Apart from classroom lectures, design exercises and practical laboratory work, the faculty accompanied the participants to various demonstration sites in Agartala and also to Udaipur in South Tripura district for plants evaluation and spot water quality checking of the ground water sources. The case studies presented by participants were discussed and evaluated critically by faculty.

CAMP PROGRAMME

Inauguration : The inaugural function was held on July 14, 1987 in the Rabindra Bhawan Auditorium of Agartala. Shri Nripen Chakrabarty, Hon'ble Chief Minister, Tripura inaugurated the function and Shri Baidyanath Majumder, Hon'ble Minister, Public Works Department, Power and Transport presided over the function.

Shri K.R. Bulusu, Deputy Director, NEERI and Coordinator, Water Technology Mission, gave the welcome address and later on presented an overview of Water Technology Mission. Shri D.C. Debnath, Chief Engineer, IFC & PHED, informed that Tripura has acute problem of excessive iron in water. He also informed that his department has made a beginning towards iron removal by resorting to aeration, adsorption, sedimentation and disinfection steps of treatment. He was of the opinion that it was necessary to modify certain technologies to suit the prevailing conditions.

Laboratory Demonstration

Field Demonstration

Shri N.P. Nawani, Chief Secretary, Government of Tripura, presented an account of general water supply policy and gave his views on its improvement. He cautioned the people against the use of short term, cheaper technologies. Shri P.L. Ganguly of IFC & PHED introduced the forty participants from the various states. Dr. V.P. Thergaonkar, Scientist, NEERI spelt out the aims and objectives of the Camp and informed about the other training programmes to be conducted by NEERI under the Water Technology Mission.

NEERI constructed one demonstration plant of 1 m^3/h capacity for iron removal using the principle of surface aeration, pH adjustment, sedimentation, filteration and disinfection at Rabindra Bhawan and another of the same capacity at Govinda Ballabh Pant Hospital using tray aeration, sedimentation, filtration and disinfection. Apart from these two units, muscle powered dissolved air floatation unit, domestic chemical treatment units and hand pump attachable aeration/filtration units of NEERI were also assembled and put up for demonstration, during inauguration. An iron determination field kit developed by NEERI was also demonstrated. The amount of iron present in raw water fed to these plants was around 8 mg/L which could be brought down to below 0.3 mg/L.

All the distinguished visitors saw these plants in operation during the Camp duration.

Training Programme : The training comprised (i) discussions on training course modalities with participants; ii) water quality assessment and related characterisation; (iii) iron removal -the intricacies and choice of methods available; (iv) design calculations and analysis of case studies; (v) laboratory exercises for the estimation of free carbon dioxide, pH, ferrous and total iron; (vi) specific treatment design exercises for rural/urban community water supply; and (vii) field work. The field work mainly foccused on a) water quality assessment on the spot; b) demonstration of iron removal methods; and c) disucssions of the participants with the users and faculty. The participants were taken to Udaipur of South Tripura district for demonstration to users. The villagers participated in the demonstration of the technologies and discussed at length in local language about their working. The District magistrate of Udaipur evinced keen interest and retained the plants at Udaipur for use on a regular basis.

The camp concluded with the valedictory function presided over by Shri D.C. Debnath, Chief Engineer, IFC & PHE. Certificates of participation were handed over to the participants. The Camp received wide publicity through Doordarshan, All India Radio and Press.

WATER QUALITY ASSESSMENT

North Tripura District

Water quality assessment studies were conducted in Kanchanpur, Chamanu and Salema blocks of North Tripura District. Samples from deep tube wells, dug wells, hand pumps and shallow tube wells were taken and spot tested for pH, conductivity, free dissolved carbon dioxide, ferrous iron and temperature. Remaining tests were made at the NEERI laboratory established for this purpose at Agartala. Results are tabulated in Table 2.

TABLE 2 : Water Quality in North Tripura Districts

Sl. No.	Place/Source	Temp.	Conductivity µs/ms	pH	p-alkalinity mg/L as $CaCO_3$	M-alkalinity mg/L as $CaCO_3$	Total hardness mg/L as $CaCO_3$	Ca-Hardness mg/L as $CaCO_3$	Mg-Hardness mg/L as $CaCO_3$	Chloride as Cl mg/L	Fluoride as F mg/L	Sulphate as SO_4 mg/L	Iron (Total) mg/L	Free CO_2 mg/L
1.	Dasdabazar - DTW	32	300	7.7	0	164	96	92	4	6	0.3	1	0.05	5
2.	Satnala - DW	32	170	8.1	0	96	82	52	30	7	0.3	1	1.1	26
3.	Satnala - Cherra	32	185	6.5	0	58	52	40	12	24	0.2	1	1.7	2
4.	Laljuri Bazar-DW	32	500	6.4	0	40	156	112	44	89	0.2	1	0.1	34
5.	Laljuri Bazar - Chepra (revulet)	32	74	6.8	0	30	28	26	2	6	0.2	3	2.3	6
6.	Santipur - DW	32	195	6.5	0	68	60	60	0	23	0.2	6	2.7	34
7.	Kanchanpur-DWT	32	340	7.8	0	178	98	90	8	7	0.2	5	0.05	6
8.	15 km from Kanchanpur spring water	32	110	7.9	0	70	44	28	16	6	0.2	4	0.6	2
9.	Machmara - DW	32	90	6.1	0	18	22	14	8	16	0.2	3	0.3	40
10.	Machmara-Mark II	32	250	8.1	0	190	64	48	16	9	0.3	5	0	6
11.	Dhanichara - DW	32	260	6.6	0	110	70	46	24	27	0.3	7	0.2	40
12.	Dhanichara - DTW	32	280	9.1	16	156	6	6	0	6	0.2	5	0	0
13.	Patharchel - DTW	32	-	8.9	12	162	8	8	0	6	0.2	3	0.75	
14.	Kanchancherra-DTW (82 miles)	32	120	6.2	0	62	30	16	14	5	0.2	3	6.4	100
15.	Karamcherra - HP	32	220	6.4	0	112	70	40	30	5	0.2	2	7.4	103
16.	Masli - DTW	32	200	6.2	0	94	30	30	20	5	0.2	3	5.8	92
17.	Chalengta - TW	32	130	6.2	0	54	44	32	12	12	0.2	3	1.6	30
18.	Manu - DTW	32	150	6.2	0	74	36	20	16	6	0.2	3	7.0	80
19.	Minama-Mark II	32	250	6.8	0	134	86	50	36	4	0.2	2	5.6	80
20.	Sidukumarappa - Mark II	32	200	6.4	0	86	50	30	20	7	0.3	3	6.0	70

DTW : Deep Tube Well, DW : Dug Well, Mark II : Hand Pump HP : Hand Pump

Results indicated that the North Tripura water samples are characterised by low dissolved solids, pH, hardness, chlorides, sulphate and are aggressive to metals. Large quantities of dissolved carbon dioxide and high concentrations of ferrous iron are present in deep tube well water samples. It is noteworthy that the problem of dissolved ferrous iron was not observed in all the places. Significant problem was noticed in nearly 30% of the sources sampled.

Agartala

The city water supply is supplemented from eight deep tube wells located in various corners of the city. The total water from all the sources is 11250 m^3/day. In addition to this, certain localities supplement their requirement from shallow tube wells and hand pumps. Samples were collected and spot tested for physico-chemical characteristics, the results of which are in the Table 3. The results of the study reveal that (i) excessive dissolved carbon dioxide is present in most of the samples and is responsible for the aggressiveness of the water and dissolved iron; (ii) almost all ground waters sampled contain high amounts of dissolved ferrous iron usually in the range 5-6 mg Fe per litre; (iii) Some areas showed much higher concentrations of dissolved iron upto 12 mg Fe per l.; and iv) all samples examined are soft and with dissolved solids concentration below 100 mg/L.

Shallow tube wells are used when there is no supply from the system and these contained invariably high iron concentration. Continuous withdrawl of water from such sources showed a falling trend in the iron concentration to convey dissolved iron contribution to water is also due to the corrosion of the pipe material from excessive dissolved carbon-dioxide.

TABLE 3 : Iron Concentration at Agartala

Sl.No.	Tube well	pH	Conductivity s/cm	Ferrous Iron as Fe mg/L	Total Iron as Fe mg/L	Free CO_2 mg/L
1.	Pratapgarh	7.1	160	5.5	11.6	10
2.	Palace compound	6.6	155	6.8	7.4	56
3.	Rampur	6.8	160	5.0	6.5	50
4.	Dhaleswar	6.8	160	5.8	8.6	60
5.	G.B. Hospital	6.8	170	6.8	8.5	52
6.	Harijan colony	6.8	210	6.0	6.5	38
7.	Malandra Nivas	6.3	160	11.5	15.6	80
8.	Golchakra, Jaynagar	6.7	210	0.3	5.0	10
9.	Bhati Abhaynagar	6.7	170	5.0	6.0	60
10.	Shallow tubewell in Pratapgarh	6.6	200	14.0	14.4	78
11.	Dugwell in Abhaynagar	7.1	140	0.3	3.5	16

PERFORMANCE EVALUATION OF IRON REMOVAL SYSTEMS

Plants erected by IFC & PHED

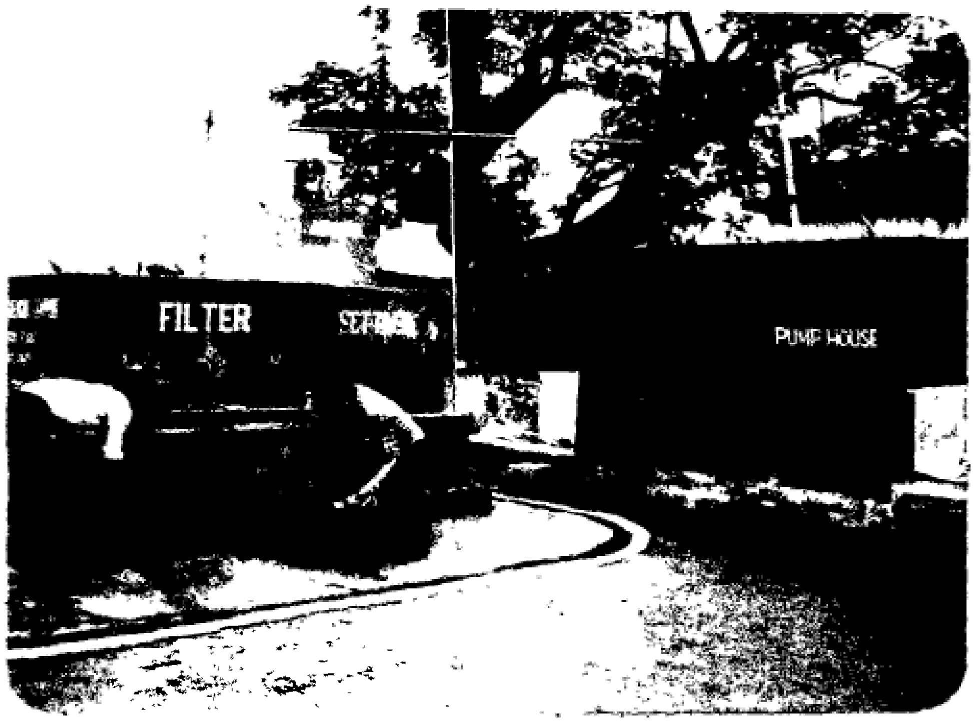
Eight deep tube wells are supplementing water by direct pumping into the service line. Problem of excessive iron was identified by the IFC & PHED and they have designed and implemented iron removal by aeration to all of them. Water is initially pumped from the tube well through a jet aerator into a water tank. The aerated water flows through gravel sand or charcoal filter bed at the bottom of the tank. Raw and treated water samples from all the tube wells were tested, the results of which are summarised below :

	Raw water	Treated water
Dissolved ferrous iron, mg/L	3.0 - 8.0	1.0 - 2.5
Free Carbon dioxide, mg CO_2/l	50 - 70	5 - 12
pH	6.5 - 7.0	6.7 - 7.2

The spray aeration reluts in a significant loss of water through wind carriage, etc. An estimated 30 - 40% water is lost in the process of aeration. The results of the evaluation reveal that 60 - 80% dissolved iron is removed in the current system and in no case values 0.3 mg/L or below were observed. It is evident that aeration as practiced is not adequate to reduce the dissolved iron to value prescribed by Government of India. The sedimentation of the oxidised and precipitated iron is also inadequate with the result a certain carry-over is always there in the system. The physico-chemical nature of the raw waters is such that a certain amount of pH adjustment with alkali is unavoidable besides aeration and sedimentation.

Plants installed by NEERI at Ravindra Bhawan and G.B. Hospital

The schematic diagrams of the 1 m^3/h capacity plants is shown in Figs. 1, 2. The NEERI systems include aeration, sedimentation, filtration and disinfection. While the system at G.B. Hospital is designed on tray aerator concept, the iron removal unit at Ravindra Bhawan is designed based on trickling aeration. Performance of these plants is shown in Table 4.



Iron Removal Plants installed by NEERI

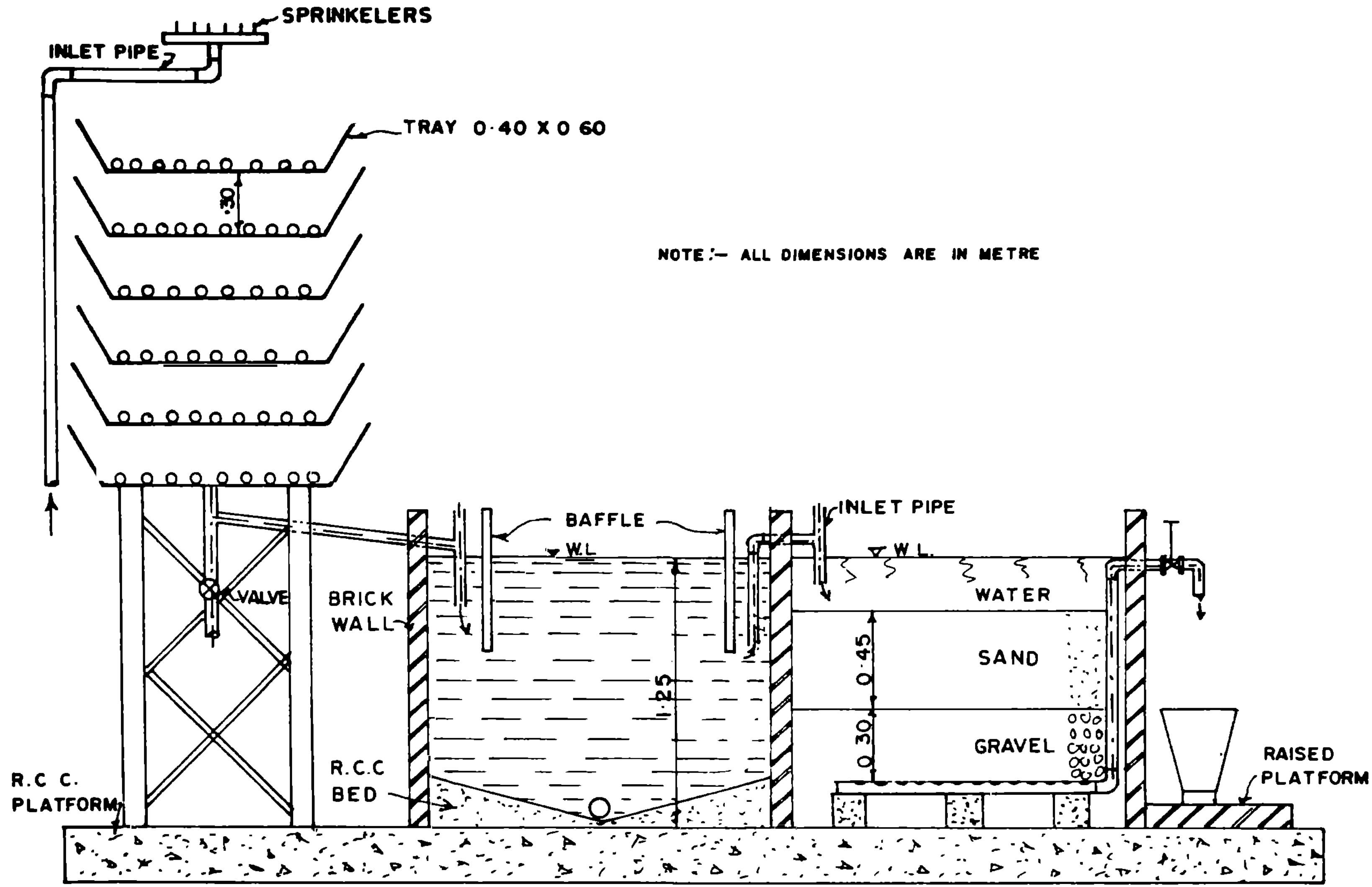


FIG. I G.B. HOSPITAL IRON REMOVAL DEMONSTRATION PLANT

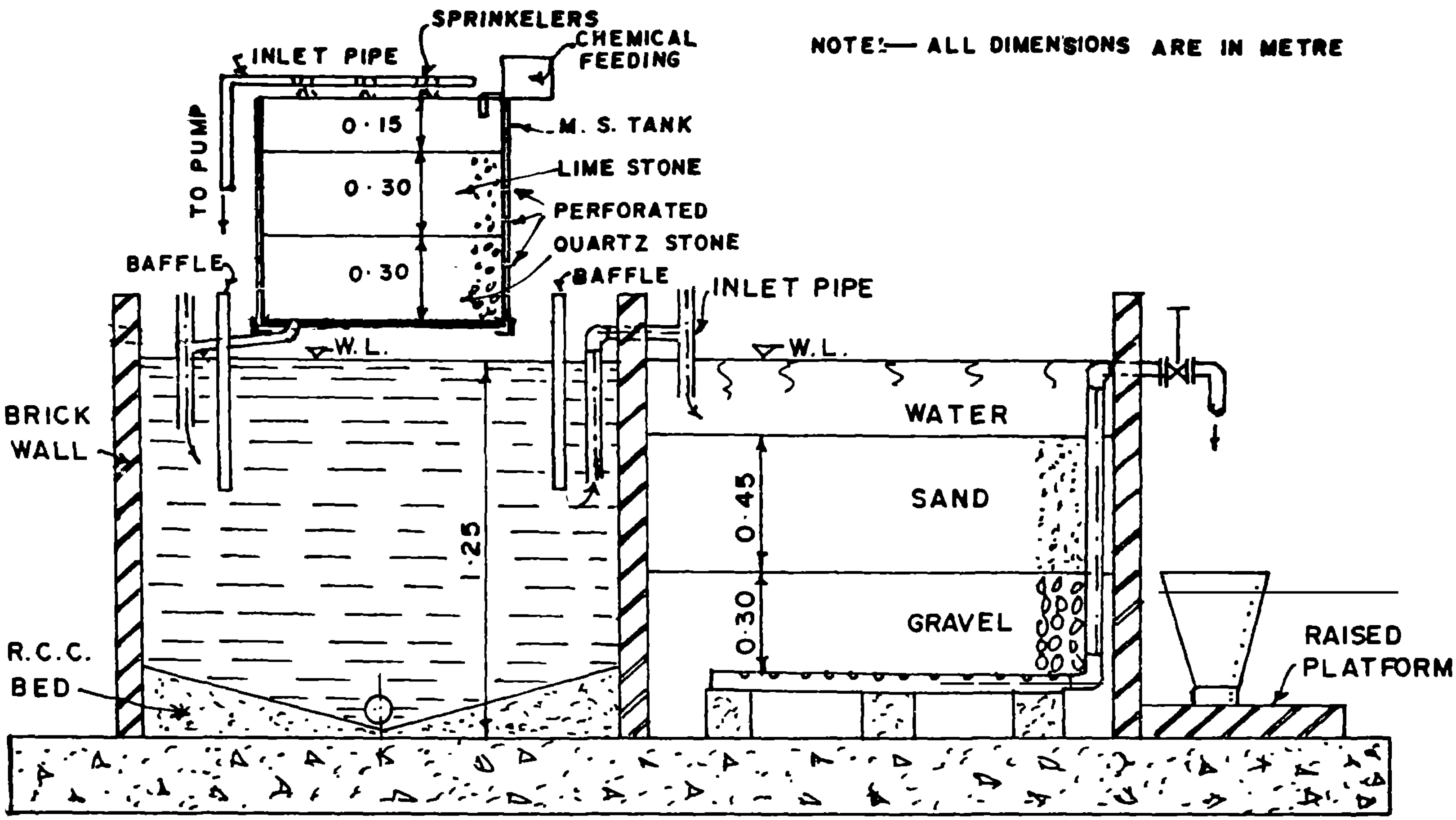


FIG. 2 RAVINDRA BHAWAN IRON REMOVAL DEMONSTRATION PLANT

TABLE 4 : Evaluation of NEERI Iron Removal Plants at Agartala

Location	G.B. Hospital			Rabindra Bhawan		
Parameters	RW	A.A.	A.F.	RW	A.A.	A.F.
pH	6.2	7.0	8.2-8.4	6.4	6.8	7.6
Carbondioxide, mg/L	85-100	4.5	Nil	75	6	Nil
Dissolved Oxygen, mg/L	Nil	5.5	5.1	Nil	6.2	40
Temperature, deg.C	26	26	26	26	26	26
Conductivity. s/cm	150	150	150	220	220	220
Alkalinity, mg/L	60	60	60	90	90	90
Chloride, mg/L	6	6	6	5	5	5
Sulphate, mg/L	3	3	3	3	3	3
Total Hardness, mg/L	30	30	30	50	50	50
Ca Hardness, mg/L	20	20	20	26	26	26
Ferrous Iron, mg/L	6	-	Nil	4	-	Nil
Total Iron, mg/L	6	-	0.2	4	-	0.10-0.2
Aeration time s provided	10	-	-	3	-	-

RW = Raw water, AA = After Aeration, AR = After Filtration

The plant at G.B. Hospital is to meet the acute need for good quality water meaning water free from dissolved iron. It may be mentioned that except for low pH, excessive dissolved carbon dioxide and excessive iron, the other chemical characteristics are good. The other plant was located at a place of social gathering viz. Ravindra Bhawan and here to except for aggressive water and high dissolved iron, the other characteristics are acceptable.

The Table given under design exercise gives the working of these two plants and helps in evaluation of the systems of NEERI.

Participants of the Camp were explained the necessity for adopting two different types of aeration systems, viz. the surface aerator and the tray aerator. They were also explained with examples as to when it would be necessary to adjust the pH of raw water. Generally speaking aeration followed by filtration is adequate when the raw water iron concentration is less than 5 mg/L but when it exceeds this value it is necessary to introduce clarification following aeration to be followed by filtration. In the opinion of NEERI, it is usually cheaper to neutralise with an alkali than to employ aeration when the dissoloved carbon dioxide concentration of the raw water is below 10 mg/L.

Design Exercise : A design exercise was given to the participants so that they could immediately apply the acquired knowledge to a situation in their respective states. The example was as under :

> "Design a water treatment facility for a population of 500 for removal of iron with iron and carbon dioxide contents of 5 mg/L and 40 mg/L respectively. It has been decided to use India Mark II for pumping water into the water treatment plant. The basic design criterion to be used are as follows :

Water consumption	40 LPCD
Tray Aerator	
Spacing of Trays	0.01 m^3/m.s
Aeration Rate	1.26 m^3/m.s
Sedimentation	
Detention period	2.5 h
Sand Filter	
Effective size	0.6 - 0.8 mm
Uniformity Coefficient	2.0
Sand Depth	0.6 m
Total head above the sand	0.5 m
Rate of Filtration	0.15 m/h
Gravel Depth	0.30 m

Work out the capital, operation and maintenance cost from the experience in your State. The treatment facility includes India Mark II pump, aerator, sedimentation basin and filter. Indicate novel types of aerator/sedimentation/basic/filter for the removal of iron in the water treatment scheme."

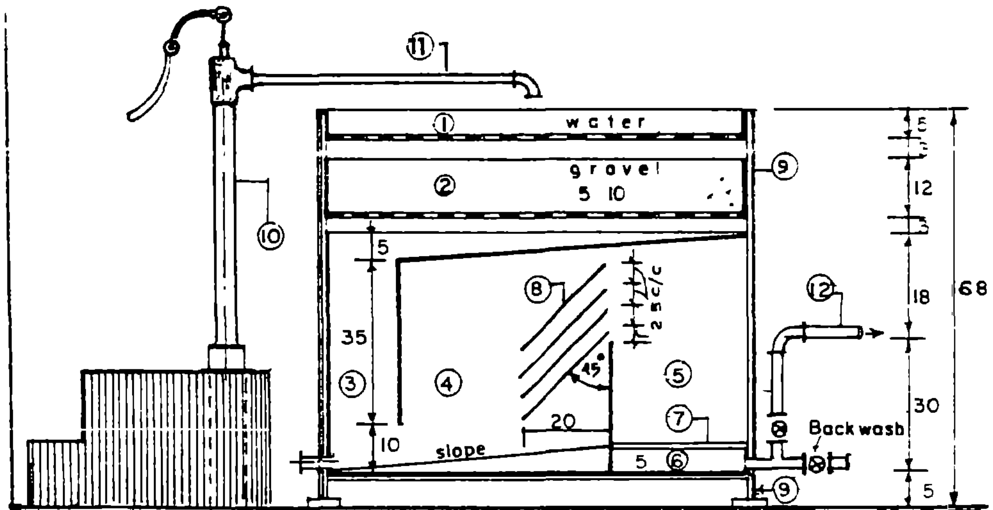
It is worth recording here that some of the designs indicated by participants are quite novel and related to their specific situation. This showed active participation and involvement of the participants. A mention is made of the special situations reported by the participants in Kerala, West Bengal and Arunachal Pradesh.

NEERI's Iron Removal Plant (for Hand Pump Connections)

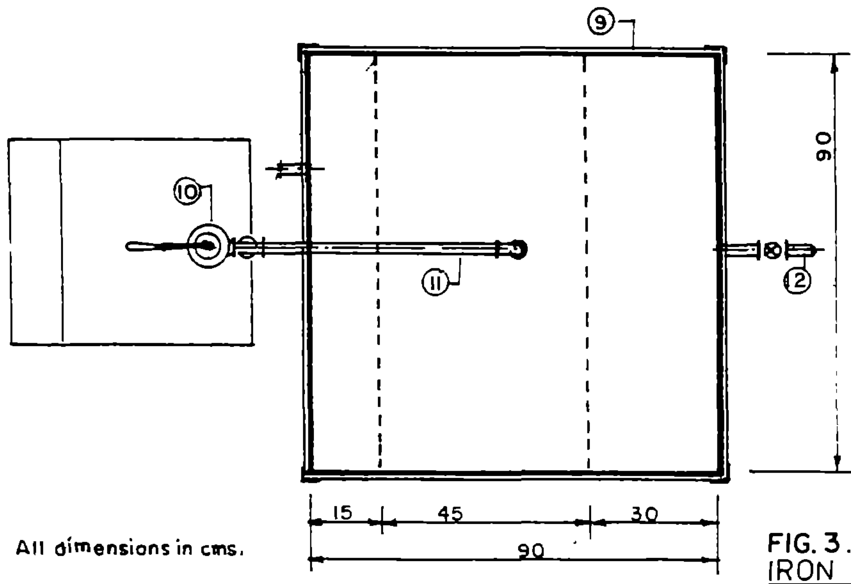
NEERI designed this plant on the principle of aeration and contact oxidation of iron in water. The hand pump water falls over sprayer tray, from where it trickles over an aerator tray. The aerator tray containing gravel/crushed stone media to increase the surface area of the air-water interphase. The aerated water from the tray flows through the pores over baffle plate to sedimentation tank. The sedimentation tank is provided with a plate settling device to enhance the settling. The settled water flows through the plate settlers to the filter bed. The filtered water is taken out by the tap attached to it. The plant is designed for 5 L/min with 90 x 90 x 80 cm size. (Fig.3). The units was assembled and demonstrated at Rabindra Bhawan. The results revealed that after conditioning the system for 24 hours, iron from an inital value of 8 mg/L came down to below 0.3 mg/L. The free carbon dioxide is lowered to 0-3 mg/L from the initial 60-80 mg/L. The IFC & PHED retained the plant for installation at an appropriate hand pump.

Muscle-powered Dissolved Air Floatation Plant

The package water treatment plant using 'Dissolved Air Floatation' principle was demonstrated at Rabindra Bhawan. The plant was tested with a raw water containing 6-8 mg/L Fe (II) and 50-60 mg/L dissolved carbon dioxide.



SECTIONAL ELEVATION



All dimensions in cms.

PLAN

SPECIFCATIONS

(1) SPRAY TRAY		G I SHEET, 18 GAUGE, 90x 90x5, PERFORATED BOTTOM OF 30 mm Ø HOLES AT 2 cm C/C
(2) AERATION CHAMBER	size	——— do ——— 90x90x35
(3) COLLECTION CHAMBER	"	90 x 15 x35
(4) SETTLING CHAMBER	"	90 x 45 x 35
(5) FILTER CHAMBER	"	90 x 30 x 40
(6) FILTER WATER CHAMBER	"	90 x 30 x 5
(7) PERFORATED PLATE	"	90 x 30 x 0.2 30 mm Ø holes at 2 cm c/c
(8) PLATE SETTLER	"	90 x 28 x 0-2 4 Nos inclind at 45° at 2.5 cm c/c
(9) M.S Angle iron Frame with support	"	35 x 35 x 6
(10) BORE WELL HAND PUMP		
(11) RAW WATER INLET PIPE	"	50 mm Ø
(12) TREATED WATER INLET PIPE TO STAND POST	"	50 mm Ø

FIG. 3.
IRON REMOVAL PLANT FOR HAND PUMP
(CAP: 5 Lit/min)

NEERI NAGPUR

Iron Estimation Kit and Domestic Iron Removal Units Developed by NEERI

Field Demonstration

Domestic Treatment Unit (chemical precipitation)

In order to facilitate iron removal in houses, NEERI demonstrated a unit consisting of a bucket of 40 L capacity with centrally placed 10 cm dia perforated PVC cylinder. Inside the cylinder is a nylon bag filled with 0.5-1.0 mm sand/charcoal. Raw water with iron is filled in the bucket and a chemical mix in the form of a solution is added and stirred manually around the central cylinder with a stick. The dissolved carbon-dioxide is removed and iron is precipitated. The settled water in the bucket is drawn through the vertical cylindrical filter at the centre of the bucket (Fig. 4). The results are summarised below :

Chemicals used is treatment	Chemical Dose, mg/L	Raw water Ferrous Iron, mg/L	Treated water Ferrous Iron mg/L	Treated water pH
Sodium Carbonate +	75 +	6 - 8	below 0.3	average 7.2
Sodium Aluminate	75			
Sodium Carbonate +	50 +	6 - 7	below 0.3	average 7.0
Sodium Phosphate	5			
Sodium Carbonate	75	6 - 7	below 0.3	average 7.5

Tripura's House-hold Unit

In Tripura, it is observed that many houses use an indigenous iron removal unit. This is made of concrete and has two compartments in it. Iron bearing water brought home is poured into the upper compartment-connected to the lower chamber through a filter filled with charcoal from pipal tree mixed with local clay. This unit is available for Rs.150/- and the candle filter is replaced reportedly once every six months. The participants to the Camp were informed that it is not essential to use charcoal from pipal tree and any media capable of holding the iron precipitates can do the job equally effectively. The unit is seen to produce water with around 1 mg/L iron in filtrate.

HOUSEHOLD WATER TREATMENT UNIT

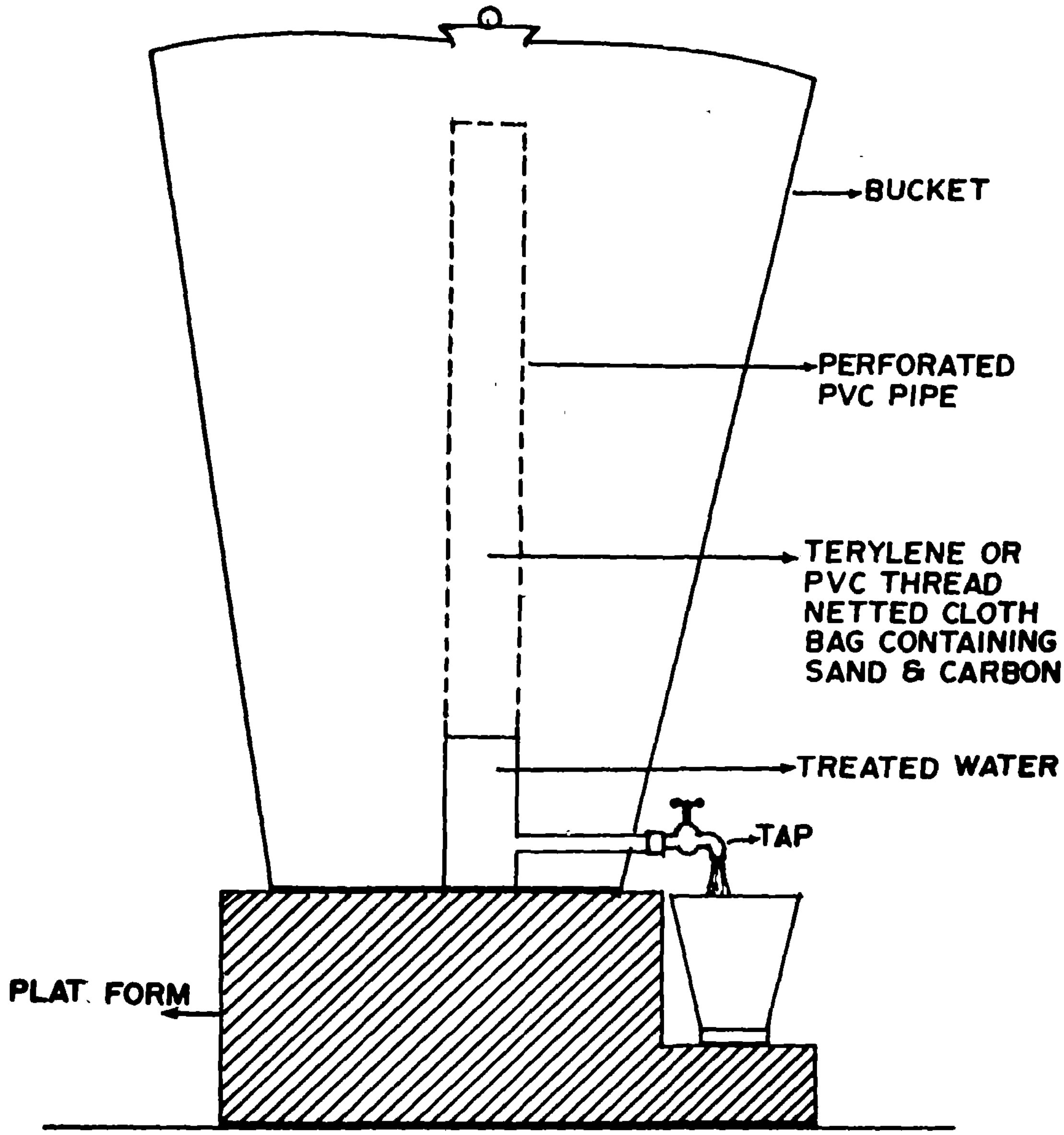


FIG. 4.

NEERI's Iron Field Test Kit

Reliable iron estimation calls for spot checking of samples for iron. This has been made possible through NEERI made IFT Kit, which comprises colour comparator, nesseler tube, measuring cylinder and ferro ampoules. These are securely housed in a fibre-glass box and the determination is possible upto 6 mg/L ferrous iron. Higher concentrations can be tested with suitable dilution with distilled water. The Kit was handy in water quality assessment and evaluation of the treatment plants. All participants showed keen interest and several decided to buy it for field use.

Tripura's State Laboratory

The State IFC & PHED needs to be complimented for they had modernised their laboratory at a short notice as per report submitted by NEERI. This laboratory located at the College Tilla Water Works is sufficiently equipped to meet the demands of the routine water analysis.

Participants were taken to this laboratory where they analysed themselves the most important parameters like pH, dissolved carbon dioxide, dissolved ferrous and total iron, alkalinity, conductivity, etc. It was repeatedly emphasised to the participants that these parameters have to be estimated at site if they wish to effectively solve the problem of dissolved iron in the ground water.

RECOMMENDATIONS

1) Iron may originally be present in a water as derived from the source or as acquired from metals with which the water subsequently comes in contact. Decide this important point by examining samples collected directly from the source on the spot. If the latter is a deep bore-well and samples can only be obtained from the pump delivery, a series of samples should be collected at intervals throughout several hours' continuous pumping at maximum capacity. Should the examination

of these samples show that the amount of iron present in the water decreases rapidly as pumping proceeds, it is fairly certain that some, if not all, of the iron is derived from the metal of the bore-hole tubing, strainer and rising main. This is required to be ascertained before further action.

2) The problem of iron can be classified to fall under categories :

   i) Water with low iron content (below 5 mg/L) and when the carbon-dioxide content of the water is below 10 mg/L.
   ii) Water with high iron content (above 5 mg/L) and carbon dioxide exceeding 30 mg/L: and
   iii) Water with iron and other objectionable substances.

3) The affected States should go-in for iron removal systems using data in NEERI's Technology Package on Iron Removal wherever excessive iron falling in any of the above categories is encountered.

4) Sanitary draw wells with hand-pump should be adopted in areas with excessive iron concentration.

5) Efficiencies of the domestic iron removal units, muscle-powered unit, tray, cascade and sprinkler aerators should be further studied by NEERI using the plants installed by them. This will facilitate incorporation of necessary modifications in the designs for replication in the concerned States.

Acknowledgements

NEERI is grateful to Mr. G. Ghosh, Mission Director, Water Technology Mission, Government of Inida and Dr. Ram K.lyengar, Additional Director-General, CSIR for their kind help in giving shape to the Camp.

NEERI would like to record its gratefulness to the Government of Tripura whose deep interest and concern for safe water supply made this camp possible; to all State Governments who deputed their engineers for this camp.

ANNEXURE - I

FACULTY

NEERI

1. Mr. K.R. Bulusu, Dy. Director
2. Dr. A.K. Basu
3. Dr. V.P. Thergaonkar
4. Dr. S.D. Badrinath
5. Dr. S.N. Kaul
6. Mr. K.K. Das
7. Dr. M.V. Nanoti
8. Dr. M.Z. Hasan
9. Mr. R.C. Dixit
10. Mr. A.M. Deshkar
11. Mr. H.J. Patil
12. Mr. D.N. Kulkarni
13. Mr. S.L. Lutade

IFC & PHE

1. Mr. D.C. Debnath, CE
2. Mr. P.L. Ganguly O.S.D
3. Mr. C. Sengupta E.E.,

ANNEXURE - II

PARTICIPANTS

Tripura

1. Dr. J.C. Das
   Assistant, DHs
2. Er. S.B. Day
   E.E. Udaipur
3. Er. P.L. Roy
   E.E., Kumarghat
4. Dr. Swapan Roy
   M.O.I./C
5. Mr. H.Bhattacharya
   S.E. PHE Circle
6. Er. P.K. Bhattacharjee
   A.E., PHE Sub Divn.
7. Er. S.K. Dhar
   A.E., PHE
8. Er. S.C. Bhowmik
   E.E., IFC & PHE
9. Er. Ashim Chakrabarty
   A.E, IFC & PHE
10. N. Bhattacharya
    A.E., PHE Sub Divn. I
11. B.B. Burman
    E.E., Rural Engg. Divn.
12. Mr. N.N. Karmakar
    E.E., Rural Engg. Divn.
    Kumarghat
13. Mr. A.R. Majumdar
    Rural Engg. Orgn.
14. Mr. A.K. Ghosh
15. Mr. S.C. Goon

West Bengal

16. Mr. S. Bagchi
    S.E., PHE
17. Mr. K.K. Sanyal

Uttar Pradesh

18. Dr. P.K. Pande
    E.E., UP Jal Nigam
19. Dr. M.A. Faruqui
    R.O., UP Jal Nivam

Andhra Pradesh

20. Mr. Srinivasa Rao
    Dy. E.E., (PR)
21. Mr. Reddy Ram
    E.E., Panchayati Raj

Sikkim

22. Mr. V.P. Varghese
    A.E., R.D.D.

Orissa

23. Mr. B.M. Hotta
    A.E., PH Sub Division
    Bhanjanagar

Karnataka

24. Mr. A. Balakrishna
    E.E., Z.P. Divn.
    Bellary.
25. Mr. C. Ramanna
    S.E., PHE Circle

Manipur

26. Mr. G.C. Nath
    E.E., Monitoring & Env.

Manipur

27. Mr. Shangreiphao
    Vashumwo
    A. Sur. Works

Arunachal Pradesh

28. Mr. P.C.Shrivastav
29. Mr. M.K. Chandra

Mizoram

30. Mr. Lalmuan Zova
    A.E.,
31. Mr. M. Dawngliana
    Ex. Director, TM

Madhya Pradesh

32. Mr. S.K. Swamy
    A.E., Kanker
33. Mr. H.C. Tantwai
    E.E., Kanker

Kerala

34. Mr. M. Malik Mohd.
    S.E., K.W.A.,
    Quilon
35. Mr. Ganapathi
    Asstt. Adviser
    R.D.D., GOI.
36. Dr. Geopaul
    P.T.C., CSIR
    Calcutta.

ANNEXURE - III

PROGRAMME

14.7.1987	Inauguration - Hon'ble Chief Minister, Tripura Chief Guest, Minister for Power, Public Health, Irrigation etc. Technical Sessions on Water Quality, Iron Removal, Sampling, preservation and analytical methods. Design for rural and community water supply Demonstration - estimation of iron, CO_2 and pH
15.7.87	Technical Sessions on aeration, presentation of case studies and approach to iron removal systems Demonstration and evaluation of the iron removal plants.
16.7.87	Evaluation of plants, of domestic units and demonstration of domestic units
17.7.87	Water quality evaluation in Agartala and evaluation of conventional iron removal plants. Audio visual on disinfection, defluoridation
18.7.87	Visit to Udaipur (South Tripura) Community Demonstration to rural masses Valedictory