

250

87TE

91/5210



**TECHNOLOGY MISSION ON
DRINKING WATER IN VILLAGES AND
RELATED WATER MANAGEMENT**

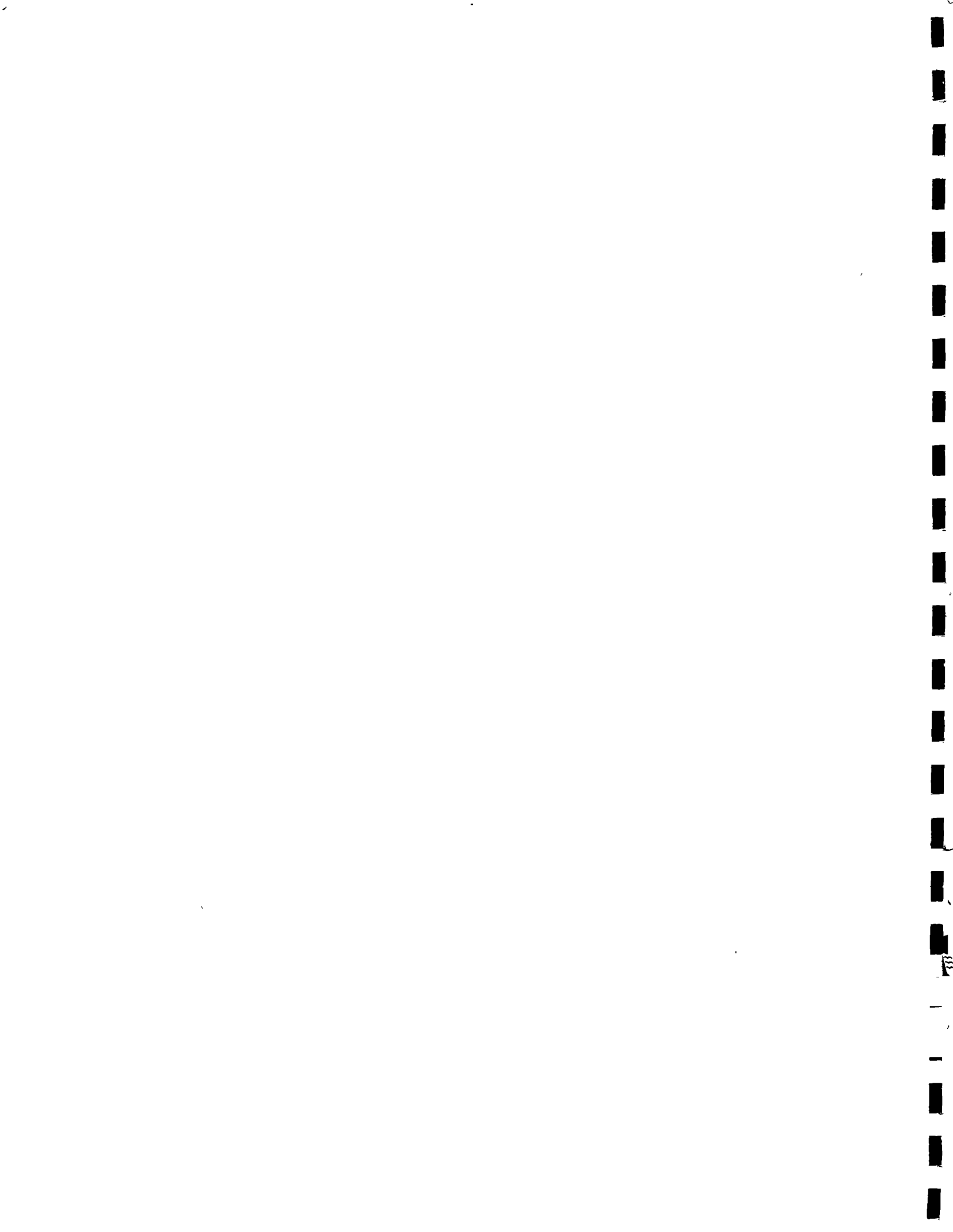
LIBRARY
INTERNATIONAL REFERENCE CENTRE
FOR COMMUNITY WATER SUPPLY AND
SANITATION (IRC)

**TECHNOLOGY PACKAGE ON
IMPROVED MUSCLE POWER
WATER TREATMENT PLANTS**

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



250-5210



TECHNOLOGY MISSION ON
DRINKING WATER IN VILLAGES
AND RELATED WATER MANAGEMENT

TECHNOLOGY PACKAGE ON
IMPROVED MUSCLE POWER
WATER TREATMENT PLANT

LIBRARY, INTERNATIONAL REFERENCE
CENTRE FOR COMMUNITY WATER SUPPLY
AND SANITATION

P.O. Box 117, 199 AD, New Delhi
Tel: (011) 214111 ext. 141/112

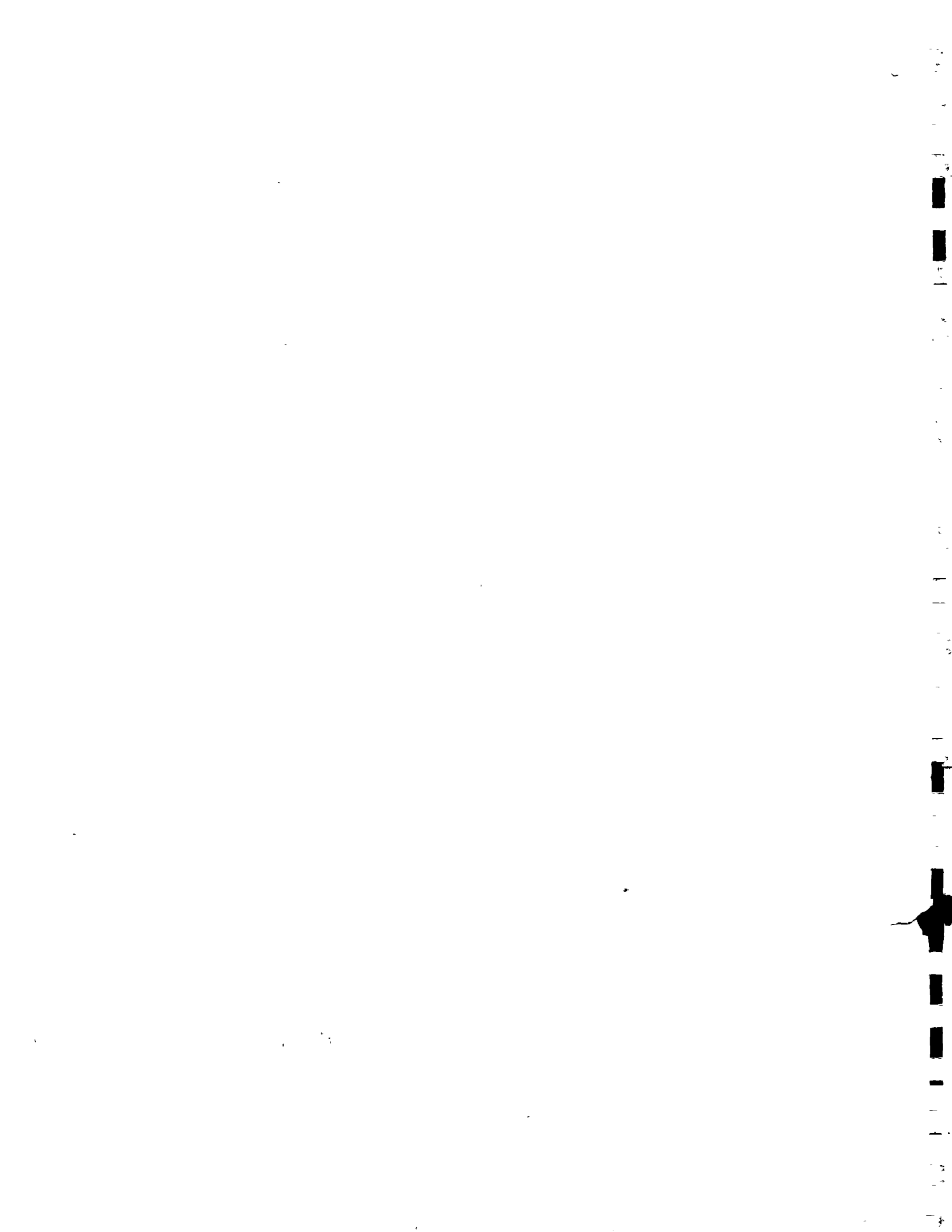
RN Wn 5210

LC 250 87TE



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

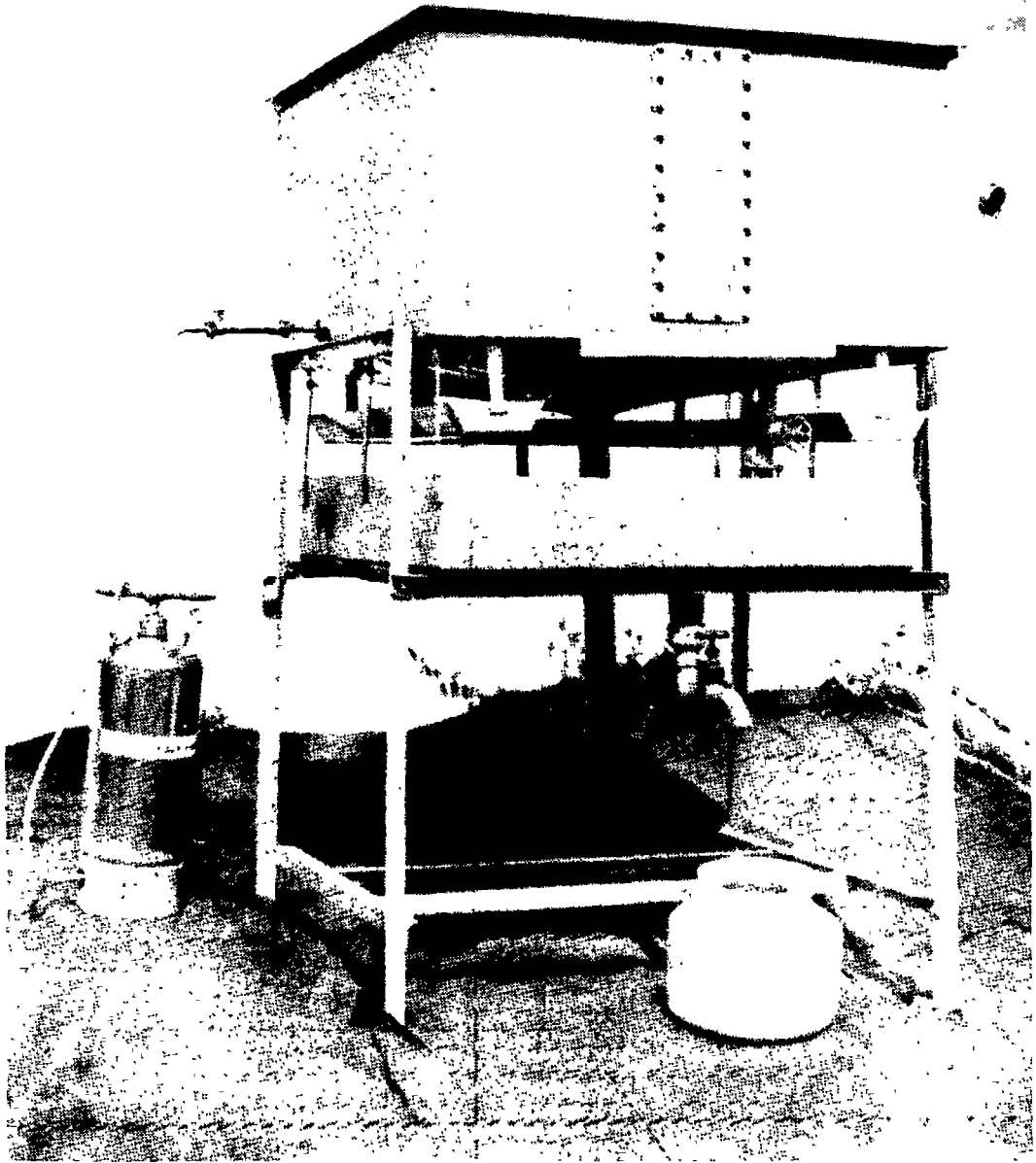
MAY-1987



LIST OF CONTENTS

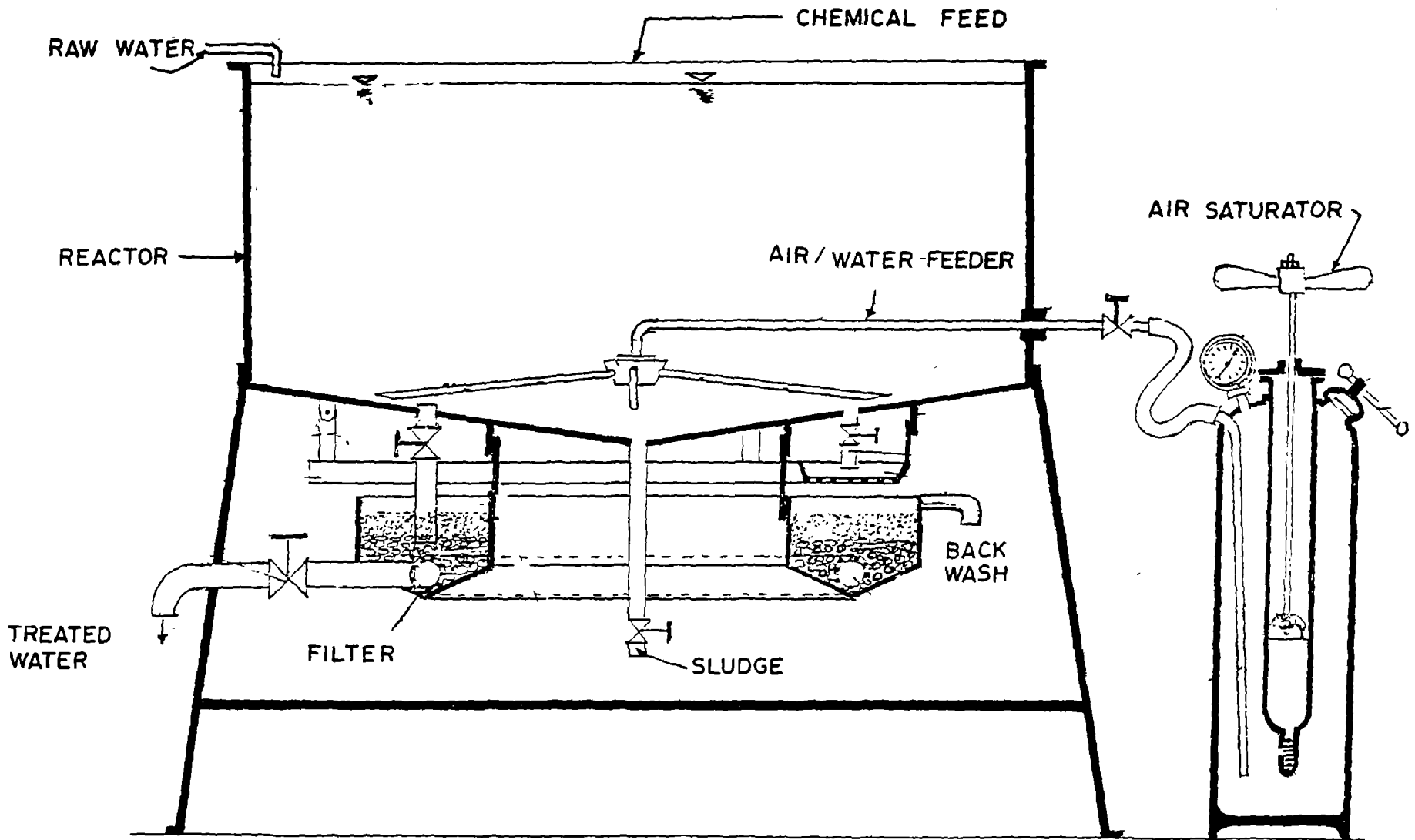
	Page No.
• Concept	5
• Salient Features	5
• Working Principle of the System	6
• Plant Layout	6
• Plant Operation.	6
• Performance Evaluation	7
• Advantages of the Package.	8
• Package for 500 Lit/Batch Treatment	8
• Cost Estimates	9

LIBRARY, INTERNATIONAL REFERENCE
CENTRE FOR AGRI-CULTURAL WATER SUPPLY
AND IRRIGATION
115 CONNOR ROAD, SINGAPORE
TELEPHONE 334-1611 ext 141/142
FACSIMILE 334-1611
C.O.

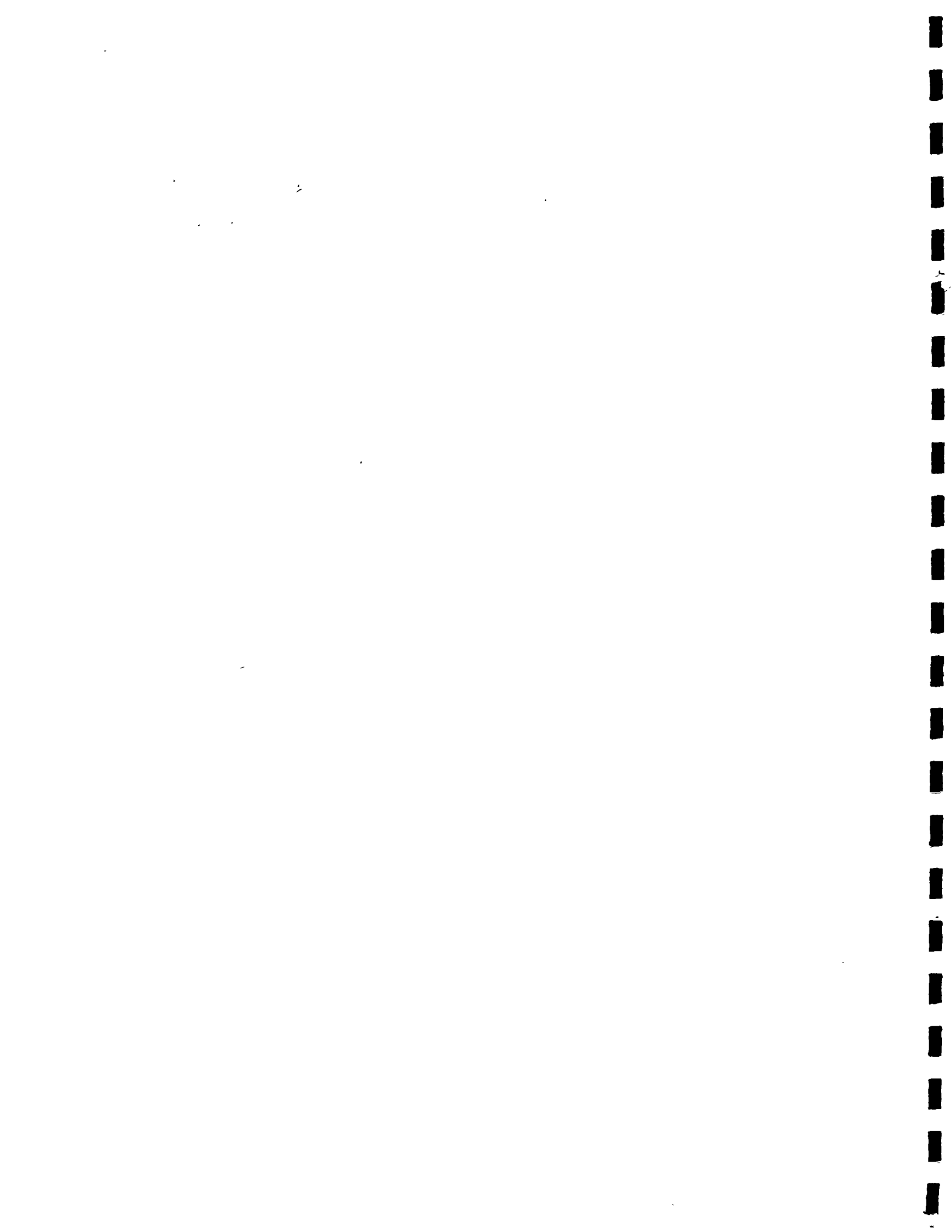


MUSCLE POWER WATER TREATMENT PLANT





MUSCLE-POWER DISSOLVED AIR FLOATATION SYSTEM FOR WATER TREATMENT



CONCEPT

- * Technology Mission on drinking water warrant simple, efficient and cost effective technologies for adequate quantity of safe potable water to the problem villages.
- * In view of the shortage and nonavailability of power, the technology package must be musclepowered, easy to operate, versatile with respect to varying sources of water and to quality.
- * The problems of water quality which the package should resolve are removal of suspended solids, hardness, fluoride, dissolved iron and bacteriological quality with minimal maintenance.
- * Keeping in view the foregoing requirements, a cost effective muscle powered technology system is presented here as NEERI's contribution to Water Technology Mission.

SALIENT FEATURES

- * The system operates on the principle of floatation.
- * The rate of floatation being higher than that of sedimentation, as much as 500 litres of treated and disinfected water is produced in each batch taking about 25 minutes.
- * The package is useful for the treatment of surface and ground water to achieve removal of bacterial contamination, turbidity, hardness, fluorides or iron.
- * The expenditure being that of essentially the chemicals used in the treatment, working cost is minimal.
- * Electrical power is not required.

WORKING PRINCIPLE OF THE SYSTEM

According to Henry's Law, solubility of a gas in liquid increases with pressure at a temperature. When water saturated with air at elevated pressure is exposed to atmosphere, excess air equivalent to the difference of solubility is released from the water. The gradually ascending micro bubbles of air attach to the precipitate or Floc produced during the process resulting in the bubble-solid agglomerate floating to the surface. The suspended particulates are thus removed resulting in an acceptable treated water quality.

PLANT LAYOUT

The plant is adaptable to domestic as well as community treatment.

Domestic Treatment : This is a decentralised system to be attached to a Hand Pump for capacities upto 500 litres per batch operation.

Community Treatment : The same principle is extended to a centralised community to obtain nearly 1 m^3 treated water per hour for small communities.

PLANT OPERATION

The plant comprising air saturator and floatation tank with filter can be made of MS, FRP or HDPE. No intricate structural design is involved and the system can be fabricated with local talent. The desired treatment of water is achieved through the following sequence of plant operation.

Air Saturator : Raw water is filled in the saturator to approximately three-fourths its volume and the screw-cap is tightened. The pneumatic hand pump is operated by stroking the handle to achieve 3.5 kg/cm^2 pressure. Water gets saturated with air at this pressure, which is then

admitted into the floatation tank through a distributor, regulated by hand controlled shut-off valve, connected, with flexible hose, to the distributor manifold.

Floatation tank with filter : The tank filled with raw water is dosed with requisite quantity of chemical and disinfectant and thoroughly mixed so that reaction is complete and floc is produced to entrap suspended matter. At this stage, air-water is admitted from saturator. The micro-fine air bubbles quiscutely lift the floc formed to the surface along with the impurities. The air-water mix discharge from the saturator continues for nearly 20 minutes by which time the water in the floatation tank becomes clear and rid of impurities and bacterial contamination.

The treated water from the floatation tank then flows into a sand filter through a perforated tray. The filtrate collected through a manifold is stored in a treated water tank.

PERFORMANCE EVALUATION

The package system has been evaluated for removal of bacterial contamination, turbidity, fluorides and iron.

Field trials for removal of Iron were carried out at Bhandara in Maharashtra.

The performance of the unit is shown below :

Parameter	Raw Water	Treated Water	Remarks
Turbidity	25 to 80 NTU	5 NTU	20 to 30 mg/l alum dose.
	10 to 25 NTU	5 to 7 NTU	20 mg/l alum dose.
Fluorides	2 to 6 mg/l	1 to 1.5 mg/l	250 to 450 mg/l alum dose.
Iron	5 PPM	0.5 PPM	Aeration using 2.5 Lit of air saturated water.

ADVANTAGES OF THE PACKAGE

- * The rate of floatation is faster than the rate of settling of the floc, hence the time required to remove the suspended impurities is shorter.
- * Since sufficient pressure is achieved by pneumatic hand pump to prepare air-water mix, need of an electrically operated pump is eliminated, this makes the system highly useful in remote and hilly areas.
- * The process in the treatment scheme is simple and does not require sophisticated machinery, hence easy to install and maintain.
- * The device has been tested for removal of turbidity, dissolved iron, fluorides, hardness and bacterial contamination from water. The results are very satisfactory compared to other conventional treatment systems in terms of time and cost.
- * The unit should be adapted to solve water quality problems with respect to the removal of iron, fluorides, hardness, and turbidity.
- * As the principle of treatment is floatation, the floc formed is light, hence the dose of chemicals is low as compared to any sedimentation based system.

PACKAGE FOR 500 LIT/BATCH TREATMENT

The package consists of main floatation tank with filter and air-water saturator.

- * Floatation tank comprises of 1.0 x 1.0 x 0.6 m rectangular unit with hopper bottom (Slope 12°), for a through put of 500 litres in 25 min. A 6 mm dia distribution manifold with perforations is provided near the bottom of the tank, for a uniform dispersion of air saturated water.

* The water after floatation treatment is distributed over a filter using perforated tray. The sand filter is located at the bottom of the floatation tank. The dimension of the filter are 20 cm width and 20 cm depth. The filtered water is collected in a storage tank through a common manifold.

COST ESTIMATES

Population served - 150 @ 40 Lpcd.

a) TURBIDITY REMOVAL :

- o Capacity : 500 L/batch.
- o Raw water Turbidity : 80 NTU
- o Alum dose : 30 Mg/L
- o Man Power : One unskilled worker.
- o Batch Operation : 15 per day.
- o Water treated : 7.5 m³/day.
- o Design period : 15 year.

Cost :

- o Capital cost of unit Rs.4000/-
- o Cost of alum Rs.120/year.
- o Cost of manpower Rs.4000/year (@ Rs.11/day)
- o Cost of maintenance Rs.200/year.
- o Capital cost has been annualized using following eqn.

$$A_c = C \left(\frac{\alpha (\alpha - 1)^n - k}{(\alpha + 1)^n - 1} + \frac{P}{100} \right)$$

Where C = capital cost
n = life of unit.

α = rate of interest.
k = Salvage factor = 0
p = maintenance cost of components in % pa.

Cost of water is Rs.1.9/m³. The cost ranges from Rs.1.6 to Rs.1.9/m³ for turbidities varying from 30 to 80 NTU

b) DEFLUORIDATION

Cost of defluoridation varies as per the fluoride concentration in raw water.

i) Raw water containing fluorides in the range of 2 to 4 MgF/l the cost of treatment = Rs.1.8/m³.

ii) Raw water containing 4 to 7 MgF/l.

The cost of treatment = Rs.2.0/m³.

The cost calculations are made as mentioned in (a) above.

The cost varies from Rs.1.8 to Rs.2.0/m³ for raw water fluoride concentration ranging from 2 to 6 MgF/l.

In this process, the cost is essentially governed by the labour cost. The effect of concentration of impurities on the cost is marginal except that in 'Defluoridation' where the consumption of alum varies with the concentration of fluoride.

* * * *



