NON-CONVENTIONAL WATER TREATMENT PLANT - REVERSE OSMOSIS METHOD

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Introduction

One of the bare necessities of human life is water which we get from either surface water or underground water.

Among surface water river water and lake water are considered to be good quality of water having low total dissolved solids (TDS) but contains high quantity of suspended solids or turbidity. Seawater containing abnormally high TDS as such unless treated cannot be used in our daily life including cultivation of land. In coastal area there is an acute crisis of sweet water and even for cultivation of land treatment of water to convert the water suitable for daily use has become essential.

Quality of underground water depends upon the depth from where it is obtained and resource being limited cannot be considered as abundant source of water.

Therefore our main consideration is to obtain drinking water from naturally available surface water. Table No. 1 shows standard of drinking water as per IS 10500 of 1991.

Treatment Scheme

Setting, followed by filtration and then disinfections are adopted before distribution for domestic/industrial uses.

Following are the methods of purification of water:

1. Sedimentation and Filtration
2. Boiling Method
3. Ultra Violet Radiation Disinfections
4. Activated Carbon Filter
5. Iodide Resin Based System
6. Reverse Osmosis System

From Table 2 : It can be seen major diseases caused by pollutants in water and comparison of various type of water purification.

We shall limit our discussion on reverse osmosis system.

Underground Water

Open well water, Bore well water, are generally clean in appearance but contains higher dissolved solids or salts viz. salts of Iron, Calcium, Magnesium, Sodium, Potassium, Silica, Arsenic and Fluoride, etc. These salts are soluble in nature but are harmful in higher limits. BIS has fixed desirable limits of all salts in water for domestic uses as per IS 10500.

Treatment Scheme

The water containing Iron, Calcium, Magnesium salts generally get precipitated with little change in temperature or with atmospheric contacts.

But water containing Sodium Salts, Silica Salts, Fluoride and Arsenic Salts are soluble in nature and to bring down below the desirable limit is very expensive treatment. This can be done by (a) Distillation Process (b) Demineralization Process (c) Reverse Osmosis Process.

General Information

How the filter works (Cartridge type)

Most raw water supplies contain a variety of contaminants. While some of them are dissolved, e.g. salts and organics, others float in water. The cartridge filter, rated for 5 microns, will remove any particulate matter 5 microns or larger in size (A 5-micron particle is 0.0002 inches). The filter traps particulate matter on its surface as the water passes through. (Over time, sufficient particulate matter will accumulate to reduce the flow of water through the filter. At that point, the

cartridge filter must be replaced).

How the activated carbon filter works

A significant portion of soil is made up of organic materials. Raw water is often yellowish in colour, with a bad taste and odour. This is due to decayed vegetation leached from watershed runoff. Agriculture discharge adds other contaminants to the water supply.

Activated carbon 'adsorbs' these organic materials from the water to the surface of the filter. Adsorption is a process where in organic molecules physically adhere to the surface of an adsorbing material. When filtered water passes through an activated carbon filter, organic material present in the water is removed and the water becomes colorless, sweeter and odour free. (Over time, the color and taste of the filtered water changes, indicating the carbon filter needs to be replaced).

How The Softener Works

Most of the deep tube well water is rich with soluble salts and minerals during the perpetual concentration process within the reverse osmosis system, certain sparingly soluble salts, such as calcium carbonate, calcium sulphate, barium sulphate and iron can precipitate out on the membrane surfaces during the concentration process, the membrane surfaces can be irreversibly fouled. To prevent this fouling these scale-forming salts have to be removed under pre-treated management, providing a base exchange softener. It is the best solution to protect the surface of the membrane from the fouling of the scale forming salts. Alternatively a scale inhibitor injection system is included. But this involves higher running cost than a softener.

Modern Technology - Membrane Technology

This is a process in which water is forced through a semi permeable membrane having a force size of 0.0001 micron diameter, which rejects almost all undiscovered impurities like dirt, dust, bacteria, viruses and also the dissolved impurities like iron, fluoride, lead, pesticides, sodium chloride and various other ions like calcium, sulphate, etc. which give a bad taste, colour, contaminations and odour in drinking water.

When water is passed through membrane under high pressure it is separated into two streams : pure product water (Permeate) and salty water (Concentrate). The permeate is virtually free of all organics and contains less than 10% of the dissolved minerals originally present. It is than piped to storage tank or directly to the faucet while concentrate is piped to the drain. When TDS contents is very high in the order of 8,000 PPM or more cascade system is adopted i.e. product water of first unit is fed to 2nd unit and so on till the desired TDS is obtained in output water (permeate).

The permeate comes out under low pressure and is stored for end uses after disinfections by chlorination/ultra violate lamp system/treatment. The concentrate comes out under moderately high pressure and may be reused either by effluent re-circulation treatment or by using for industrial uses, land scaling, grading, etc.

A schematic flow diagram of Water Treatment Plant has been given at the end of this article.

Constraints

1. Membranes are to be imported.
2. To generate continuous high pressure the pump required is not available in our country as such to be imported.
3. Huge water is wasted as concentrate drained.

Utility

Although above constraints are there use of R. O. system has found wide market in our country and particularly in coastal areas for both domestic and cultivation purpose.

In National laboratories efforts are taken to develop R.O. cartridge with indigenous materials and it is hoped that very soon cartridges would be available in our country.

To have drinking water free from all contaminations in remote places we have to have our own cartridges like generation of electricity from solar / wind / ocean energy within affordable price.

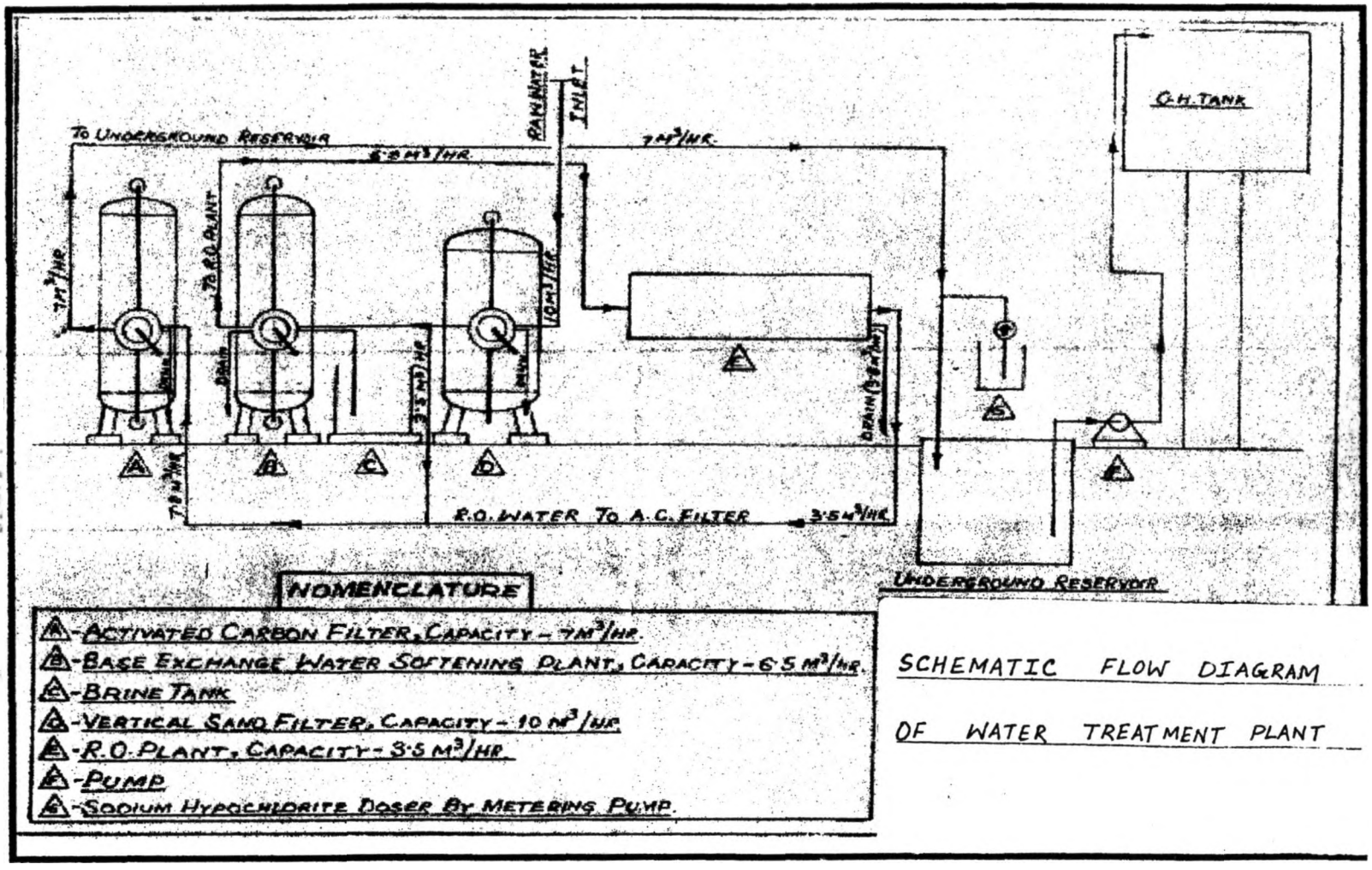
Table 1 : Standard of Drinking Water As Per IS 10500-1991

Sl. No.	Test Parameters	Norms as per IS 10500 - 1991 (Desirable Limit)
01.	Colour (Hazen Unit)	5
02.	Odour	Unobjectionable
03.	Taste	Agreeable
04.	Turbidity in (N.T.U)	5
05.	pH value at 26°C	6.5-8.5
06.	Total Hardness (as $CaCO_3$) in mg/L	300
07.	Iron (as Fe) in mg/L	0.3
08.	Chloride (as Cl) in mg/L	250
09.	Residual free Chlorine in mg/L	0.2 (Min)
10.	Total Dissolved Solids in mg/L	500
11.	Calcium (as Ca) in mg/L	75
12.	Copper (as Cu) in mg/L	0.05
13.	Manganese (as Mn) in mg/L	0.1
14.	Sulphate (as SO_4) in mg/L	200
15.	Nitrate (as NO_3) in mg/L	45
16.	Fluoride (as F) in mg/L	1.0
17.	Phenolic Compounds (as C_6H_5OH) in mg/L	0.001
18.	Mercury (as Hg) in mg/L	0.001
19.	Cadmium (as Cd) in mg/L	0.01
20.	Selenium (as Se) in mg/L	0.01
21.	Arsenic (as As) in mg/L	0.05
22.	Lead (as Pb) in mg/L	0.05
23.	Zinc (as Zn) in mg/L	5.0
24.	Anionic Detergents (as MBAS) in mg/L	0.2
25.	Chronium (as Cr^{+6}) in mg/L	0.05
26.	Alkalinity (as $CaCO_3$) in mg/L	200
27.	Aluminum (as Al) in mg/L	0.03
28.	Boron (as B) in mg/L	1.0
29.	Magnesium (as Mg) in mg/L	30

Table 2 : Table of Major Diseases Caused by Pollutants in Water and Comparison of Various Types of Water Purification Processes

Cannot Remove ♣ **Partly Remove ♥** **95% To 99.9% Remove ♠**

WATER PURIFICATION PROCESS	Pollutants	Lead & Iron	Sodium	Sulphur	Potassium	Chromium	Phosphate	Magnesium	Calcium	Fluoride	Arsenic	Mercury	Bacteria	Virus	Pesticide	Organic Matter	Chlorinate
	Major Diseases	Kidney Ailment Neurosis	High Blood Pressure Cardiac	Digestive related Sickness	Electrolysis imbalance	Bone Deformation Lumbago	Organic phosporus poisoning	Digestion related Sickness	Stone Formation Arthritis	Flurosis	Digestive Sickness	Poisoning	Infection & Disease	Infection & Disease	Poisoning Hepatitis	Poisoning	Decayed Tooth Carcinogens
	Sedimentation & Filtration	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
	Ultraviolet Radiation Disinfection	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♠	♠	♣	♣	♣
	Activated Carbon Filter	♣	♣	♣	♣	♣	♣	♥	♣	♣	♣	♣	♠	♠	♣	♣	♣
	Iodide Resin Based System	♣	♠	♣	♣	♣	♣	♣	♣	♣	♣	♣	♠	♥	♥	♥	♥
	R.O Technology	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠	♠



SCHEMATIC FLOW DIAGRAM OF WATER TREATMENT PLANT