2. PROCESS USED IN THE WATER TREATMENT PLANT OF THE BANGKOK WATER WORKS.

2.1 Introduction. At the early stage of operation of the Water Treatment Plant fifty one years ago, there were good reasons in using rapid sand gravity type of filters in filtration of water. The reasons are:-

1. That filtrating by rapid sand gravity type of filters the plant requires less area an important consideration since the Water Treatment Plant is situated in the city, on Rama VI Road. As the price of land is very high, the plant area needed should be kept at a minimum.

2. That the water in the Chao Praya River being high in turbidity during the rainy season, it is necessary for the water to go through the process of pretreatment before filtration, that is, coagulation and sedimentation. This condition is suitable for filtration of rapid sand gravity type.

The processes employed at the Water Treatment Plant are such that the water to be treated is first secured through a coarse screen at the plant inlet to prevent damage of raw water pumps caused by big pieces of wood or other materials. The raw water is then lifted up to the sedimentation tank. At this stage solution of chemicals is introduced into the raw water. The chemical used consists of alum alone, or alum and lime, depending on the condition of the raw water quality. The lime solution is usually use during the rainy season when raw water is low in alkalinity. The addition of lime solution is to raise the alkalinity and form good floc with alum. The clarified water is then passed on to the filters. The filtering beds consist of fine sand, coarse sand, fine gravel, with coarse gravel at the bottom of the beds. After filtration the water flows to the clear water reservoirs. Before pumping to the distribution mains, chlorine gas, the sterilizing agents, is added to the water. Then the treated water is pumped into the distribution system.

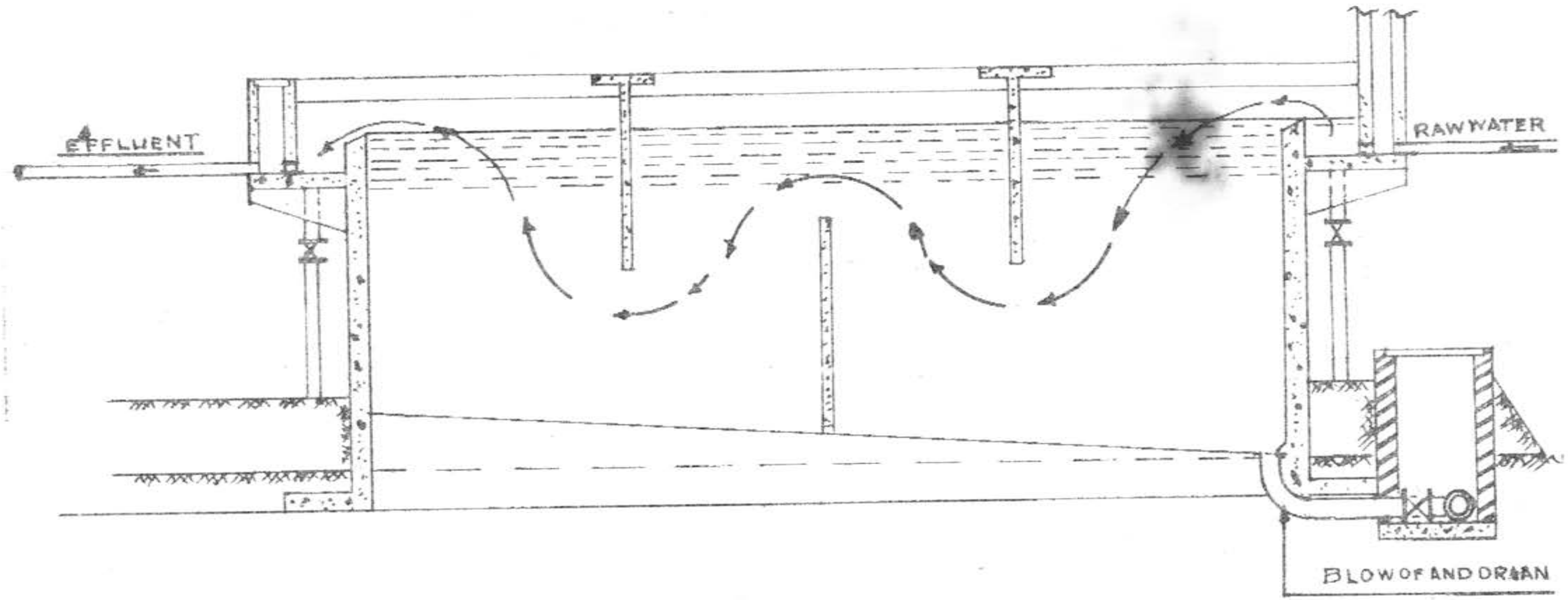
Following are the various stages of treatment at the Samsen Water Treatment Plant, Bangkok Water Works:

2.2 Screening. In general there are two kinds of screen used at the Water Treatment Plant. They are fine screens, and coarse screens, according to the size of particles in raw water. At the Samsen Water Treatment Plant there are only coarse screens placed at every inlet chamber. The velocity of water through the screen opening usually should not exceed 3 fps. In the case of higher velocity of water passing through the screen some pieces of hard materials might pass through it which could cause damage to the pumps. The screen openings used at the Samsen Water Treatment Plant consist of $\frac{3}{8}'' \times 2''$ iron bars placed at 5 cm. intervals. The surface area of the screen is 10 ft^2. The rate of flow through each screen is about 29.5 cuft./sec. and the velocity of flow is $\frac{29.5}{10}$ or about 3 fps.

2.3 Coagulation and Sedimentation. Turbidity in water is caused by suspended and colloidal matters in water. Coagulation can be facilitated by using suitable chemicals to form larger particles. Aluminium sulfate is the coagulant used in the treatment plant, but during the rainy season a solution of lime is introduced with the solution of Aluminum sulfate to produce good floc. In mixing the chemicals with raw water and in the formation of floc, rapid mixing is required with the speed being decreased as floc is formed. Them the water flows through a sedimentation basin in which the coagulated solids settle to the bottom.

There are two types of sedimentation basin:- the up and down sedimentation basin used during the early years of the operation of the plants at the first, second and third filter houses. The other type is circular in shape, called accelator. The accelator produces clearer water in shorter time. Nowadays, there is a tendency to build the accalator type of sedimentation basin. All the sedimentation basins built in the later years were of accelator type.

2.4 Filtration. As the turbidity of clarified water is about 10 ppm, it is necessary that it be filtered additionally by passing through the sand and gravel beds. The filtered water will then become clear and the turbidity will not exceed 1 ppm.



SETTLING TANK "UP AND DOWN"

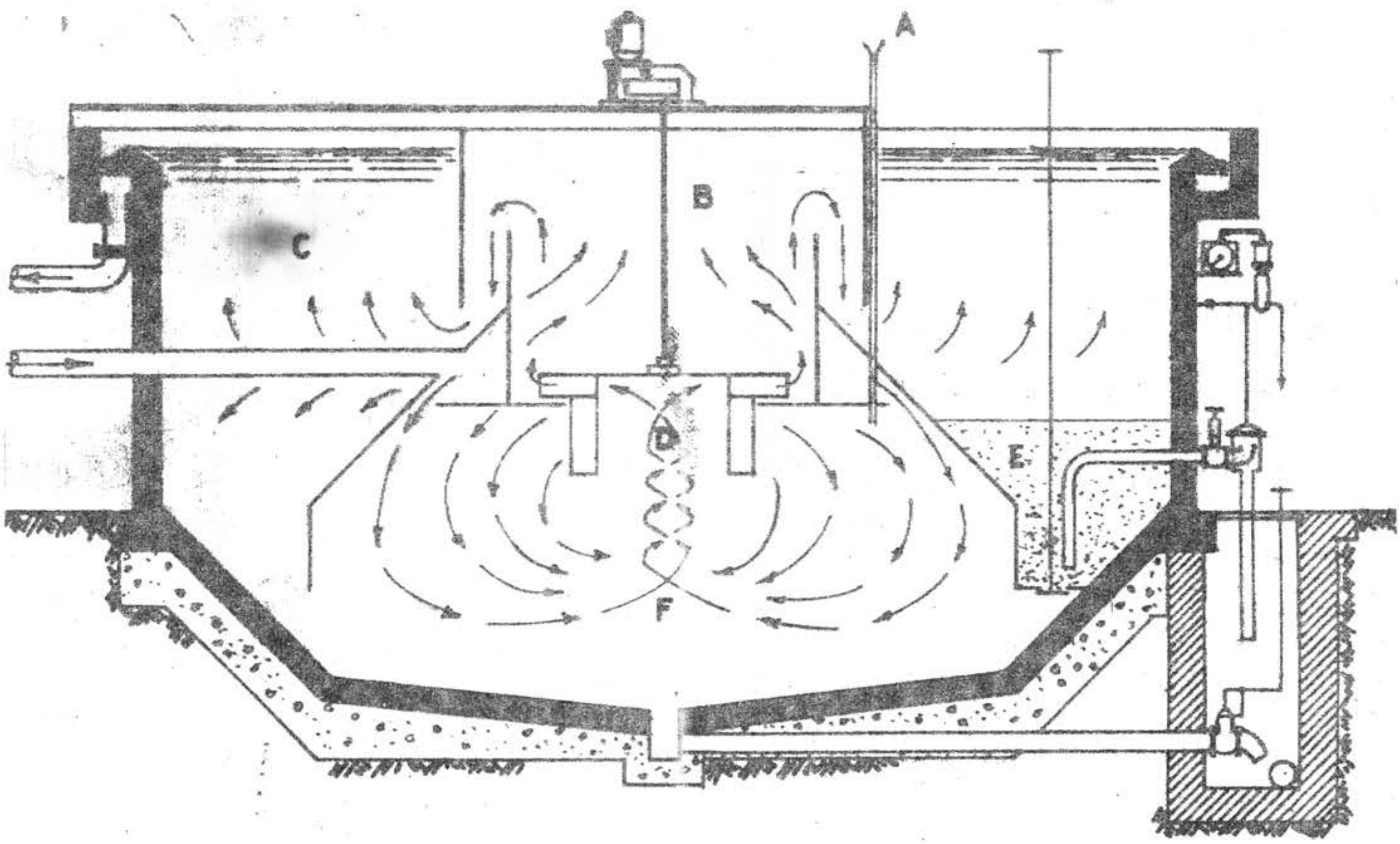


DIAGRAM SHOWING THE OPERATION OF AN ACCELATOR CLARIFIER

A. REAGENT INLET.

B. SECONDARY REACTION ZONE.

C. CLEAR WATER.

D. IMPELLER.

E. SLUDGE CONCENTRATION ZONE.

F. PRIMARY REACTION ZONE.

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Filter beds usually consist of reinforced concrete tanks with andunderdrain system at the bottom to collect the filtered water and deliver it to the clear water reservoirs. There are layers of sand and gravel of differnt sizes. The efficiency of the filtration depends on the size and the unifor-mity of the sand. The effective size of the sand normally is about 0.50 mm., and the uniformity coefficient 1.70 to 1.20.

Quality of sand and gravel

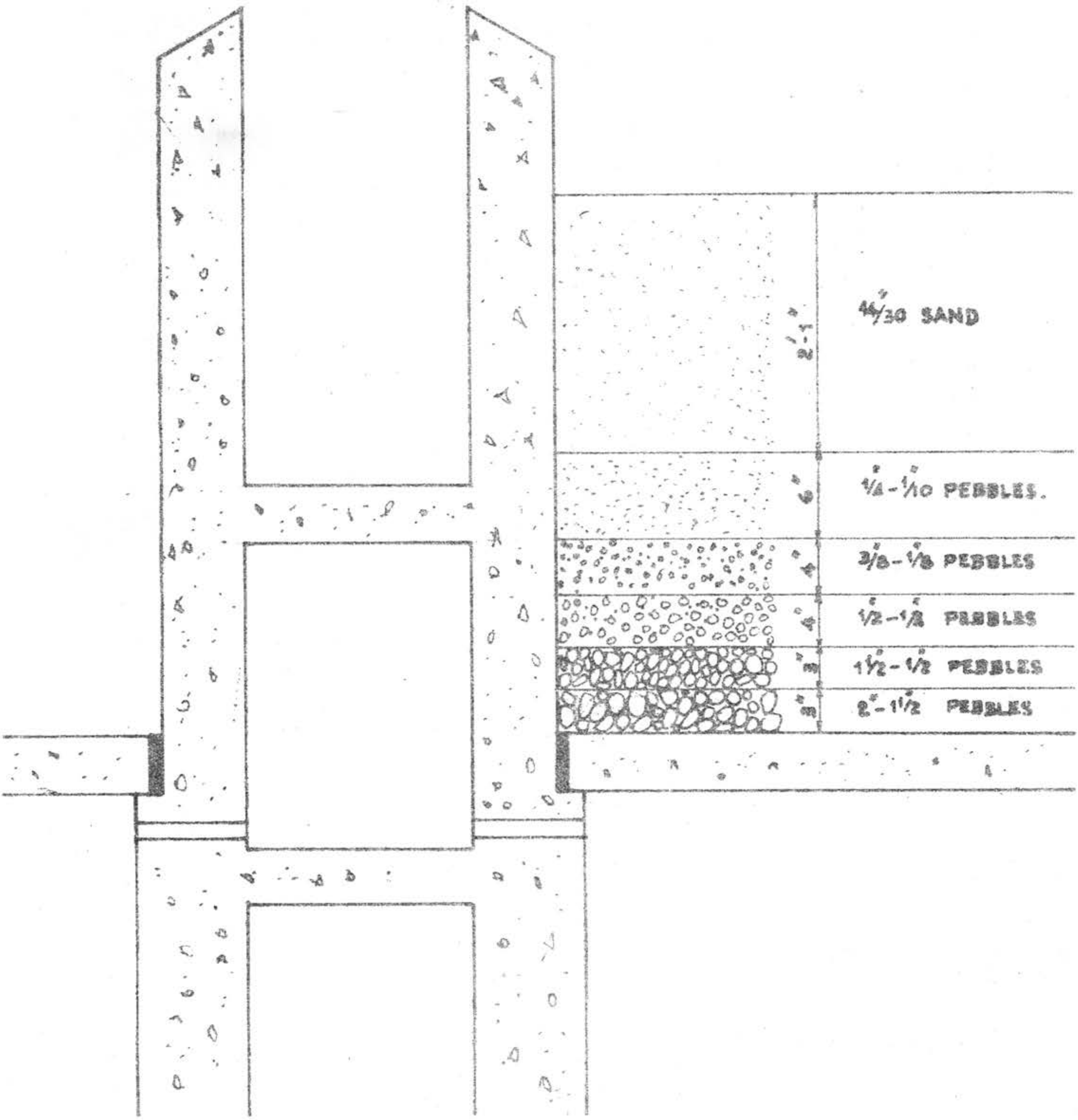
Sand and gravel containing at least 98% silica is generally used. The granules must be hard in order to prevent wear by friction during washing. There is a choice between smooth granules(from river or sea) and rough granules(from crushed material).

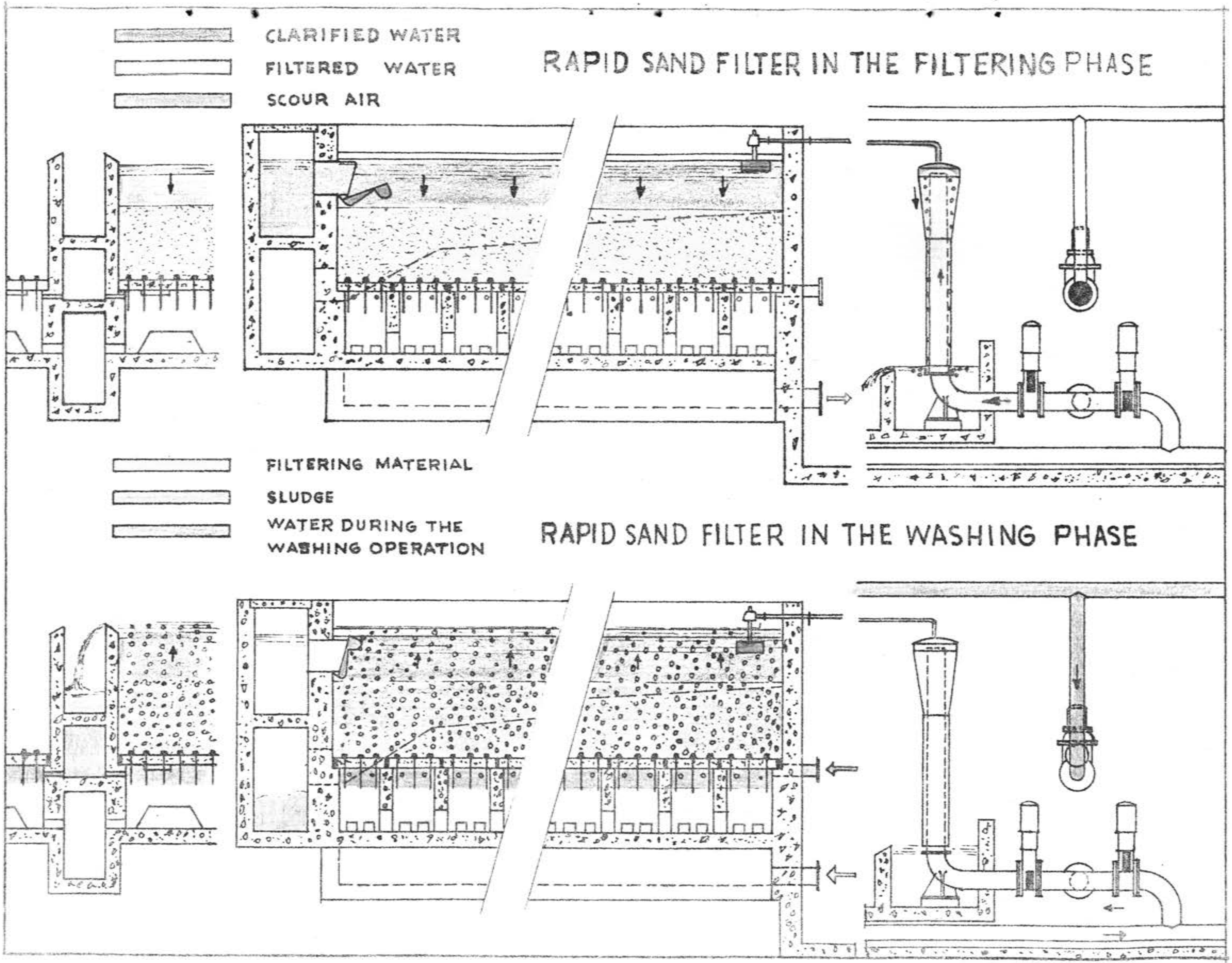
Depth of the filtering layer

The loss of head through a filtering mass is directly proportional to its height and rate of flow of water. The retention of impurities by the filter(particularly near the surface) leads to a reduction in porosity; the rate of develop-ment of the resultant head loss is faster the dirtier the filter becomes.

This explains why filter head loss during operation at a constant flow does not appear on a graph as a straight line but, on the contrary, in the form of a parabola (the head loss curve of the filter).

RAPID SAND GRAVITY FILTER





CLARIFIED WATER
FILTERED WATER
SCOUR AIR
RAPID SAND FILTER IN THE FILTERING PHASE
FILTERING MATERIAL
SLUDGE
WATER DURING THE WASHING OPERATION
RAPID SAND FILTER IN THE WASHING PHASE

In order to obtain a flow of clear filtrate at all times it is essential that the loss of head should remain between two limits, depending upon the nature and quantity of the impuri--ties to be retained and also on the rate of filtration.

The lower limit is that necessary to obtain clear water immediately upon resumption of operations, when the filter is clean. It is achieved by using a layer of sand which is greater - in depth the coarser the grain.

The upper limit is that which must not be exceeded if the previously retained impurities are not to be detached from the sand by the pressure of the water and carried into the filtrate. This limiting value is higher the finer the sand.

As a general rule it may therefore be said that the sand the less the depth of the filtering bed, but also the higher the mean loss of head.

On the other hand, the coarser the sand, the greater the depth of the filtering layer, but also the lower the mean loss of head.(6)

<u>Filter beds at the Samsen Water Treatment Plant.</u>

Two types of sand grading are used,

1. Sand grading for filter beds of filter houses Nos. 1,2, 3,4,5,6,7, and 8 is 0.3 mm. to 0.5 mm. The loss of head may reach 2 meters (about 6 ft.) with a cloogged filter. The sand layer is about 25 to 30 cm. deep, beneath the sand layer are coarse sand, and gravel as shown in the diagram of the filter bed section.

2. Sand grading for filter beds of the filter houses Nos. 9 and 10 is 0.8 mm. to 1.00 mm. The loss of head may reach 1.5 meters(about 5 ft.). Sand layer is 80 cm. deep. There is only one layer of uniform sand. Beneath the sand layer is the strainers and gravel which fill the space between strainer to strainer about 5 cm. deep.

All the filter beds are washed by air scour and water at 24 - 30 hours interval, the frequency of washing depending on the quality of clarified water. The process of washing is:

1. The influent valve is closed. The filter is then allowed to operate until the water level reaches the edges of the troughs.

2. Compressed air is used to agitate the sand while the wash water is applied.

3. After 5 minutes of air scour the wash water is applied alone and continues until the wash water appears fairly clear to the operator.

4. Close wash water and waste-water valves, then open influent and effluent valves.

2.5 Sterilization. Chlorine gas is commonly used for the sterilization of water because of its enormous efficiency when used even in minute quantities, and to its simplicity in use and handle.

Various Other Processes:

1. Sterilization by ultra-Violet rays.

Ultra-Violet rays are produced by very low-pressure mercury vapour lamps.

Wavelengths between 2,000 and 3,000 Angstrom units are used, the maximum germicidal action being in the neighbourhood of 2,600 Angstroms. The water to be sterilized must circulate near the lamp in as thin a layer as possible, as ultra-violet rays are rapidly absorbed by water. The water must be perfectly clear.

A 25 - watt lamp can sterilize approx. 2,000 litres(440 Imp.gal.) of water per hour, 15 - 20 cm.(6 to 8 in.)deep. The average life of a lamp is 2.000 hours.

2. Sterilization by metallic ions.

The introduction into the water of traces of certain metallic ions, particularly silver, causes the destruction of microbic germs. For example, the immersion of a piece of silver can sterilize a small quantity of water in a period of from 6 to 12 hours. On an industrial scale the production of metallic ions is accelerated by electrolysis using a silver anode. The water charged with silver ions retains its bactericidal power for a very long time.

3. Sterilization by electricity.

Sterilization can be achieved electrically if the water contains a sufficient quantity of sodium chloride. The electro--lysis of this salt is brought about by means of carbon electrodes, and produces free chlorine or sodium hypochlorite. A 1.6 volt D.C. current is normally used. The consumption of electric power depends on the salinity of the water, the surface area of the electrodes, and the degree of pollution of the water.

4. <u>Sterilization in the field</u>. By iodine

A) Iodine tablets (to make 100 tablets):

Potassium iodide : 10 g.

Sodium iodate : 1.06 g.

B) Tartaric acid tablets(to make 100 tablets):

Tartaric acid 10 g.

C) Thiosulphite tablets (to make 100 tablets):

Sodium thiosulphite 0.16 g.

One tablet of A and one tablet of B must be dissolved per litre of water to be sterilized in order to set free the iodine. After 10 minutes add one tablet of C.

By sodium hypochlorite.

Add one drop of commercial hypochlorite per litre of water to be sterilized. Wait half an hour. Destroy the excess chlorine with one crystal of sodium thiosulphite or merely by adding a little wine.

By calcium hypochlorite (bleaching powder)

Mix one teaspoonful of reagent to one-quarter litre of water. Leave to settle for 15 minutes. Add the resulting liquid to 100 litres of the water to be sterilized and stir. After allowing to stand for half an hour neutralize the excess chlorine by adding a pinch of sodium thiosulphite previously dissolved in a little water.

This procedure is applicable to ordinary chloride of lime at 40 chlorometric degree. With chloride of lime of 100 chlorometric degrees use half a teaspoon.

By chloramines. Chloramine tablets sterilize without causing any noticeable taste.

By chlorine dioxide. Use a 4% solution of sodium chlorite and a solution of hydrochloric acid containing 40 ml. per litre of hydrochloric acid at 22° Beaume(1.2 S.G.)

Into a test tube or a small flask pour as many drops of each of these two solutions as there are litres of water to be sterilized. Dilute the resulting volume by once or twice its volume of water. Wait five minutes, and then pour the resulting yellow solution into water to be sterilized and stir. It is better to wait half an hour before drinking the water.[6]

Chlorine gas is used in the sterilization of water at the Samsen Water Treatment Plant. Chlorine is supplied in liquid form under pressure from metal cylinders. The gas emerging from the cylinder is released at constant pressure and the adjustment of the output can thus be effected by the simple operation of a regulating valve. A meter indicates the output at all times and the gas is dissolved in a small quantity of water which is itself subsequently mixed with the water to be treated.

The quantity of chlorine used is 1.0 - 1.2 ppm. After twenty to thirty minutes of contact time there is 0.6 to 0.8 ppm. of residual chlorine. At the Plant the total quantity of chlorine gas used is 550 to 600 kilograms per day.

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