4. THE RESULTS OF WATER EXAMINATION AT THE BANGKOK WATER WORKS.

4.1 pH Values of Raw Water and Filtered Water. pH is a term used rather universally to express the intensity of the acid or alkaline condition of a solution. More exactly, it is a way of expressing the hydrogen-ion concentration. Measurement of the pH value is an essential factor in water treatment practice. In particular it plays an important part in the efficiency of the coagulation process, disinfection, water softening, and corrosion control.(2)

The pH values of raw water and filtered water at the Plant lie between 7.6 - 8.0 and 6.8 - 7.2 respectively. During the hot months of April to June, the pH values are usually slightly higher. During the rainy months from June to October the pH values are low, but show a tendency to rise in the months of October to December. We can see that the pH value in the hot season is higher than that in other seasons.

4.2 The Turbidity of Raw Water. Turbidity of water is caused by suspended and colloidal matter, or by living or dead algae or other organisms in the water. Under flood conditions, great amounts of topsoil are washed to receiving streams. Much of this material is inorganic in nature but considerable amounts of organic matter are included. As the rivers progress toward the ocean,

they pass through urban areas where domestic sewage and industrial wastes, treated or untreated, may be added. The domestic sewage may add great quantities of organic and some inorganic materials that contribute to turbidity, Certain industrial wastes may add large amounts of organic substances and other inorganic substances and produce turbidity. Street washing contributes much inorganic and some organic turbidity. Organic materials reaching rivers serves as food for bacteria, and the resulting bacterial growth and other microorganisms that feed upon the bacteria produce additional turbidity.(2)

We can see from the graph of turbidity of raw water that the turbidity will be higher to maximum during the rainy months. The water will be clearer after the month of August till December.

An exception for the turbidity of raw water took place in 1963, which showed a great difference from other years, because an excavation was made to widen the intake canal. The turbidity was high in January to August, but in December it was low as usual.

In 1964 the turbidity was the highest in the months of mid rainy season, and was lower near the end of the year.

4.3 Alkalinity of Raw Water and Filtered Water. The alkalinity of natural water is due to the presence of salts of weak acids. Bicarbonates represent the major form of alkalinity since they are formed in considerable amounts from the action of carbon dioxide upon basic materials in the soil. Other salts of weak acids, such as borates, silicates, and phosphates, may be present

in small amounts. A few organic acids that are quite resistant to biological oxidation, for example, humic acid, form salts that add to the alkalinity of natural waters.

Under certain conditions natural waters may contain appreciable amounts of carbonate and hydroxide alkalinity. This condition is particularly true in surface waters where algae are flourishing. The algae remove carbon dioxide, free and combined, from the water to such an extent that pH values of 9 to 10 are often obtained.[2]

On looking at the diagram of alkalinity, the alkalinity of raw water is found to be 82 to 87 ppm. and that of filtered water to be 62 to 67 ppm. as $CaCO_3$ in January. It gradualy increases in February and March and reaches a maximum in April. After May and June, during the rainy season, the alkalinity of water gradualy decreases and reaches a minimum in September and October when it is found to be only 2 to 8 ppm.

4.4 Hardness of Raw and Filtered Water. Salts of calcium and magnesium cause hardness in natural water, but salts of ferrous, manganous and strontium are scacely found. These salts form an insoluble compound with soap, which then loses a portion of its detergent power and can only with difficulty be made to lather. The terms "hard water" and "soft water" are in general use but there is no defined line of demarcation between the two. If it is found that the quantity of the salts of carbonates, sulfates of calcium and magnesium is very high, it requires process of softening.

Water having a total hardness up to 500 ppm. can be used for domestic purposes, but the most suitable value is around 150 ppm.

Water of very low hardness, that is, of less than 50 ppm., forms with soap a very abundant lather which leaves the skin with a slightly greasy feeling which is very pleasant and the skin remains soft and supple, while hard waters tend to harden the skin.

When washing clothes the use of hard water gives rise to a waste of soap, but the consumption of water for rinsing is reduced by using slightly harder water, for example, a hardness of 100 ppm.

In steam boilers, where water is concentrated by evaporation, the sulfates and chlorides of calcium and magnesium also give rise to scale formation. It is for this reason that boilers must be fed with water which is as soft as possible.

In the case of town water distribution the presence of a certain degree of hardness is useful in order to form a calcium carbonate layer on the piping, which is thus protected against corrosion.(6)

In the diagram showing hardness of raw water, there is 80 ppm. in January which gradualy increases to 140 ppm. in May and June. During the rainy season, the hardness of water decreases to 60 ppm. After that time the hardness will increase again.

In paragraphs 4.1, 4.2, 4.3, and 4.4 the results of examinations on pH valve, turbidity, alkalinity and hardness of raw and filtered water are explained. They follow the same pattern, while all the changes in their quantities are due to rain water. Rain water as it falls upon the earth is capable of dissolving tremendous amounts of solids found in the soil. The ability to dissolve is gained in the soil where carbon dioxide is released by bacteria action. The water then becomes highly charged with carbon dioxide which, of course, exists in equilibrium with carbonic acid. Under the low pH conditions that develop, basic materials, particularly limestone formation, are dissolved. As rivers descend from mountain areas onto the plains, they recieve organic materials, inorganic materials, domestic sewage, and industrial wastes. Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and other microorganisms produce acid, so that at the same time the pH value is decreased, the alkalinity is increased, the turbidity is increased, and so is the hardness in the rainy months.

4.5 Chloride in Raw Water and Filtered Water. Chlorides occur in all natural waters in widely varying concentration. The chloride content normally increases as the mineral content increases. Upland and mountain supplies usually are quite low in chlorides whereas river and ground waters usually have a considerable amount. Sea and ocean water represent the residues resulting from partial evaporation of natural waters

that flow into them, and chloride levels are very high. Chlorides gain access to natural waters in many ways. The solvent power of water dissolves chlorides from top soil and deeper formations. Human excreta, particularly the urine, contain chloride in an amount averaging about 6 grams of chlorides per person per day and increases the amount of Cl^- in sewage about 15 mg/l. above that of the carriage water. Thus sewage effluents add considerable chlorides to receiving stream. Many industrial wastes contain appreciable amounts of chlorides.(2)

It is found that the chloride in the water is maximum in the month of June. During the months of July and August to December the chloride content decreases steadily. The reson is that the amount of domestic and industrial wastes draining into receiving rivers is usually the same each month, whereas during the rainy months the chloride in the water is diluted by rain water, which makes the chloride content in the water usually lower then.

4.6 Iron content in Raw Water and Filtered Water.

The presence of iron in water always creates difficulties. Iron precipitates on contact with air and forms red flakes which produce turbidity and mark clothing. Organisms whose life process depends on compounds of iron may cause tasts and odor and attach themselves to the walls of pipes, thus causing the latter to corrode with the formation of bulky and hard

incrustation. The upper limit for iron content in water can be regarded as 0.3 ppm.[6]

In the graphs showing iron content in raw water and filtered water, the quantity of iron does not depend on the season but on the soil which the water flows through, and whether it is high in iron salts or not.

The amount of iron content in raw water is higher than that in filtered water, because the iron salts present in raw water are in ferrous form and are oxidised into ferric form and precipitate while in the process of being treated at the Water Treatment Plant.

4.7 Total Solids Content of Raw Water and Filtered Water.

This indicates the amounts of soluble and insoluble substances in the water after its evaporation. The amount of undissolved colloidal and suspended matter increased with the degree of pollution sludge represents an extreme case in which most of the solid matter is undissolved, and the dissolved fraction is of minor importance.

In comparing the graphs of total solids with that of hardness of water, it is found that the hardness increases when the total solids increase, an indication that part of the increased solids are carbonates or bicarbonates.

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