# Aluminium in drinking-water

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THE design of water treatment plants is dependent on a number of things. The raw water quality, the quality of water after it has been filtered and the construction cost of the plant. All types of water treatment plants (biological filtration, rapid-sand filtration and high-rate filtration), typically employ coagulation as one of the unit treatment operation. The other unit operations being flocculation, sedimentation, filtration and disinfection.

Coagulation and flocculation units are used in conjunction with each other. In coagulation unit, coagulants are added to the incoming water and, intense mixing is done for few seconds. Thereafter, the water flows to the subsequent flocculation unit, where floc formation is achieved through slow and gentle mixing.

Some of the factors, influencing the coagulation process are water temperature, particle size, concentration of particles, type of coagulant used, water pH, electrolyte concentrations, exchange capacity and electrical charges on particles.

The most common and widely used coagulant is aluminium sulphate. This is because of its free availability, ease in handling and relatively lower costs.

The handling of dry aluminium sulphate is not free from hazards. Its dust exhibit properties of acidic chemical and is relatively more hazardous. Protective clothing, goggles, gloves, neck cover and respirators are used by sensible chemical operators of the water treatment plants.

The optimum pH range of water for use of aluminium sulphate is 5.5 - 8.0 for turbid waters. For coagulating highly coloured waters, the pH range is 4.4 - 6.0. Typically, aluminium sulphate is added at the rate of one grain per gallon of water (20 mg/1 - milligrams per litter). Experience indicates that, under some conditions, the amount of coagulant required may increase with the increase in water temperature. Additional coagulation would be required, if the concentration of surfactants in water increase beyond 15 mg/1. At low temperatures (below 20 C), difficulty may be encountered in achieving good floc formation.

Some water treatment plants use coagulants at two or more points in the treatment process. This is known as double coagulation; but is rarely practised.

According to the 1984 WHO *Guidelines for Drinking-Water Quality*, a value of 0.2 mg/1 of aluminium in drinking-water has been recommended, based on aesthetic considerations. The maximum admissible level of aluminium set by the European Economic Community, *Drinking Water Quality Standards* is also 0.2 mg/1. The US Environmental Protection Agency, under *Safe Drinking-Water Act*, has set a secondary maximum level of aluminium as 0.05 - 0.2 mg/1.

In water treatment, most of the aluminium used as coagulant, settle out and is removed as waste sludge. Some is also removed by filtration units in the plant. Despite this, some aluminium always remain in the finished waters.

All well-designed and properly-operated water treatment plants are technically able to meet the WHO set value of 0.2 mg/1. The higher aluminium level in finished waters (greater than 0.2 mg/1), would signify fault in coagulation, flocculation, sedimentation or filtration units.

**All well-designed and professionally operated water treatment plants are technically able to meet the recommended value of 0.2 mg/1. The higher aluminium level in finished waters would signify fault in coagulation, flocculation, sedimentation or filtration units**

Higher levels of aluminium in finished waters would lead to aluminium deposition in the distribution system (post-flocculation), during the periods of low water flows, reducing the hydraulic capacity of the distribution system.

Subsequent high flows in the system would re-suspend the aluminium sediments, conveying it all to the consumers' taps. Hence, some consumers may, at some time, get higher levels of aluminium in drinking-water.

The level of residual aluminium in finished waters is greatly influenced by the presence of fluoride and alkalinity. Research indicates that, presence of 0.8 mg/1 of fluoride will cause elevated levels of aluminium in finished waters.

High levels of residual aluminium in finished waters would also be caused by the presence of low levels of alkalinity (8-10 mg/1 as calcium carbonate) in the water. This is, probably, explained by the poor floe formation.

Though the WHO value is 0.2 mg/1, the intake of aluminium through drinking-water in people, living in hot climates, is slightly more, as compared to people living in cold regions. This is because of more intake of drinking-water by people each day in hot climates (three litters, as against 1.5 litters per day, consumed in cold regions).

In Karachi, every third person is under some sort of stress and tension. This, together with the diet, containing high levels of red chilies, has made the 'acidification' condition, a common health problem.

The regular use of 'antacids', containing aluminium hydroxide, is another source of intake of aluminium. The use of aluminium utensils has also its share, in the intake of aluminium on diurnal basis.

In Karachi, due to relatively high levels of turbidity in drinking-water (greater than 5 JTU - Jackson Turbidity Units), especially during the rainy season, people use alum to coagulate and remove the turbidity.

This again increases the daily intake of aluminium of Karachi populace. This is bound to have its effects on the population's health.

Research conducted during the last two decades, appears to implicate rather strongly the intake of excess aluminium through drinking-water (containing greater than 0.2 mg/1 aluminium).

This level many believe results in several neurologica diseases, like Alzheimer's di ease, pre-senile dementia an two severe neuro-degenerativ diseases, namely amyotroph lateral sclerosis (ALS) an parkinsonism dementia (PD).

According to a researc work, using laboratory animal there is a significant differen in aluminium metabolis between young and old anima and that of 25 per cent of th older animals who have a muc greater ability to absorb al minium into tissues, includi the brain. Since, aluminium toxic to brain cells, it poses potential health problem older people, if confirmable humans.

Another research study inc cates that, people wi Alzheimer's disease and Down Syndrome have a defective for of the protein transferring. Th protein normally binds alumin um in the blood and prevents from entering the brain. In pe ple with this problem, less al minium is bound, hence more available to enter the brai which may result in the neur toxic changes, seen Alzheimer's disease.

There is some evidence su gesting that individuals suffe ing from chronic renal problem absorb aluminium more readil than normal person Aluminium once absorbe appears to bind to serum pr teins, in particular the plasm protein, transferrin.

Absorbed aluminium appea to be excreted from the body b the kidneys. People with ren insufficiency tend to accum late aluminium, because of the inability to eliminate it throug the kidneys.

People, who require ren dialysis, can suffer sever health complications, du to the presence of aluminiu in dialysis fluids. The mai risk to dialysis patients fro high aluminium levels dementia.

Water quality guidelines ar currently being reviewed b international agencies. Whil the guidelines values of alu minium in drinking-water (0.2 mg/1) are based on aesthetic conditions, to prevent post-floc culation and discolouration o water in the distribution sys tems, it appears unlikely tha the current review may change the aluminium guidelines fro aesthetic considerations t health-related guidelines. ■