Identification of mineral deposition at Akurana distribution line of Greater Kandy Water Treatment Plant

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Introduction

A water distribution network cannot be considered an inert system but a reactor interacting with the interior aqueous environment. One of the main consequences of such interaction is the formation of unwanted deposits. The main sources of deposits in water distribution systems are particulate matter transported by water, microbial activity and physicochemical reactions both at the water pipe wall interface and within the water bulk (Chawla et al, 2012).

Greater Kandy water treatment plant is situated at Katugastota in the Central province of Sri Lanka Mahaweli river water taken as raw water is treated and distributed to the Northern part of Central province. This plant has four transmission lines to distribute water. Those lines are Asgiriya (A1),Gohagoda (A2), Kahawatte (A3), and Yatiyawala (A4). A3 transmission line transmits water to Kahawatte and it distributes water to Akurana area. The reddish brown color deposition can be observed, when flushing of the ductile iron pipes at pumping main of the Akurana distribution line at Greater Kandy Water Treatment Plant. Natural river water containing dissolved ions such as Ca, Mg, Al, and Si etc which can form stable mineral phases. Those minerals can be deposited in distribution lines when they meet the favorable conditions to form possible mineral phases. In this research, we will try to identify possible mineral phases are formed by using VMINTEQ software.

Materials and methods

Water samples analysis was related to identification of causing factors of mineral deposition at raw water and treated water. Samples were collected from plant, Akurana reservoir and Akurana distribution lines. In plant samples were collected from raw water from intake, distribution chamber, after flocculation tank, after sedimentation, filter inlet, filter outlet, and Sump. Two distribution samples were collected from near the Akurana reservoir and at Akurana town.

pH, turbidity , electrical conductivity and colour were measured. Nitrate, nitrite, fluoride, phosphate, sulfate anions and iron were analyzed using UV spectrophotometer. Iron concentration of water was rechecked by using AAS (Atomic Absorption Spectrophotometer). Powder fillers were used to measure ions by using UV spectrophotometer. Ferro Ver, SulfarVer 4, Nitro Ver 3, Nitro Ver 5, PhospoVer were used as powder fillers to measure iron, sulfate, nitrite, nitrate and phosphate respectively. Different colours were given according to element contained in samples. Ammonia was measured by adding mineral stabilizer, polyvinyl Alcohol and Nesslar reagent, using spectrophotometer. Fluoride was also measured by adding SPANS using spectrophotometer. Chloride was measured by using digital titration method. Hardness and

Alkalinity were measured by using titration method. Then deposited sample was collected from a tap which carrying sump water, was centrifuged and dried. It was analyzed using X-ray diffraction method (XRD) at Chemistry laboratory of Peradeniya University. Visual MINTEQ software was used to analyze water quality data and possible mineral phases that form deposits.

Results and Discussion

C1, C2,C3,C4,C5,C6 are in plant premises as raw water intake, distribution chamber, flocculation tank, filter inlet, filter outlet and Sump respectively. C7 and C8 are two Akurana reservoiers. C9 and C10 are two distributions of Akurana reservoiers. According to graphs fistly they descrease gradualy to flocculation tank and it increase at filter outlet and again it decrease to Sump. When water flows to Akurana again it become increase.

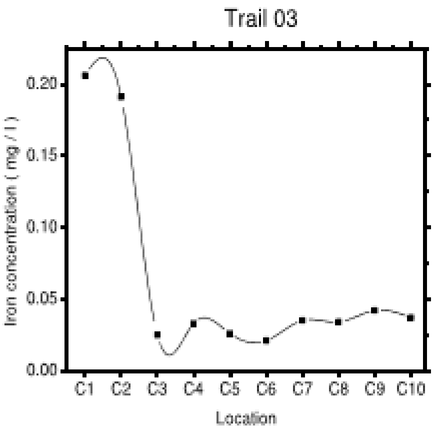

Figure 1. Iron concentrations

The posibility to form deposits can be analysed by using VMINTEQ software. According to data $Fe(OH)_{2.7}Cl_{.3}(s)$, Ferrihydrite , Ferrihydrite (aged) , Goethite , Hematite, Lepidocrocite , Maghemite , Magnetite , Strengite can be deposited. By plottingErying's model for treated water ln (k/T) Vs 1/T, A linear relationship is obtained and one can determine $\Delta H^{\#}$ from the slope ($-\Delta H^{\#}/R$) and $\Delta S^{\#}$ from the y-intercept [$\ln(K_b/h) + (\Delta S^{\#}/R)$]. So $\Delta H^{\#}$ is 132.00364 KJ /moland $\Delta S^{\#}$ is 0.23113 KJ/mol K. The XRD resulted graphs are shown below. Red colour lines are peaks for sample and ash colour lines are related to standard peaks of Maghemite.

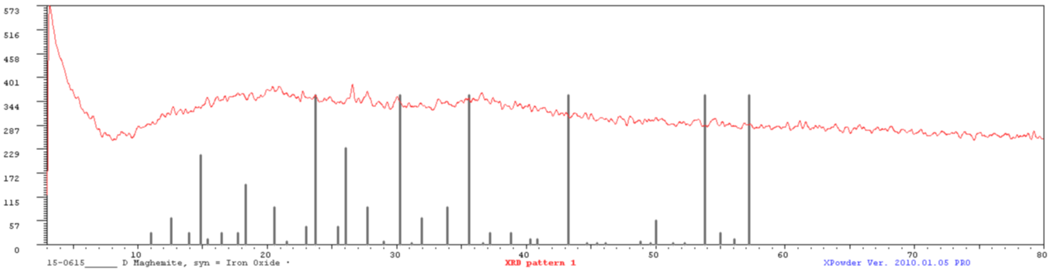

Figure 2. XRD data for Maghemite before washing Acetone

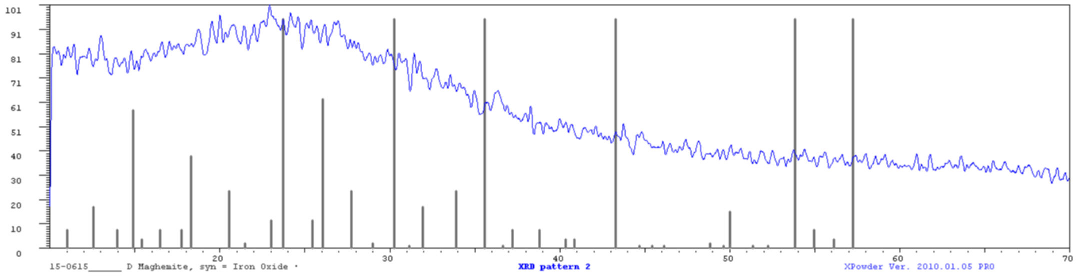

Figure 3. XRD data for Maghemiteafter washing Acetone

Conclusions

Iron concentration variation is decreased in plant locations except Inlet of filter. Filter inlet value is increased little bit and lowest iron concentration at Sump. Small floccus which are not settled in sedimentation tanks come to filter inlet and that cause small increment of iron concentration at filter inlet point. But when those particles are traveled through the filter medium trapped to media and decreases the iron concentration at filter outlet point. Water contain iron concentration is increase at Akurana reservoirs and Akurana distribution. Water pressure and Temperature are varied in Kahawatta transmission line and because of that deposited samples can be re-dissolved. Akurana reservoir is gained water from Kahawatta transmission line and the iron concentration can be increased because of re dissolving of iron deposition. According to Erying model calculation $\Delta H^{\#}$ is 132.00364 KJ/moland $\Delta S^{\#}$ is 0.23113 KJ/mol K .This values are moderately close to standard values of the ΔH^{θ} =250.8 KJ/mol and ΔS^{θ} = 142 J /mol K (Stumm,1996). So according to water quality data it has possibility to form Maghemite even in low concentration point of Sump where the place deposit was collected. So other places of plant have possibility to form deposit, but at tank surfaces the deposited cannot be observed because of cleaning. But in line surfaces have passivity to observe the deposit. XRD Diffraction data is also moderately same to Maghemite data. The peaks are slightly observed because that XRD instrument has not iron filter. So according to water analysis and deposited analysis the deposit is iron contain and it is Maghemite. To reduce to from this deposited it is possibility to use aeration unite. Because of aeration iron are oxidation and precipitate.

References

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