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Effect of Filter Back Wash Water for Removal of Ammonia, Turbidity and Iron by mixing with Source Water

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ABSTRACT

The overall purpose of this research was to examine the impact of filter backwash water (FBWW) on coagulation- sedimentation processes. Samples were collected from two different surface water treatment plants: Bhagirathi water treatment plant (BWTP) and Wazirabad water treatment plant (WWTP). Jar test results indicated that the improvement in source water (SW) quality could be achieved by recycles of FBWW with SW. Jar test study showed that less alum required when FBWW was added to the SW for both plant. The data suggested that when ammonia free FBWW added to SW, the less amount of chlorine was required to remove ammonia. This study also showed the fact that the WWTP treated poorer raw water quality than that of the BWTP, which results in higher alum dosage required and higher amount of contaminant presence. Implication of this study helps in water conservation by recycling FBWW with SW.

Keywords: Filter backwash water, source water, alum dose, jar test, turbidity, chlorine demand.

INTRODUCTION

Water treatment plants generate various waste residuals during the drinking water purification process. All water treatment plant produce residuals that may be very different in physical, chemical and biological compositions which are comprise 2-10 % of plant throughout. FBWW make up more than 7% of plant production waste residuals of filtrate from a filter press, and clarifier sludge (CSW) represent less than 3% of plant production [1,2]. Increasingly stringent discharge requirements, expensive chemicals and conservation efforts have forced many plants to consider or implement recycling. Recycling of water treatment plant waste residuals is an acceptable practice of good water conservation management [3].During treatment of SW for drinking water, waste residual volumes are generated according to the nature of the unit operations involved in treating the raw source water. Water quality concerns with recycling residual water during treatment relate to the potential of concentrating dissolved chemicals and microorganisms to levels that may compromise the efficiency of the main treatment plant process [4]. FBWW contains high concentrations of turbidity, natural organic matter (NOM) and residual inorganic and organic polymers. It is well established that organic colors in natural water has the physical and adsorptive properties of negatively charged colloids [5]. Previous research that has investigated the impacts of recycling FBWW with the main process trains of conventional filtration water treatment plants (WTPs) has concluded that by using settling either a thickener or a lagoon system include increased particle and cyst loadings, hydraulic surges and changes in coagulation chemistry [6,7]. Many utilities that practice waste stream recycling have reported both benefits and problems for this form of waste residual management [8]. Such types of work on impact of recycling of FBWW with SW water stimulated interest to analyze different physical and chemical parameters of SW and FBWW with SW. For this study samples were collected from two different surface water treatment plants, BWTP and WWTP to gain better understanding impact of FBWW on SW by either physical or chemical mechanism. The analyses were materialized to find out different parameters of SW and FBWW with SW as blended water. This study was undertaken for the first time.

MATERIALS AND METHODS

Supply of SW to BWTP is from Ganga canal near Murad Nagar. Supply of SW to WWTP is from river Yamuna. The plant loses 10% by volume of its water as waste residuals. A representative 100 L FBWW sample was collected from the both WTP after one complete backwash cycle. The ratio of 1:1 of was selected for a blend of FBWW and SW which was referred as blended water. This ratio was selected for both WTP so that the direct comparisons could be made between the SW and FBWW with SW. Samples were analyzed for general water chemistry parameters as presented in Table 1 and 2. FBWW from the WTP contained precipitated aluminum hydroxide [$Al(OH)_3$] solids from the main treatment plant were used in this study.

Parameter Tested

Water quality parameters were measured using standard testing procedures outlined by standard method [9]. In particular, temperature and pH were measured using by an orion pH meter. Turbidity was measured using a HACH 2100P turbidimeter; total suspended solids and solids content were measured as per Standard Method. Color, total iron, total manganese and total aluminium concentrations were all measured using a HACH DR/2010 Spectrophotometer as defined by standard method. Ammonia and alkalinity were estimated by colorimetric method and titrationmetric method respectively as per standard method [9].

Jar Test

The Jar Test is used for determination of alum doses to remove turbidity of water samples. According to this alum dose the addition and mixing of alum solution applied for main treatment plant. The Jar Test experiment was conducted using a Phipps & Bird standard jar-test unit consisting of six 2-L square jars filled to the 1.0-L mark. SW and FBWW were collected from both the WTP during summer. Jar tests for each sample set were conducted in duplicate for a total of four samples analyses (n = 4) per experimental trial. Alum solution was injected using graduated syringes and rapidly mixed at 100 rpm for 2 min. Following the rapid mix, flocculation was employed for 10 min at 30 rpm.

Chlorine Demand

The test was performed by using laboratory method. Chlorine solution of 2mg/L (standard chlorine solution) for test was used which had same strength as the actually applied in plant treatment process. Same concentration solution was used so that adding the Chlorine solution would not increase the volume of treated portions by more than 5ml was considered. First, the blank reading was determined by adding identical volume of acetic acid, KI and starch indicator to a volume of chlorine demand free water corresponding to the sample used for titration. 5 liter sample was collected from each WTP. Ten 250 ml stoppered bottles were taken which rinsed with Chlorine free water. 200 ml of SW was taken in each bottle. Concentration 0.2ppm, 0.4ppm, 0.6ppm… 2.0ppm of standard chlorine water was added respectively. The bottles were closed and shacked properly and kept for 30min. for completion of chlorine solution reaction. After completion of reaction time, 2ml of Acetic acid, 2ml potassium iodide (KI) and starch indicator were added to all the bottles. At specific concentration, blue color was appeared and intensity of color increased onwards. On which concentration blue color appeared first was the chlorine demand of the SW.

RESULTS AND DISCUSSION

The differences observed in the residuals treatment processes depend in large measure on the raw water quality as well as chemicals used in the main treatment processes. The raw water BWTP was characterized by low turbidity and color. The plant uses alum as the primary coagulant at an average dosage of 22 mg/L, as $Al_2(SO_4)_3.18H_20$, in conjunction with pH adjustment.

The raw water WWTP was characterized by high turbidity and ammonia with elevated levels of color. The plant uses alum as the primary coagulant at an average dosage of 30 to 40 mg/L, as $Al_2(SO_4)_3.18H_20$, in conjunction with pH adjustment.

The FBWW produced during the filter cleaning process. FBWW and CSW currently discharge to a nearby drain through pump by the both plants. In this research work FBWW used for recycling. To optimize water efficiency, the FBWW blended to raw water to recommence the treatment process.

In comparisons to the BWTP, the WWTP sample contained significantly higher concentrations of organic and metal contaminants (Table 1). The difference in FBWW between the two plants can be attributed differences in raw water quality and the difference in alum dosages. Generally, the BWTP FBWW quality was found much better than that of the WWTP FBWW, based on a 1:1 ratio of SW and FBWW (Table 2). The sedimentation process worked well for the FBWW samples from both plants. In the case of the BWTP, the final water after the sedimentation process of blended water was found to be very close to the quality of the final water from raw water source. Similarly, for WWTP blended FBWW sample was treated by sedimentation process and get a quality that was better than the average raw source water quality (table 3). The WWTP source water characteristically contains higher turbidity and uses approximately twice alum dosages than BWTP to achieve the required potable water quality (Table 4).

Sample analyzed for general water chemistry parameters are presented in table 1 for SW and in table 2 for blended water. The values of all the parameters in WWTP raw water recorded higher than the BWTP Raw water. Similarly higher values for all parameter were recorded for the FBWW of WWTP than BWTP. The values of all parameters except ammonia were recorded higher in both blended water than SW. For removing ammonia from water, chlorine is required. In FBWW, there was no ammonia, no chlorine was required when FBWW was added to the raw water (table 4). In raw water, the turbidity is natural turbidity. Turbidity found much higher in both FBWW than SW. This high turbidity due to high density suspended particles of aluminum hydroxide ($Al(OH)_3$) which comes from alum solution added to the raw water (Figure1). This alum solution is required to remove the turbidity of raw water. When SW added with FBWW having already high turbidity, less alum was required for the treatment of water (Table 4). The treated waste residual effluent quality with respect to aluminum concentrations was found 0.07 mg L^- in BWTP and 0.10 mg L^- in WWTP whereas absent in SW. Although iron concentration of blended water was slightly higher than source water. Final water iron concentration was similar to SW (Figure 2).

CONCLUSIONS

The purpose of this research evaluated significant differences in physical and chemical parameters in SW and FBWW with SW. The data presented in the present research suggests that high turbidity having high density of suspended particles in FBWW is depended on alum used in SW. If high density turbidity FBWW used with SW, less amount of alum required to achieve the required potable water. The data suggests that when ammonia free FBWW added to SW, the less amount of chlorine is required to remove ammonia. The focus of this study was directed to use FBWW with SW so less cost on treatment, saving of going water level low, and use of treated water could be achieved. The WWTP source water characteristically contains higher turbidity and uses approximately twice alum dosages to achieve the required potable water quality. This can be attributed to the fact that the WWTP must treat a poorer raw water quality than that of the BWTP, which results in higher alum dosages being required and higher amounts of contaminants being removed in the process. This study would help in the recycling of water treat plant residuals in good water conservation management.

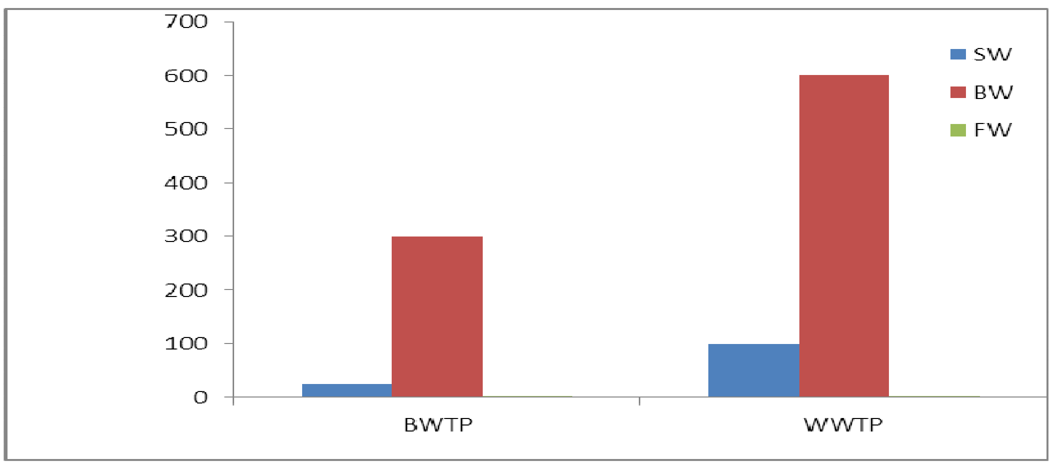

Fig.-1 :Removal of Turbidity

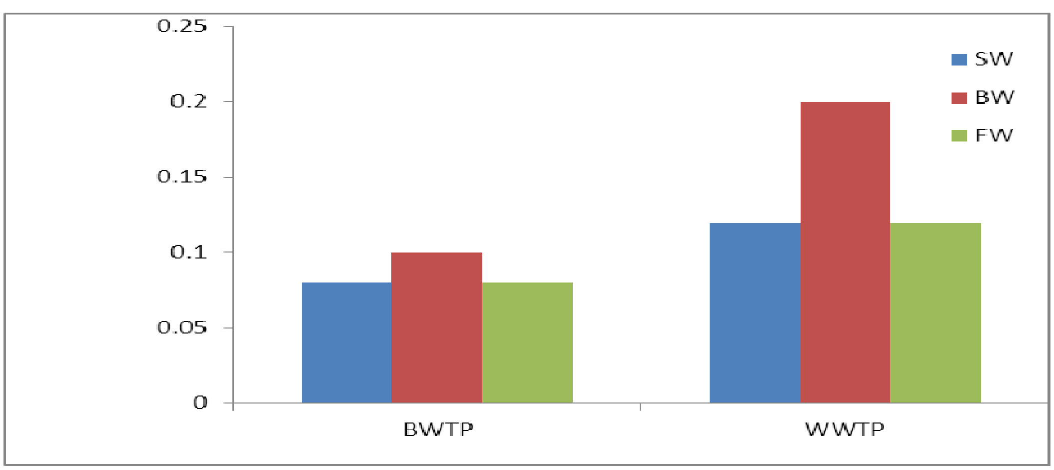

Fig.-2: Removal of Iron by Blended Water

Table-1: Source Water Quality

Parameter	Units	SW Bhagirathi WTP	SW Wazirabad WTP
Temperature	C	20	26
pH	-	7.8	8.1
Alkalinity	mg L^{-1} as $CaCo_3$	58	86
Turbidity	NTU	25	100
Total Aluminum	mg L^{-1}	Absent	Absent
Total Iron	mg L^{-1}	0.08	0.12
Total Fluorine	mg L^{-1}	0.3	0.45
Total Ammonia	mg L^{-1}	0.02	0.10
Chlorine demand	mg L^{-1}	0.8	1.4

Table-2: Water Quality of blended water

Parameter	Unit	BWTP Bhagirathi WTP	BWTP Wazirabad WTP
pH	-	8.0	8.2
Turbidity	NTU	300	600
Alkalinity	mg L^{-1} as $CaCo_3$	60	110
TSS	mg L^{-1}	200	326
Total Aluminum	mg L^{-1}	0.07	0.10
Total Iron	mg L^{-1}	0.10	0.12
Total Ammonia	mg L^{-1}	Absent	Absent
Residual Chlorine	mg L^{-1}	0.25	0.15

Table-3: Water quality of final water of SW and final water of blended water

Temperature	C	Final water of SW		Final water of blended water	
		22	25	Final water of SW	Final water of blended water
pH	-	7.6	7.5	30	32
Turbidity	NTU	1.0	1.0	7.6	7.5
TSS	mg L^{-1}	80	100	2.0	1.0
Alkalinity	mg L^{-1}	60	64	140	110
Total Ammonia	mg L^{-1}	Nil	Nil	90	86
Total Aluminum	mg L^{-1}	0.08	0.1	Nil	Nil
Total Iron	mg L^{-1}	0.08	0.1	0.2	0.2
Total Fluorine	mg L^{-1}	0.14	0.1	0.14	0.12

Table-4: Applied doses for Source Water and Filter backwash water with source water

Parameter	Unit	SW Bhagirathi WTP	SW Wazirabad WTP	FBWW with SW of BWTP	FBWW with SW of WWTP
Alum Dose	mg L^{-1}	22	30	16	24
Chlorine	mg L^{-1}	0.8	1.4	Not required	Not required

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