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POSSIBILE RECYCLING OF SPENT FILTER BACKWASH

MARINA VALENTUKEVICIENE

Vilnius Gediminas Technical University, Sauletekio al. 11, APF, Vilnius-40, Lithuania LT-10223,
e-mail: marina.valentukeviciene@ap.vgtu.lt.
Phone: +370 616 537 46. Fax: +370 5 274 47 31.

Abstract: Spent-filter backwash water is usually discharged into sewers or returned to the head of a water treatment plant (WTP) to be re-processed. The purpose of this study was to characterize and compare two different WTP filter backwash water contents that were obtained by using conventional and air scour backwash methods, and influence the recycling of spent-filter backwash water. For this purpose, the spent-filter backwash water was analyzed at two different Lithuanian WTPs i.e. one using a conventional backwash method and another using an air scour backwash method (Eades, 2001). The impact of recycling spent-filter backwash on the treated water's quality was evaluated by comparing the concentration of the total iron content with suspended solids in the filtered water by following legislation rules. Backwash water in this research contained a significant concentration of total iron and a large amount of suspended solids. In this study it was found that, conventional sedimentation by gravity was sufficient for the removal of suspended solids and iron from the backwash water. Further, the presence of analyzed chemical compounds accumulating into the backwash water after sedimentation had no significant impact on the filtration's effectiveness. Therefore, this research shows that air-scour backwash water can be recycled in the same way as conventional backwash water, but a different sedimentation rate needs to be evaluated.

Keywords: spent filters, air-scour backwash, sedimentation, backwash water recycling

INTRODUCTION

A large portion of the liquid waste produced at water treatment plants (WTPs) is spent filter backwash water. This spent-filter backwash water contains a large volume of liquid with relatively low solids content and typically comprises 2-5% of the total processed water (Amburgey, 2005). The concentration of solids in spent-filter backwash water can vary from 50 to 400 mg/L and can also vary widely from plant to plant, depending on the raw-water quality, the efficiency of the treatment units, and the duration of the filter run and the backwash cycle (Adin, 2002). Spent-filter backwash water traditionally is discharged to surface water sources (rivers, seas etc.) or returned to the head of a WTP to be re-processed (Yang, 2006). Spent-filter backwash water solids are characteristically difficult to separate from the liquid (Kötzle, 2006). Wash water recovery ponds are built to hold spent backwash water for 24 hours or more and can recover up to 80% of the solids (Eades, 2001). Concerns over the decrease of the input water's quality and other issues have greatly reduced the number of WTPs that directly recycle spent-filter backwash without some further treatment (Bourgeois, 2004).

Another form of liquid waste processing is a filter-to-waste method, which has a time-period for ripening the freshly backwashed filter which, at most WTP's, ranges from 15 min to 30 minutes. The filter-to-waste flow is generally a fairly clean water stream that sometimes can be useful for auxiliary scouring of filter media. Concerns about the effects of recycle streams sometimes indicate the necessity of treatment prior to recycleing (Arora, 2001).

The approach of the research reported here was to evaluate the possibilities of applying recycled backwash water from spent-filters by using a simple gravitational treatment without adding chemicals.

MATERIALS AND METHODS

Backwash water testing was conducted at two Lithuanian water treatment plants (Nemencine, Ukmerge). Both plants pump water from groundwater sources at water fields and are designed for the removal of iron, manganese and ammonium into gravitational spent filters with quartz sand packing material.

Typical water quality parameters for the source water are as follows - for WTP equipped with air-scour backwash: pH 7.33-7.52; conductivity ~514 μS/cm; Fe_{total} 0.3-2.86 mg/L; NH_4^+ 0.19-0.59 mg/L; Mn 0.13-0.19 mg/L; Na ~ 13 mg/L; Ca 57.8-74.5 mg/L; and dry residual - 306 mg/L; for WTP equipped with conventional water backwash: pH 7.21-7.72; conductivity ~ 510 μS/cm; Fe_{total} 1.80-2.94 mg/L; NH_4^+ 0.28-0.695 mg/L; Mn 0.068-0.084 mg/L; Na ~ 15.4-17.5 mg/L; Ca 95.7-96,8 mg/L; and dry residual - 371 mg/L.

The air-scour backwash (Amburgey, 2003) runs according to the following operational scenarios and includes:

1. Conventional backwash with backwash water recycling (operational scenario when backwash water was supplied 6 min at 14 $L/s{\cdot}m^2$);
2. The air-scour backwash with backwash water recycling (operational scenario when backwash water was supplied 12 min at 2,2 $L/s{\cdot}m^2$).

Three replicated experiments were performed for each operational scenario. Each experiment consisted of one control (no recycling) filter run followed by one experimental (recycling) filter run, where the latter is defined by the operational scenario. Each control run generated backwash water for the subsequent recycle run. Experimental runs were performed directly after control runs, so that possible differences in plant performance could be attributed to the effects of recycling rather than changes in the quality of the source water. Collected backwash water was supplied to the gravitational sediment unit at both WTPs (Tobiason, 2003). Total iron concentration and suspended solids were measured into the collected backwash water and clarified the water from the sedimentation unit after 3, 6, 12 and 24 hours of conventional gravitational sedimentation (Fig. 1). To characterize the impact of backwash recycling, a comprehensive study was conducted using SS as the main indicator. Particular emphasis was given to the SS values in the development of the backwash water's recycling.

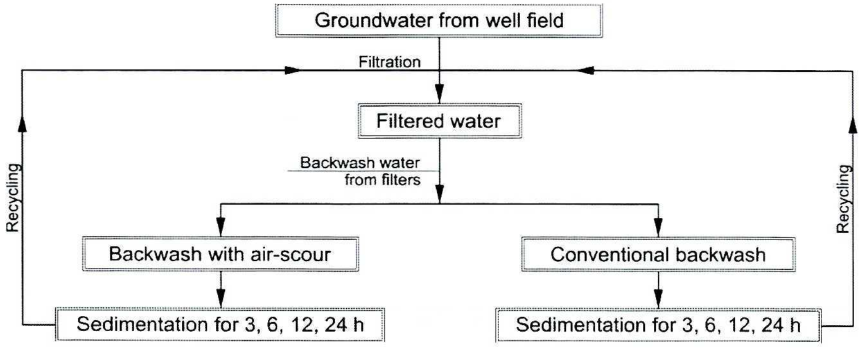

Fig. 1. Experimental design used in the present study, where backwash water corresponds to the use of conventional backwash or backwash with air-scour, separately

RESULTS AND DISCUSSION

Total iron concentration and suspended solids were analyzed in order to test the efficiency of the gravitational sedimentation procedure (Richman, 1999). Values from the collected backwash water and water from the sedimentation unit - after four different retention times - were compared for their conventional and air- scour backwash water, respectively (Table 1, 2).

Table 1. Conventional backwash water recycling results

Measurements	Fe_t, mg/l	Fe_t, mg/l	Fe_t, mg/l	Fe_t, mg/l	SS, mg/l	SS, mg/l	SS, mg/l	SS, mg/l
Backwash water from filter	18.60	22.00	29.00	15.00	537.67	628.00	643.00	600.67
Backwash water after sedimentation	8.60	8.00	8.00	3.77	140.70	103.67	146.54	107.00
Groundwater from well field	3.00	2.90	3.00	3.20	6.70	6.00	6.10	6.00
Groundwater and backwash water after sedimentation mixture	5.00	2.00	4.00	3.10	10.00	12.33	7.00	5.00
Filtered water	0.28	0.28	0.30	0.29	0.66	0.63	0.62	0.64
Sedimentation efficiency evaluating residual iron (%)	54	63,00	72	73				
Sedimentation efficiency evaluating residual SS (%)					73	83	77	82

Table 2. Results of air-scour backwash water recycling

Measurements	Fe_t, mg/l	Fe_t, mg/l	Fe_t, mg/l	Fe_t, mg/l	SS, mg/l	SS, mg/l	SS, mg/l	SS, mg/l
Backwash water from filter	18.60	22.00	29.00	15.00	537.67	628.00	643.00	600.67
	260	311	221	331	770	910	739	1082
Backwash water after sedimentation	9.52	8.02	9.52	9.70	38	49	58	30
Groundwater from well field	0.72	0.3	1.14	2.86	1.10	4.60	3.40	3.20
Groundwater and backwash water after sedimentation mixture	3.00	2.50	3.50	4.50	8.90	7.80	7.50	9.80
Filtered water	<0.01	<0.01	<0.01	<0.01	0.10	0.20	0.11	0.16
Sedimentation effectiveness evaluating residual iron (%)	96	97	96	97				
Sedimentation effectiveness evaluating residual SS (%)					95	95	92	97

Tables 1 and 2 show that, in most cases, the values from different backwash procedures are different, and in a few cases the differences are 62,5% for suspended solids (and in a few cases above 93% for total iron concentration). These results show that the air scour backwash water is much more saturated with total iron compounds and suspended solids as compared with conventional backwash water.

As described in the "Materials and Methods" section, all samples from control and experimental runs were analyzed for their total iron concentration and suspended solids. Source water, recycle water, settling basin effluent (gravitational sedimentation), filter effluent, and backwash water samples were analyzed in duplicate. The average of each sample is reported in Tables 1 and 2. These tables indicate that the settling basin suspended solids (SS) values are higher during air scour backwash runs when an air-water mixture was used for the spent filters backwash treatment. It was also noted that for the same scenario there is a difference in the suspended solids. As expected, the SS values are higher when the untreated spent filter backwash water is recycled into the system. The SS values of the filter effluent are, however, too low to be measured due to the prohibitive volumes of water that would be required to measure them in low turbidity waters. These results indicate that, with respect to the SS, recycling spent filter backwash water does not significantly impact the quality of the treated water.

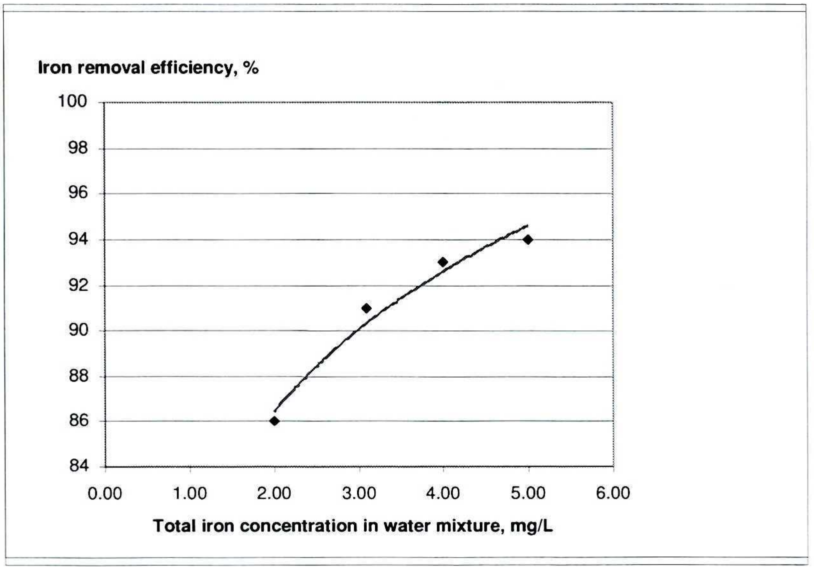

Fig. 2. Filtration efficiency for groundwater-backwash water mixture by total iron residual

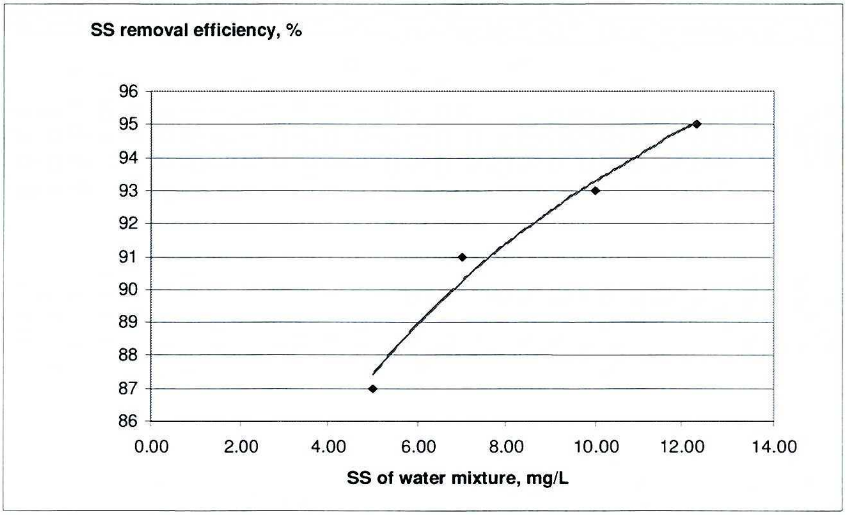

Fig. 3. Filtration efficiency for groundwater-backwash water mixture as indicated by the SS

The efficiency of filters was sufficient for the removal of iron compounds as well as the SS from the mixture of the groundwater and recycled backwash water (Figs 2, 3). This observation is further supported by measurements that showed little or no impact on the turbidity of the filter effluent and the total residual iron.

CONCLUSIONS

Based on the collected data, the following conclusions can be drawn:

- SS is a good supplement to turbidity measurements for characterizing backwash recycling and most water quality laboratories are able to conduct this analysis.
- Based on this study and the SS measurements, little or no impact, due to backwash recycling, was observed at different stages of the process. The filter loadings increased during recycling, and were higher in the non-treatment recycling scenarios. These increases were, however, compensated for in the filter treatment stage and no significant impact was observed on the filtered effluent water during the recycling processes. The only significant effect - due to backwash recycling - was an increase in the filter efficiency, and the quantity of suspended solids that were contained in the filter media. This result was consistent with the higher loading of suspended solids occurring during the backwash procedure. The practical implications of shorter filter runs are more frequent filter backwashes.
- In a given scenario, the need for filter backwash occurred when the loading of suspended solids reached a certain characteristic value, regardless of whether the backwash water was recycled or not. This allows SS values to be used to predict the possible reuse of the spent filter's backwash water in recycling after conventional gravitational sedimentation has occurred.

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