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ORIGINAL RESEARCH PAPER

Sediment features of PVDF micro-filtration layers in a pilot-scale drink-water generation organization after sediment utilizing poly silicate iron and poly aluminum chloride

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ABSTRACT

A pilot-scale microfiltration poly-vinylidene fluoride (PVDF) layer with numerous vent sizes about 0.1 ㎛ and 0.05 ㎛ has been performed after sediment utilizing a poly-silicate iron (PSI) as coagulant has been manufactured and utilized. Feculence has been released totally and organic material, humic essences, and metals (Al, Fe) have been released nicely by the practical system. Therefore, it has been deduced that a velum with dense skin has been more practical for decreasing velum sediment than a velum by analogous structure though the former nominal pore size of about 0.05 ㎛ has been less than that of the latter of about 0.1 ㎛. It has yet stayed for study the results on velum sediment of the relations among organic and oxidized inorganic materials like Fe and Mn that happen in pre chlorination.

Introduction

Lowly pressure velum methods like micro-filtration (MF) and ultra-filtration (UF) could release particulate and colloidal materials larger than the velum pore size and generally generate a filtrate free of turbidity and bacteria. These have been generally utilized for producing drink water from river, lakes, and underground water (Hagen, 1998; Ma et al., 1998; Yuasa, 1998; Bian et al., 1999; Klijn et al., 2000; Kimura et al., 2004). Nevertheless, that velum are negligibly influential in releasing dissolved molecules like humic essences and inorganic materials. For mitigating velum sediment, a hybrid velum system merged by procedures like sediment, ozone, and active carbons have been generally assumed.

Jang et al. (2002 and 2005) used the jet mixed separator (JMS) (Watanabe et al., 1998) for a sediment unit for a polymerized poly-acrylonitrile (PAN) UF velum by a nominal pore size about 0.01 ㎛. The utilization of the sediment procedure by a poly-silicate iron (PSI) for a coagulant (Hasegawa et al., 1991) expanded the UF velum process period by releasing dissolved organic carbon (DOC) productively. Lee et al. (2004) noted that pre-ozone decreased velum sediment of a PVDF velum by a nominal pore size about 0.1 ㎛ by polluting organic matters like humic essences. The particle size expansion by utilization of an ozone-induced destabilization reaction enhanced the purification performance of the velum.
The velum purification efficacy relies on the natural water quality and the operational requirements.

Since this high permeance, high-strength PVDF velum has been only newly produced for drink water generation (Yeh and Wang, 2004; Kurihara et al., 2004). Thus, the possibility of the new PVDF velum methods should be considered by long-term trials utilizing natural water. Constructing upon the last work, this investigation has been developed for challenging recent problems in drink water generation connected to contaminant reduction and velum sediment utilizing a novel PVDF velum for purification after pre-sediment.

Methodology

Natural Water Features

Chitose River water in the Kamiebetsu Water Purification Plant (Ebetsu City, Japan) has been utilized as natural water. Though the water quality of the Chitose River varied seasonally, it generally possesses high turbidity, organic material, and humic essences (Bian et al., 1999; Jang et al. 2002).

Practical system of a pilot-scale PVDF velum purification procedure

The pilot-scale velum purification procedure has been comprised of a sediment (JMS and sand purification) procedure and purification utilizing PVDF velum (TORAY Industries, Inc., Japan) including numerous pore sizes. Components of the components of this approach are outlined in Table 1. Regular backwashing has been performed as follows: thirty minutes purification; thirty seconds backwash by pervading; 1-minute backwash by pressurized air; one minute idle; thirty seconds' fill. In this situation, the whole recovery rate has been found to be nighty eight percent.

Table. 1. Process situation of the pilot-scale velum purification structure

Structure data	Jang et al., 2002 and 2005	This investigation
sewage	**Chitose River water**	**Chitose River water**
TOC (mg/l)		2.54
DOC (mg/l)	2.31	2.07
Temperature	21.9	7.4
Turbidity	20.3	13.1
pH	7.2	7.3
E260 (1/cm)	0.12	0.08
Total Al (ppb)	500	194
Total Mn (ppb)	100	171
Total Fe (ppb)	2,100	473
sediment procedure	**JMS**	**JMS**
Hydraulic retention time	84 minutes	84 minutes
pH	6.2	6.5
Dosage	12 mg/l as Fe	12 mg/l as Fe
Coagulant	Poly-silicate-iron, PSI	Poly-silicate -iron, PSI
Membrane filtration process	**PAN membrane**	**PVDF membrane**
Chlorine dose (as Cl2)		1 mg/l (in-line addition)
Interval of physical cleaning	0.9 - 1.5 m/day	30 minutes
Permeate flux	1 hour	2.5 m/day
Module type	Hollow fiber	Hollow fiber
Nominal pore size	0.01 ㎛	0.1 ㎛ and 0.05 ㎛
Operation mode	Pressurized type	Pressurized type
Filtration mode	Constant flow rate	Constant flow rate
Surface area	12 m^2	7 m^2
Sand filtration		**Three-layer sand filter**
Backwashing		every 48 hours
Linear velocity		100 m/day

Analytical techniques

Turbidity has been investigated utilizing a coalition ball kind turbidity meter (SEP-PT-706D, Mistubishi Chemical, Japan) by ultra-sonification for ten moments. For checking PH and temperature, a transportable PH meter (HM-12P, TOA electronics Ltd., Japan) has been utilized. Humic essences have been calculated by UV/VIS spectrophotometer (U-2000, Hitachi, Japan) by a one cm cell. Completely organic carbon (TOC) and DOC have been estimated by a TOC meter (TOC-5000A, Shimadzu, Japan). Mineral materials like Al, Mn, and Fe have been selected by an inductively associated plasma atomic emission spectrophotometer (ICPS-7500, Shimadzu, Japan). The DPD process has calculated the chlorine dose.

Result and Discussion

Turbidity average concentrations and humic essences (E260) in natural water have been 13.4, 2.54 mg/l, and 0.08 cm-1, orderly. Approximately eighty-one percent of turbidity average concentrations have been comprised of the liquefied subject (Fig. 1).

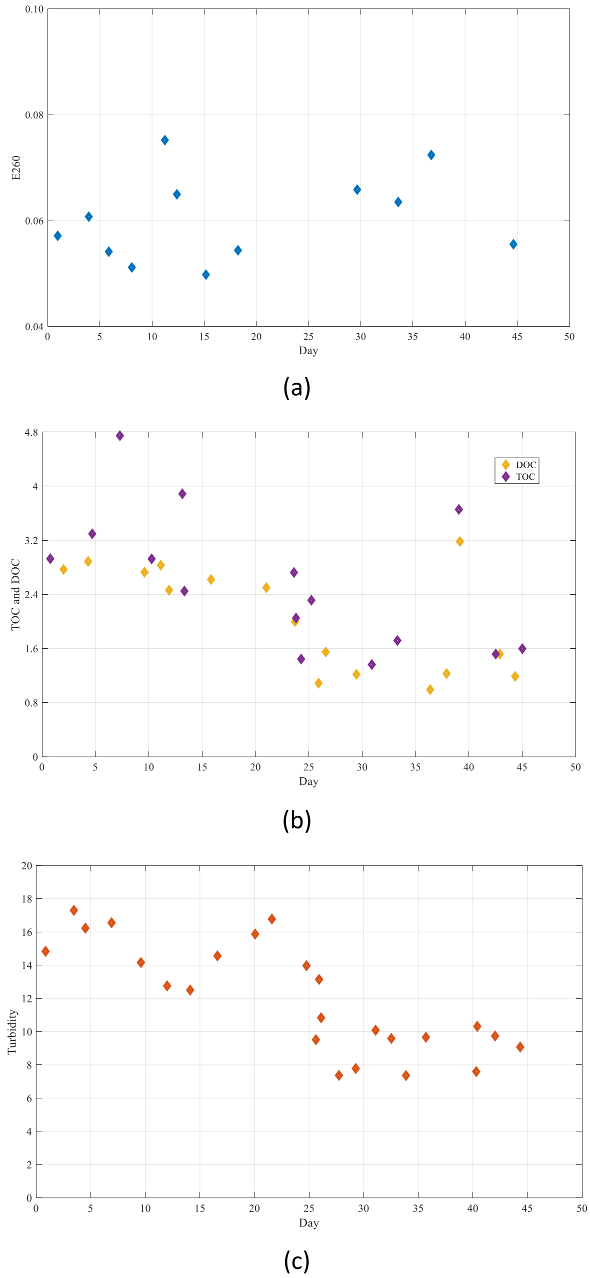
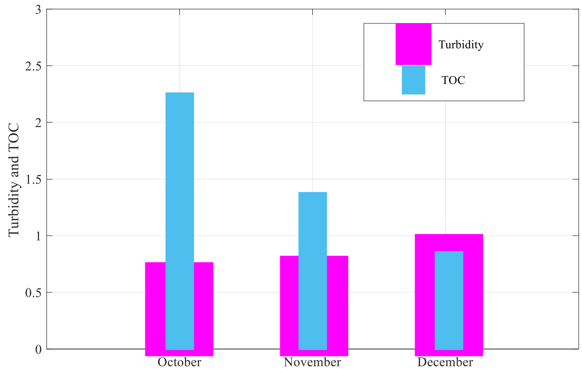


Figure 1. Natural water quality variations by considering a. E260 b. TOC and DOC c. Turbidity

The PVDF velum purification procedure demonstrated about entire disposal of turbidity, humic essences, and mineral materials (Al, Fe). Most of the turbidity about 94.1 percent, humic essences of about 78.5 percent, turbidity average concentrations of about 41.8 percent, and total Al of about 90.4 percent have been released by the sediment procedure Nevertheless, whole Fe of about 73.2 percent which has been mostly abandoned by the SF. Consequently, Al and Fe disposal efficiency has been more significant in comparison with 95 percent and 99 percent, orderly, in which Mn concentration in pervades surpassed the drink water standards of Japan (< 50 ppb). Especially, as demonstrated in Fig. 2, Fe and Mn concentration in the JMS sewage raised as the water temperature reduced. Consequently, it can be deduced which inorganic materials have been oxidized by chlorine and induced extreme velum sediment. According to the literature, Fe and Mn have been discovered for causing velum sediment in the drink water treatment (Xu et al.,2004; Choo et al., 2005).



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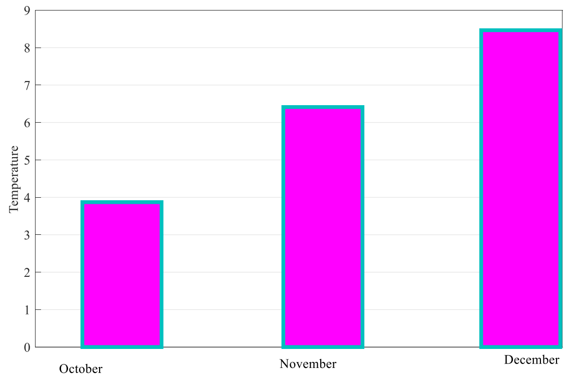

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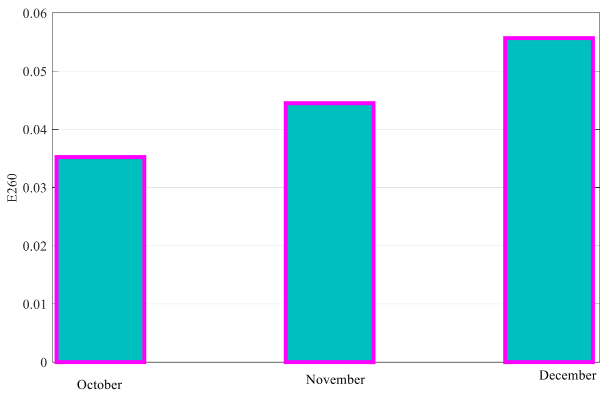

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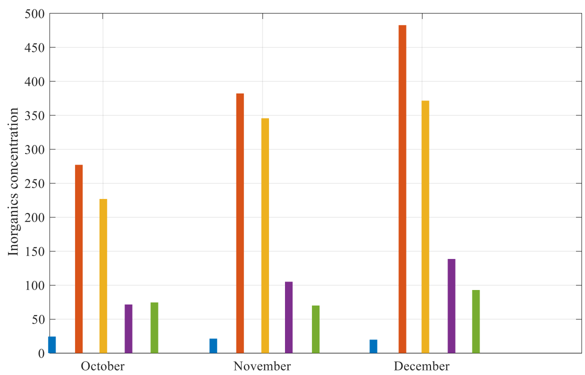
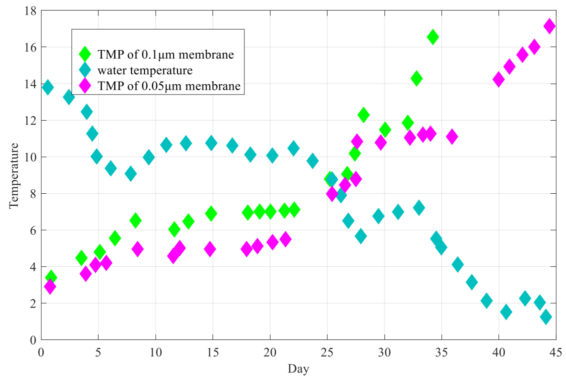


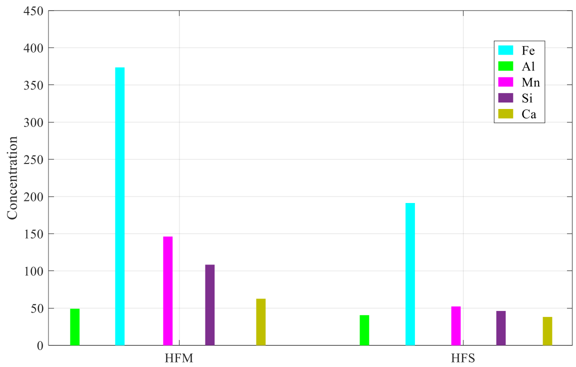
(d)

Figure 2. The sewage quality of JMS variation in the empirical course

Fig. 3 a. demonstrates deviations in temperature and transmembrane pressure (TMP) of the HFM about 0.1 ㎛ and HFS of about 0.05 ㎛ velum in the exploratory time. According to Fig. 3 b it has been deduced which reduction of temperature adversely influenced TMP, and which HFS velum has been more practical for reducing velum sediment than the HFM velum. In addition, it has been seen that Fe and Mn have been significant foulants.



(a)



(b)

Figure 3. temperature and TMP Variations and b. inorganics take out by HCl and oxalic acid

Conclusion

In this investigation, the new pilot-scale PVDF velum purification system has been manufactured and used for producing potable water from river water. Consequently, turbidity has been released totally and organic material, humic essences, and mineral materials (Al, Fe) have been released very well by the exploratory approach. as well as, it has been deduced which the HFS velum of about 0.05 ㎛ has been more impact for reducing velum sediment than the HFM velum of about 0.1 ㎛ though the former nominal pore size has been half of the latter. Nevertheless, Mn concentration in pervades surpassed the drink water norms of Japan, and velum sediment was sever by an increase of Fe and Mn concentration in the JMS sewage. In the investigation's next step, the coagulant would be transformed from PSI to poly-aluminum chloride (PACl) and coagulant dose would be handled and chlorine would be provided in the backwashing time rather than pre-chlorination for mitigating velum sediment by Mn. Collection examinations would be performed for studying the results of organic and mineral materials on velum sediment.

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Conflict of interest

The authors declare that they have no conflict of interest.

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