

EFFECTIVE WATER TREATMENT PROCESS BY HOLLOW FIBER MEMBRANES : VSA (VIBRATING & STRIPPING BY AIR) PROCESS

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ABSTRACT

MF membrane element was specially designed for water purification and VSA process which can solve the fouling problem. Especially VSA process is developed for the SK Chemicals' asymmetric microfiltration hollow fiber membranes. In case of outside-to-in filtration process, MF membrane element showed the excellent flux stability caused by cleaning ability of VSA process. Simultaneous back-washing with VSA considerably enhances cleaning efficiency. From the result, the possibility of the replacement of chemical coagulation and sand filtration process with newly developed VSA process was revealed.

INTRODUCTION

Recently, many membrane and system makers have developed anti-fouling or easy-cleaning technologies. Generally, besides back-washing, new methods controlled by air for active membrane cleaning have been introduced to the water treatment industries. Those processes enable to remove particles and microorganism from industrial water effectively. But in some cases which contain high suspended solids, it has been found that severe pretreatment should be requested for the operation of those systems.

The feasibility of replacement of chemical addition- coagulation and sand filtration process with SKMF-VSA Process has been studied. SK Chemicals uses industrial water 12,000 m³/d for cooling tower and pure water supply. So, the bench-scale system was set up for the feasibility test and we got the good result from short-term experiment. In some sense, that is the brief basic result about possibility. Recently, pilot-scale full automatic VSA system has been operated without any suspension. First of all, preliminary result from bench-scale test was reviewed in this paper.

EXPERIMENT

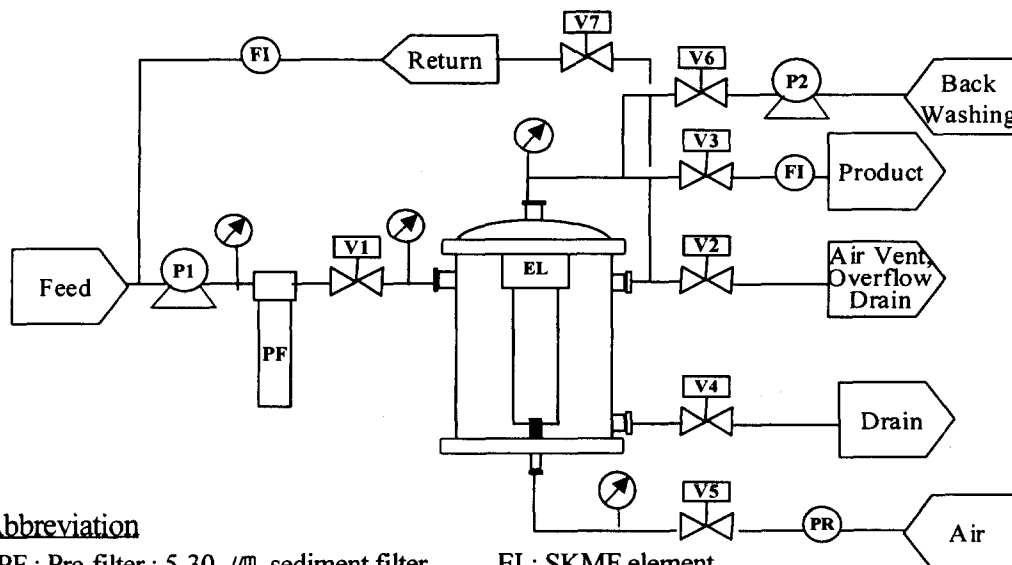
Flow Diagram and Procedure

VSA process has been applied to the industrial water treatment from Hangang-river. We have studied about the several key points for large amount of water treatment. We focused on the possibilities as follows;

- (1) Reliability of VSA process for long-term operation
- (2) Cleaning efficiency of VSA with or without back-washing
- (3) Removing ability about suspended solids and microorganism
- (4) Long-term stability of SKMF-VSA without pre-filtration

SKMF-VSA system was operated according to the scheme of flow diagram as below mentioned. Effective operating scheme was achieved by valve and pump shut-off control. Special functions of SKMF-VSA are as follows;

- (1) Back-washing and VSA process for long-term stable water flow rate
- (2) Compressed air inlet and air-vent ports
- (3) Outside-to-in filtration element housing which is specially designed for SKMF-VSA



Abbreviation

- | | |
|--|--|
| - PF ; Pre-filter ; 5-30 μm sediment filter | - EL ; SKMF element |
| - FI ; Flow indicator | - P1 ; Feed pump |
| - P2 ; Back-washing pump | - PR ; Pressure regulator |
| - V1 ; Feed shut-off valve | - V2 ; Air Vent and overflowed water drain valve |
| - V3 ; Permeate valve | - V4 ; Drain valve |
| - V5 ; Compressed air valve | - V6 ; Back washing valve |
| - V7 ; Concentrate return valve | |

Test Condition

The microfiltration membrane was made by polysulfone and has the shape of asymmetric section structure. Outer surface of MF membrane has smoother surface than that of inner surface. VSA

process is not effective for cleaning with opposite structure. So, it is very important to use outside skin MF membranes. SKMF element was both-ends-potted type cartridge. There is a perforated tube inside of the hollow fiber bundle and compressed air is ejected from the small pores on the tube. Compressed air ejected from the tube vibrates the hollow fiber membranes like harp strings. Therefore foulant on the membrane surface can be easily stripped by air bubble and back-washing pressure.

Severe condition was applied to bench test for the reliability. Basically dead-end filtration process was used. Operating pressure was 1 Kg/cm² and back-washing pressure was 1.5 Kg/cm². VSA cleaning was performed every 2 hours for 2 minutes. Back-washing was performed simultaneously with VSA. Average water quality was as follows;

- Feed water ; Hangang River water without any pretreatment including precipitation
- Turbidity ; 4 – 5 N - SiO₂ ; 7 – 8 mg/L
- Temperature ; 2.5 – 6.0 °C - Air pressure ; 40 NL/min(38L/min) at 1.2 Kg/cm²

RESULT AND DISCUSSION

VSA including back-washing and back-washing process were performed separately. We could find the result that VSA cleaning effect is better than back-washing only. From the result of Fig.1, VSA can be regarded as an effective membrane cleaning method.

Flux decline of SKMF element was examined with or without pre-filtration. In case of direct filtration without pre-filter, we could get the good result similar to the process with 25 μm pre-filtration. The flux through 25 μm pre-filter decreased rapidly and eventually there was little permeate after 3 hours passed because of clogging. VSA process enabled to operate MF element system without pretreatment. We operated VSA system without pre-filter for river water purification. Microorganisms were perfectly removed. In case of SS, conventionally use analytical method could not evaluate accurately. So, for further precise analysis we used SDI parameters. All the permeated water showed the value below SDI 3. Two months' pilot test result (Fig.2.) for the Hangang river showed that the possibility of the replacement of clarification and sand filtration.

CONCLUSION

From the test result, we could find that VSA enables to operate MF system effectively. VSA had the possibility to be used for the replacement of clarification and sand filtration process. VSA cleaning had shown more effective method than conventional back-washing process. Two months' pilot test showed the stable water flow rate of minimum 750 L/hr.EL at 1Kg/cm². Of course, because it is short-term result, we should operate VSA for a long time. We are going to investigate the effect of temperature, turbidity and various operating parameters.

Fig.1. Comparison between VSA and Back-washing Effect for Membrane Cleaning

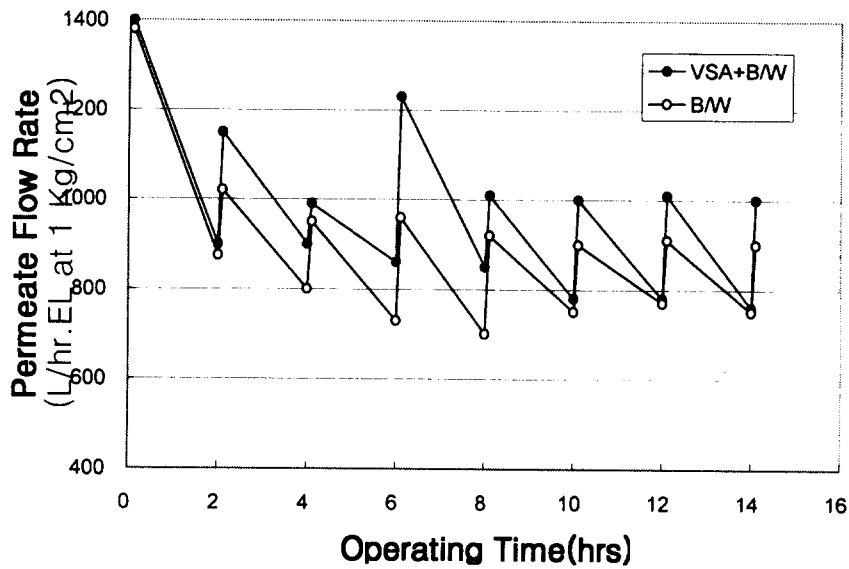
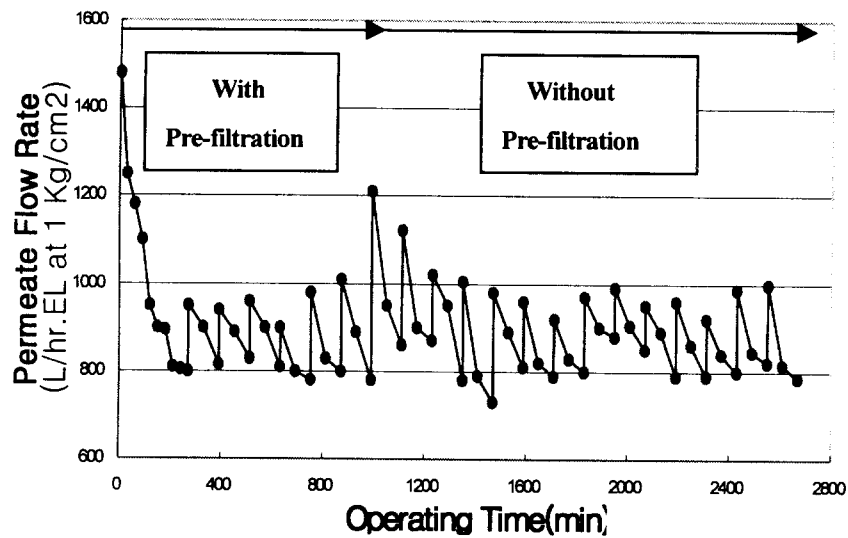


Fig.2. Direct Filtration by VSA without pre-filter and conventional filtration with pre-filter



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