[**Full-Turn-Key Basis**]

Construction of Industrial Waste Water Treatment Facilities

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Abstract

Industrial wastewater treatment facilities are critical for the environmental preservation of public waters areas. There is also pressing demand from the industry to reduce the costs and installation spaces of such facilities.

For wastewater that contains high concentration of organic substances, such as wastewater from food processing factories and chemical plants, application of the Membrane Bioreactor (MBR) system is effective and suitable for high load operation. The ceramic flat sheet membrane that we developed, manufactured, and supplied assures suitable performance for the MBR system. It can establish safe and reliable waste water treatment facilities.

Wastewater treatment facilities utilize a complex system which combines various technical fields like civil engineering, machinery installation, plumbing, and electrical instrumentation. For the convenience of customers, we have set organization functions at its Plant Construction & Engineering Business Group in order to reinforce its capabilities in handling full-turn-key contracts which involve an initial proposal stage for designing, procurement, and installation.

Drawing on past track records of plant constructions on a full-turn-key basis, and taking advantage of our unique ceramic flat sheet membranes, we are offering many of our customers a higher level of performance and durability not previously offered as membrane treatment systems.

1 Preface

Wastewater treatment facilities are constructed at the factory by combining civil engineering, machinery installation, plumbing, and electrical instrumentation. In order to improve convenience for customers, in 2014 we established a new organization at its Plant Construction & Engineering Business Group to handle a full-turn-key contract which involves an initial proposal stage to designing, procurement and installation work.

There are various factory industrial wastewater treatments in terms of chemical characteristics due to the types and methods of manufacturing products. Processes of wastewater treatments are made by combining various methods. We have supplied various water processing equipment according to the quality of water and characteristics of each factory. We supplied the system with the rotating disk method, contact aeration system, standard activated sludge method, and Membrane Bioreactor (MBR) system.

This paper introduces some examples of the application of our unique MBR using of ceramic flat sheet membranes, for wastewater treatment facilities.

2 Description of MBR

The MBR is a kind of activated sludge method, by which microbes effective to resolve pollutants are suspended in wastewater for the purpose of decomposing organic pollutants and water purification through aeration and mixing processes. Treated water is separated from activated sludge and then discharged. Mixed water of activated sludge is generally left to stand still in a sedimentation tank until the sludge settles by sedimentation. This is a typical method in sewage systems and is called the “standard activated sludge method.” Meanwhile, the MBR is a physical method to separate activated sludge from treated water with the use of a filtration membrane. It is a method that obtains clear treated water. Fig. 1 shows a comparison of wastewater treatment flows between the standard activated sludge method and the MBR method.

Compared with the standard activated sludge method, the MBR method offers some attractive features. It is free from the challenge of outflow of sludge (called carryover) and activated sludge can be condensed to a high concentration. In this connection, the capacity of the aeration tank can be reduced. Still more, it is unnecessary to install any sand filtration basin for advanced treatment because the micropore diameter is as small as 0.1μm. There is no concern of coliform outflow.

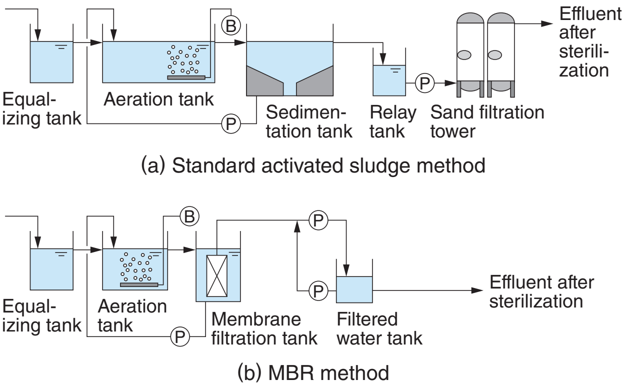

Fig. 1 Comparison of Wastewater Treatment Flows

Outlined flows are shown regarding the MBR method and the standard activated sludge method that has conventionally been widely used. The MBR method can reduce the overall capacity of aeration tanks. In addition, it offers more advantages such as the curtailment of sedimentation tanks.

2.1 Advantages of the MBR

In the case of the standard activated sludge method, activated sludge concentration (Mixed Liquor Suspended Solids 〈MLSS〉 concentration) is generally controlled at 1000～3000mg/L. If the MLSS concentration is raised, the aggregate (floc) of the activated sludge is inevitably destroyed and it becomes difficult to attain sedimentation. In the case of the MBR method, however, each microbe can be separated and the system can operate at a rate of 8000 to 12,000mg/L. As a result, the processing capability of an aeration tank can be improved and wastewater treatment at a higher load is possible with the same tank capacity.

The effect of reducing installation space by using MBR is estimated below by trial calculation. Presuming that the result of calculation is 100 for the standard activated sludge method, the result of a trial calculation is indicated by a ratio. Conditions for trial calculation are as follows:

(1) MLSS concentration: 3000mg/L for standard activated sludge method and 8000mg/L for MBR
(2) Biochemical Oxygen Demand (BOD) sludge load: 0.3kg-BOD/kg-MLSS a day
(3) Water depth in aeration tank: 4 meters
(4) Area loading in aeration tank: 10m^3/m^2/day

Other factors of the membrane unit such as dimensions and filtration rate are based on our design values.

2.1.1 Effect of Space Saving by BOD

Fig. 2 (a) shows the result of a calculation on the assumption that the amount of treated water is fixed at 200m^3/day and the BOD concentration is treated as a variable. By simple calculation, the sur-

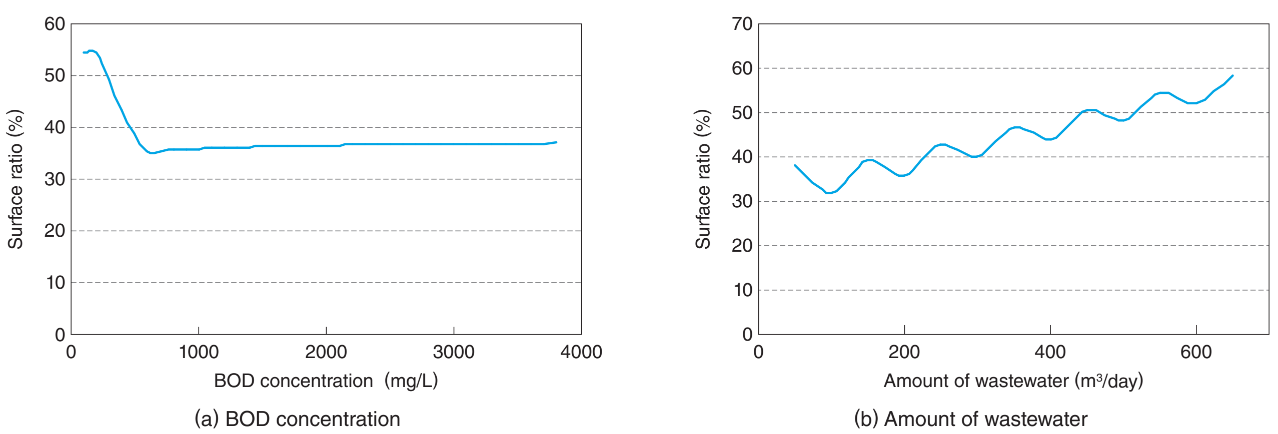

Fig. 2 Result of Comparison of Facility Installation Space

Trial calculation and comparison of installation spaces have been carried out for the standard activated sludge method and the MBT method. In particular, effective space saving can be expected in the field where the BOD concentration is high and the amount of wastewater is small.

face of an aeration tank can be reduced with the use of an MLSS concentration ratio. In this example, 3000/8000 = 37.5% is obtainable by calculation. If the BOD concentration is low, however, the retention time in the aeration tank is extremely low. The comparison is, therefore, made on the assumption that the retention time is at least six hours. Since the scale of the sedimentation tank and membrane separation tank is determined by the amount of wastewater, the surface is fixed when the amount of wastewater is fixed. Conversely, when the BOD concentration is high, the capacity of the aeration tank becomes superior in the case of an MBR. When the BOD concentration is 400mg/L or above, the surface becomes 30% to 40% which means that the effect of space saving is maximized.

2.1.2 Effect of Space Saving by the Amount of Wastewater

Fig. 2 (b) shows the result of a calculation, provided that the BOD concentration is fixed at 1000mg/L and the amount of wastewater is a variable. When the BOD concentration is fixed, the aeration tank can be reduced to approximately 40%. Both the sedimentation tank and the membrane separation tank, however, become larger in approximate proportion to the amount of wastewater. Consequently, the effect of reduction of the aeration tank capacity is lessened when the amount of wastewater is large. At a level of approximately 500m^3/day or below, the installation surface becomes 50% or below.

2.1.3 Applicable Fields of MBR

According to the aforementioned, the MBR method can yield an important effect of space saving when the BOD level is considerably high and the amount of wastewater is minimal. The wastewater containing high concentration of organic substances from food processing factories and chemical plants tends to be discharged. In the case of facility renovation and/or expansion, installation spaces tend to become a challenge. The MBR is one effective solution in such a case.

2.2 Disadvantages of MBR and Solutions

The disadvantages of the MBR method are that (1) a motor power is needed for membrane cleansing and filtration pumps, (2) periodic replacement of membranes is required, and (3) the prevention of membrane clogging (fouling) is indispensable.

Our ceramic flat sheet membranes have high permeability because their material has high hydrophilicity. This feature leads to reduced requirement for motor power for the filtration. Thanks to high physical strength and chemical durability of this ceramic material, it is possible to reduce the frequency of membrane replacement. Fouling can be prevented by performing backwash during operation and chemical cleaning during operation (inline cleaning).

These features can reduce the drawback of the MBR method. Even a ceramic flat sheet membrane is a kind of filter and cannot be free from fouling. For this reason, careful study is needed when planning the adoption of MBR with due consideration of the quality of wastewater.

2.2.1 Membrane Filtration Test

At the time of planning, a membrane filtration test may be carried out as the need arises. In this case, a test piece is used for the filtration and separation of actual sludge so that the filtration property can be confirmed through the measurement of change in filtration pressure with time during testing.

Fig. 3 shows the result of a filtration test at a food processing factory. The test data indicates that a rise in pressure difference is small and the filtration property is favorable.

Fig. 4 shows the result of a filtration test performed at a beverage factory. A rise in pressure is apparent and this fact suggests that refractory organic substances like polysaccharides and proteins remain in the water. It can, therefore, be presumed that a pressure at which difficulty in performing filtration is attained in a short time and the frequency of inline cleaning is increased. Such a situation is economically disadvantageous. In such a case,

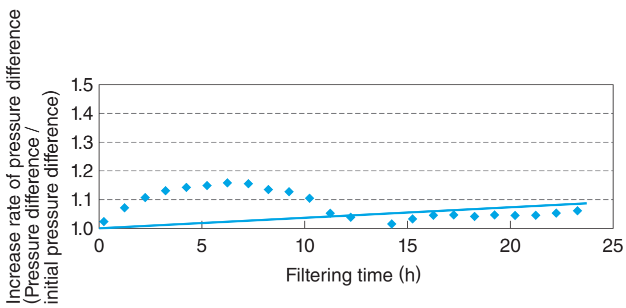

Fig. 3 Result of Filtration Test at a Food Processing Factory

The result of filtration test executed at a food processing factory is shown. The increase rate of the filtration pressure difference is low and stabilized filtration is possible.

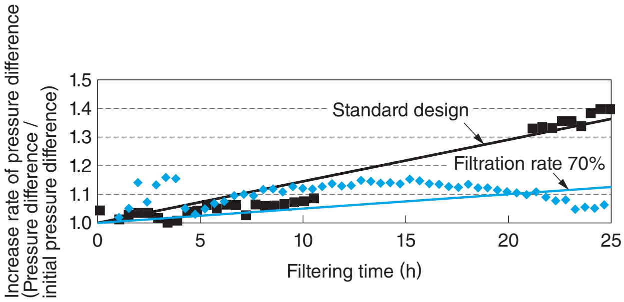

Fig. 4 **Result of Filtration Test at a Beverage Factory**

An increase in filtration pressure difference is remarkable. According to the standard design values, economically reasonable management is impossible. If flux is lowered or design values are reviewed, more economic proposal can be offered.

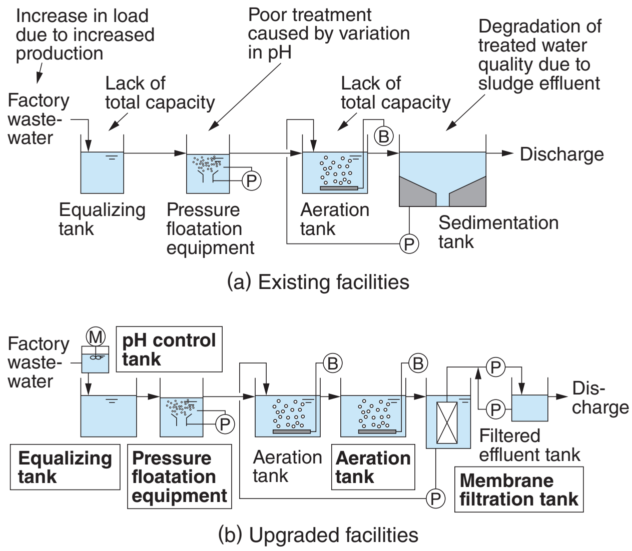

Fig. 5 **Outline of Water Processing Facility Upgrade Work at a Food Processing Factory**

An example of space saving is shown. It is realized due to the switchover from the standard activated sludge method to the MBR method. In addition, the facility functions were upgraded by the installation of pressure floatation equipment and a pH control tank.

design values must be reviewed so that the membrane surface is increased or the filtration flow rate (flux) per unit area is decreased. Fig. 4 also shows the test result of a lowered filtration flow rate to approximately 70% of the standard value. It is recognized that the pressure rise has been restrained.

3 Actual Examples of MBR-Applied Plants

Some examples about the effective utilization of the MBR features are introduced below.

3.1 Application to Processing Capacity and Increased Construction

In the case of a processing capacity increase in construction, it is essential to make full use of existing facilities. At a particular laundry factory, for example, a sedimentation tank was modified to a membrane filtration tank so that activated sludge could be concentrated. As a result, the volume of processed wastewater could be successfully doubled[1].

3.2 Treatment of Wastewater with High Concentration of Chemical Oxygen Demand (COD)

At an industrial complex, COD concentration of wastewater was high and only the activated sludge method was not enough to accomplish wastewater treatment. Accordingly, an anaerobic treatment section (Upflow Anaerobic Sludge Blanket method: UASB method) was set up at the primary stage. Since COD treatment by the anaerobic method was combined with the BOD treatment by the MBR method, the goal quality of treated wastewater could be attained[2].

3.3 Reuse of Treated Water

One of the features of the MBR wastewater is that clarity of treated water is high. For the treatment of kitchen wastewater in a building complex, this feature is effectively utilized so that the treated water is regarded as recycled wastewater and reused for lavatory cleaning water[1].

3.4 Increasing Wastewater Treatment Capabilities at Private Factories

Currently, we are engaged in the capacity upgrading work for wastewater treatment at a private factory. This project is intended to reinforce wastewater treatment capabilities so that the factory can cope with an increase in the volume of wastewater accompanied by an increase in production. In consideration of influence by oil content in wastewater, they adopted our ceramic flat sheet membranes. Fig. 5 shows outline of facility upgrading. Oil content is removed by pressure floatation equipment (renovated by this project) at the primary stage. Along with change in water quality, however, there is a concern that membrane contamination caused by oil content is not fully removed. Ceramic flat sheet membranes are considered not to be influenced easily by oil content. Although membranes are obstructed due to the contamination by oil content, their functional recovery can be expected by making chemical cleaning without the replacement of membranes. In this project, a soak washing tank has been installed so that ceramic flat sheet membranes can be cleansed at the site in the event of fouling.

4 Postscript

The ceramic flat sheet membranes developed and manufactured by us offer fine structure construction and functions suitable for use with the MBR. Compared with conventional separate membranes, the ceramic flat sheet membrane is rich in oil and chemical resistant properties. In addition, it assures a long operational life. By making full advantage of our system, we will continue to actively make proposals for high-load wastewater sectors such as food and chemical factories. In so doing, we would like to contribute to the protection of regional environments.

《**References**》

(1) Meiden Jiho Vol.346, 2015 /No.1 (in Japanese)
(2) Meiden Jiho Vol.342, 2014 /No.1 (in Japanese)