INCORPORATION OF MEMBRANE TECHNOLOGY AT WATERBOARD UITWATERENDE SLUIZEN

MBR-options for the treatment sites Heiloo and Wervershoof

Waterboard Uitwaterende Sluizen (US) has investigated whether membrane technology can be used in its operating area. For that purpose a large-scale pilot study has been initiated at sewage plant Beverwijk with four membrane system suppliers, that has eventually resulted in a project of global stature. For three conventional treatment sites the possibilities for incorporating Membrane Bio Reactor (MBR) technology have been investigated. It is concluded that dependent on the future development of technology and prices, MBR may be a likely option for the treatment site Heiloo. So, Uitwaterende Sluizen acknowledges the potential of MBR technology and in before the end of this year a decision will be taken how to proceed.

The sewage plant Beverwijk-Zaanstreek has insufficient capacity to adequately treat the current quantities of wastewater produced. In order to meet future requirements and obligations additional biological and hydraulical provisions have to be installed. It appeared from a financial point of view not to be a good idea to build the sewage plant at a new location within the US operating area (the province of North Holland north of the North Sea Canal). For that reason it was decided mid-1998 at authority level to build the new sewage plant Westpoort, in co-operation with the water authority 'Amstel, Gooi en Vecht' (AGV), on the south side of the North Sea Canal. In 1999 two developments occurred that caused US to start reconsidering this decision:

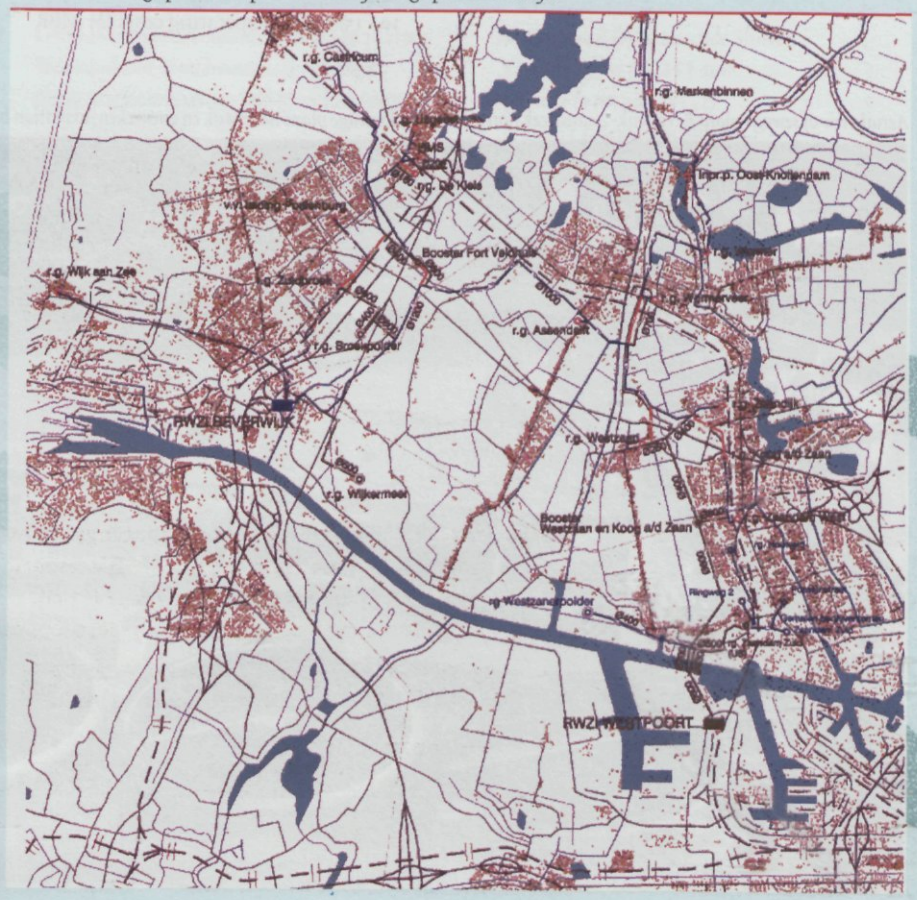
- The optimisation study of the sewerage system for Zaandam-West showed that, among other things, as a result of partial uncoupling of paved surface, US will have to treat and discharge lower quantities of sewage water than estimated in 1998. This considerably reduces the investment costs required for the transport system from Zaandam-West to sewage plant Beverwijk and the extension of this plant;

- The developments (price and performance) of the relatively new MBR technology were reason to carry out a feasibility study for sewage plant Beverwijk. It involves an MBR installation of 4000 m³/h. With the MBR technology the available space at the sewage plant Beverwijk seems to be sufficient for the required capacity extension. The feasibility study (carried out by DHV water late 1999) shows that the investment costs for this technology are competitive with a conventional new installation at a different location. This is also caused by the high investment costs for the new transport lines that direct the water to sewage plant Westpoort. Figure 1 shows the location of sewage plant Beverwijk and Westpoort.

Based on the results of the feasibility study it was decided to start next to the current project (building an own sewage plant Westpoort) a project in which the application of MBR technology at the location Beverwijk was investigated. This project included the following subprojects:

- A large-scale pilot study at the location Beverwijk involving four major suppliers;
- Accommodating research to detail a number of aspects that are essential to a MBR installation at such a scale;
- Pre-designs for the extension of sewage plant Beverwijk were made based on the results of said studies. This was done for each membrane system supplier.

Fig. 1: Area layout for the alternative Westpoort. In this case wastewater has to be pumped from Assendelft to sewage plant Westpoort instead of sewage plant Beverwijk.



Pilot study

Pilot studies are required because there is very little experience with MBR technology on the Beverwijk scale (rain water flow of 4000 m³/hour). In order to prevent upscaling problems the pilots were sized at a level which is normally used for full-scale industrial MBR's. Such a scale is necessary to be able to properly investigate various aspects that are specific to the Dutch situation (type of sewerage system, ratio between rain water flow and dry water flow and chemical phosphate removal). This study was carried out in the period march - september 2000.

Accommodating studies

The following subjects have been investigated in these studies: pre-treatment, alpha factor, flux and permeability of the membranes, fouling and cleaning of the membranes and risk inventory.

Pre-Designs

Based on the results of these studies a decision can be made regarding design parameters, treatment efficiencies, reliability and costs of a MBR system. Ultimately this resulted in pre-designs for each of the four membrane suppliers (Kubota/Solis, Mitsibushi/Grontmij, Stork/Nuon and Zenon). For every pre-design the investment costs and operating costs were estimated.

Study results

The results of the studies and the pre-designs are:

- The technical performance of the MBR is satisfactory and the technology can reliably be applied at sewage plant Beverwijk on a practical scale. It is expected that the majority of the risks connected with application of this technology can be eliminated in the design. However, developing these aspects requires more time than offered by the water quality manager. The full-scale installation must be completed in 2003 in stead of 2005, which was originally planned;
- The MBR produces a higher effluent quality when compared with conventional activated sludge treatment. This is a result of the additional removal of suspended solids and adhered components such as heavy metals and organic micro-contaminants;
- Because a MBR does not require construction of an expensive pressure transport line to the other side of the North Sea Canal, the building costs for the MBR system and a conventional activated sludge system are roughly the same. However, application of MBR technology results in a shift from investment in assets with a long service life (civil) to assets with a shorter service life (mechanical, electrical), this results in 10 - 15% higher operating costs for MBR when compared with the operating costs of a conventional activated sludge system.

Decision for Beverwijk and other US sewage plants

The higher operational costs were one of the reasons for US to decide not to use MBR technology at Beverwijk. Another reason was that despite the comprehensive pilot study at sewage plant Beverwijk this technology has not yet been sufficiently developed at this stage to be able to realise such an installation in this short period (completion 2003). In addition, it falls outside the Dutch development route for municipal MBR installations. The first full-scale MBR installation in this route is the sewage plant Varsseveld. Based on the results of this plant it is possible to design a sewage plant of a bigger scale. Because US thinks highly of the MBR it wants to be strongly involved in the future development of this technology. For Dutch standards, US already has made a significant financial contribution into the research programme. After the decision not to build a MBR in Beverwijk, US has investigated whether possibly other sewage plants within US' control area may qualify for application of this technology.

The following criteria were used:

- The sewage plant needs to be extended, biologically as well as hydraulically;
- The MBR installation must be designed at a larger scale than the MBR at Varsseveld (above 750 m³/h);

Aerial view of sewage plant Beverwijk-Zaanstreek (foreground) and sewage plant Beverwijk en omstreken (oxidation beds, background).

- Preferably the sewage plant should discharge to sensitive water. In this case a MBR has its maximum benefit;
- Design, building and start-up must be completed in the period 01/2003 - 01/2006.

Based on the above criteria it has been decided to start a feasibility study into the possibility of application of MBR technology at sewage plants Heiloo and Wervershoof.

Feasibility study Heiloo and Wervershoof

Sewage plant Heiloo must be extended in connection with the autonomous growth of inhabitants and the expected growth of the industrial estate. The effluent is discharged to sensitive surface water and it is expected that the future discharge load is not allowed to increase. This means considerably cleaner effluent in order to realise this. A study carried out in 1997 by Grontmij in which conventional extension followed by sand filtration was compared to discharge through a newly constructed pressure line to sewage plant Geestmerambacht, showed the latter alternative to be the most attractive one from a financial point of view.

Sewage plant Wervershoof will have to be extended in future, particularly the hydraulic system. In addition, the present disinfecting system (chlorinating) will have to be replaced. One of the characteristics of an MBR is that the removal efficiency for bacteria is almost 100 % and for viruses it is higher compared to a conventional activated sludge installation.

Provisional results

Sewage plant Heiloo

- The alternative in which the wastewater is transported to sewage plant Geestmerambacht is based on the current design data financially a little more attractive. One of the major reasons is the already planned extension of sewage plant Geestmerambacht that makes an additional extension for treatment of wastewater from Heiloo relatively cheaper. This difference is expected to disappear in future as a result of further optimisation of MBR technology;

- The MBR version was based on a stricter effluent demand (N_{total} = 5 mg/l) as normally required, because of the sensitivity of the receiving surface water. The effluent requirements for sewage plant Geestmerambacht were based on current legislation for discharge to surface water (N_{total} = 10 mg/l);

- As a result of MBR application the effluent of sewage plant Heiloo contains lower quantities of heavy metals, organic micro-contaminants, bacteria and viruses than the effluent of sewage plant Geestmerambacht. As current legislation does not contain special requirements for these components, no additional measures will be taken for sewage plant Geestmerambacht;

- In general it can be stated that the effluent quality of a MBR is considerably better when compared with conventional treatment.

Sewage plant Wervershoof

- Alternatives are being investigated for the current disinfecting system using sodium hypochlorite solution. Currently most membranes in MBR installations are still periodically cleaned using sodium hypochlorite solution. Current data on the use of this substance indicate that still substantial quantities of chlorine-containing compounds are being discharged into the effluent. It is absolutely needed to find an effective alternative for chlorine. Hydrogen peroxide is maybe an alternative;

- Conventional extension of sewage plant Wervershoof is substantially cheaper than extension using MBR technology.

General conclusions

From the various feasibility studies the following can be concluded:

- Financially, conventional extension is a better choice for building larger installations. Among other things, this is caused by the fact that for MBR the advantages from the upscaling effect are lower because of the membranes. The price of an installation is largely determined by the amount of membranes. The higher the hydraulic capacity, the more membranes are needed. Also in cost calculations for a MBR larger financial reserves are incorporated due to incompleteness of the design. This is justified by a lack of knowledge of this technology;

- Because MBR technology has not yet fully been developed, the designs must be based on conservative design guidelines. If flux, price and operational life of the membranes keep developing positively, this will have a favourable effect on the application of this technology;

- Currently, the improved effluent quality is not yet required anywhere by the authorities. This still causes a distorted picture when comparing conventional treatment with MBR treatment;
- It looks like MBR technology is becoming the wastewater treatment technology of the future, but still more experience have to be gained in order to design less conservatively. This ultimately results in cheaper installations;

- It is important to gain practical experience with this technology. This makes it worthwhile to apply this technology first at smaller installations in the US control area. In this case the financial risk is also limited. A further decision on the application of MBR technology at US is taken before the end of this year. ¶

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