STORK/X-FLOW - NUON

NORIT membrane technology in MBR

The application of membrane filtration to purify the effluent of biological wastewater treatment plants is increasing strongly world-wide. While many applications for municipal applications are still under development, many industrial applications are already in operation. The Netherlands plays an important role in the introduction and development of this separation technique.

The expenses for the disposal of industrial and municipal wastewater are increasing strongly due to more stringent governmental legislation ordering lower discharge limits and higher discharge taxes. Moreover, the intake of ground water is being limited to prevent a dehydration of the soil having a destructive influence on nature's flora and fauna. The call for a closed water cycle is becoming louder and the introduction of more efficient wastewater treatment techniques is being required.

Conventional treatment

The treatment of municipal and industrial aqueous waste streams is carried out by means of aerobic biological degradation. Characteristics of the conventional system are the requirements of several tanks or basins of relatively large volumes. After pre-treatment (coarse filtration in most case) the influent is stirred and aerated in the oxygenation tank containing a low concentration of activated sludge (the biomass). These organisms convert the biodegradable waste into decomposable products. Next, the biological treated sewage is transferred to the clarification or settling tank where the cleaned effluent is separated from the sludge (the latter returns to the oxygenation tank normally).

This conventional technique is robust and safe, but there are disadvantages. Besides the bulky character of this treatment system, the effluent always contains sludge carry-over requiring post-treatment in order to be allowed to discharge or to recycle the effluent. In order to minimise this sludge carry-over the concentration of the biomass in the reactor is usually limited causing, however, again a larger reactor volume to achieve a certain waste conversion.

Membrane bioreactor

A membrane bioreactor (MBR) is a compact-built purification system combining the biological degradation step with a membrane separation step. The influent is fed to the aerated bioreactor where the organic components are oxidised by the activated sludge. Next, the aqueous activated sludge solution passes through a micro- or ultrafiltration membrane filtration unit separating the water from the sludge. The latter returns to the bioreactor, while the permeate is discharged or re-used as particle-free effluent.

The combination of biological treatment with membrane filtration offers several significant advantages, such as an increase in solid contents in the reactor, resulting in a more compact system; and a decrease in sludge carry-over in the effluent, reducing the need of post-treatment of the effluent.

Effluent polishing

An intermediate solution between the conventional system and the membrane filtration integrated bioreactor is the connection in-series of a conventional Waste Water Treatment Plant (WWTP) and an ultrafiltration system. The particle-loaded effluent of a WWTP is polished by the ultrafiltration process in order to be a source for process water.

Process water applied in industry is discharged somewhere during to process either to a central sewage system leading to the municipal WWTP, or to a company-owned WWTP in case of large industries. In both cases the treated water will be discharged most likely upon the surface water. For larger industries, the effluent of a WWTP can be processed and re-used on site decreasing the discharge cost and lowering the intake cost. In the case of smaller industrial areas, some kind of catering system can be set-up locally. The ultrafiltration treated WWTP effluent of one industry can be quality tailored-made process water for another industry.

Operational modes and system designs

Two basic modes of operating a membrane filtrarion system can be distinguished, each of them with its advantages and drawbacks: cross-flow filtration and dead-end filtration.

Cross-flow

For industrial applications (such as industrial waste water treatment) the cross-flow mode is being applied successfully since the early 70's (of the last century). The main characteristic of cross-flow is that a part of

Fig. 1: *Basic system designs: (a) AquaFlex cross-flow, (b) XIGA dead-end.*

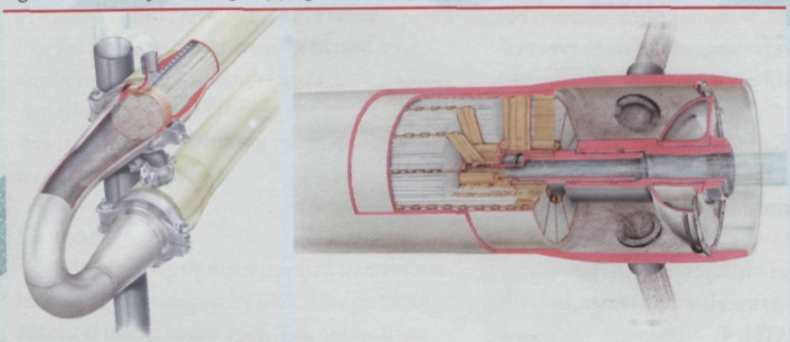

Fig. 2: *COMPACT membrane bioreactor application: (a) membrane module, (b) paper mill effluent.*