



Submerged membrane bioreactor technology for treating mixed tannery effluent

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This research programme is a European collaboration project. W2O Environment from the UK, French Leather Technology Centre CTC and the German University ISA-RWTH Aachen are testing a submerged membrane bioreactor in Tanneries d'Annonay, France. The tannery processes calf hides from raw to finished product and operates a conventional primary effluent treatment plant with neutralisation, coagulation, flocculation and dissolved air flotation, and discharges to the local sewer.

This novel membrane application, in combination with a process integrated membrane filtration system, allows high quality effluent treatment. The first results showed a stable membrane performance and high reductions in Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and suspended solids (SS) of 98-99%.

Membrane bioreactors (MBRs) are a combination of a biological activated sludge system with micro- or ultra-filtration membranes, and nowadays they are considered as the 'Best available Technology' for industrial effluent treatment. Industrial scale cross-flow MBRs have been proven a successful technology with numerous applications in various industries.^[1,2]

Two cross-flow MBRs with external ultra-filtration membrane units are reported to be in operation in European tanneries.^[3,4] However, the operation of cross-flow systems is highly cost intensive due to high cross-flow velocities of 3.5-5 m/s and to operational pressures of up to approximately 8 bars applied. 6-8 KW/h electricity are required to produce 1m³ of clean and suspended solid free effluent.

Submerged or integrated membrane systems can be operated at significantly lower pressures and hence energy consumption. In this case membranes are submerged in the bioreactor and permeate is pumped under negative pressure of only 0.2-0.4 bars. Coarse bubble aeration is applied to achieve the necessary cross-flow and to avoid membrane fouling. The energy requirements of submerged membranes are significantly lower with 0.5 KW/h per 1m³ of permeate produced.

CTC is currently testing this novel submerged MBR application in the Tanneries d'Annonay, for advanced biological

Panel 1

Submerged membrane bioreactor



Left to right: Process control unit, peristaltic pump, blower and bioreactor

Panel 2

Submerged membranes: size A4

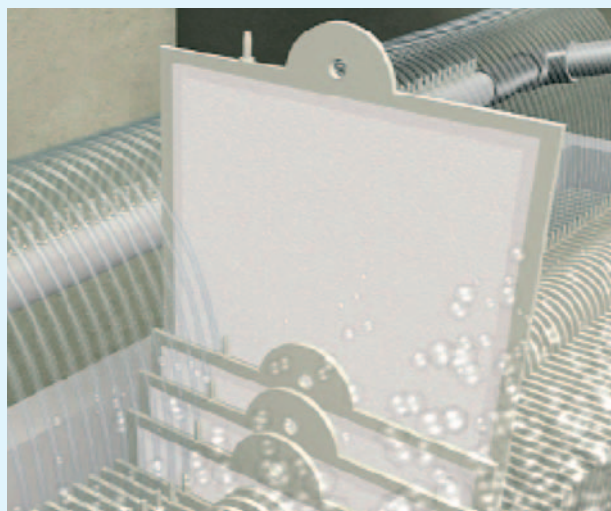


Photo courtesy of Copa UK

**Panel 3**
**Membrane bioreactor plant performance
with average reduction of COD, BOD,
Kjehldal nitrogen and chrome**

Parameters (mg/l)	Feed	Permeate	(%)
COD (mg/l)	2,478	84	96.8
BOD	1,076	<3	99.7
Kjehldal - nitrogen	166.7	69.8	58.1
Chrome	1.1	0.36	67

effluent treatment, and a photograph of the unit is shown in *Panel 1*.

Primary treated mixed effluents are collected and filtered via a 1mm sieve. They are then fed directly into the MBR for enhanced biological treatment. The MBR combines an activated sludge process with membrane filtration, which enables complete retention of the micro-organisms as a result of high microbial population densities and high biodegradation rates.

The MBR consists of a 100-litre bioreactor, which is aerated with coarse bubble diffusers. A framed 1m² plate membrane rig—shown in *Panel 2*—is submerged into the aerated tank, with the permeate drained via a suction pump.

To start up the MBR process, the plant was inoculated with 150 litres of activated sludge from a biological tannery wastewater treatment plant and the bioreactor was fed with up to 50 litres of effluent per day. The first results showed excellent performance of the MBR plant. The bioreactor proved to be very suitable for biodegrading the organic compounds of the effluent. During the course of the initial trials a COD and BOD reduction of up to 98% and 99% was achieved, as shown in *Panel 3*.

A typical visual example of the difference between inflow and outflow using the MBR treatment is shown in *Panel 4*.

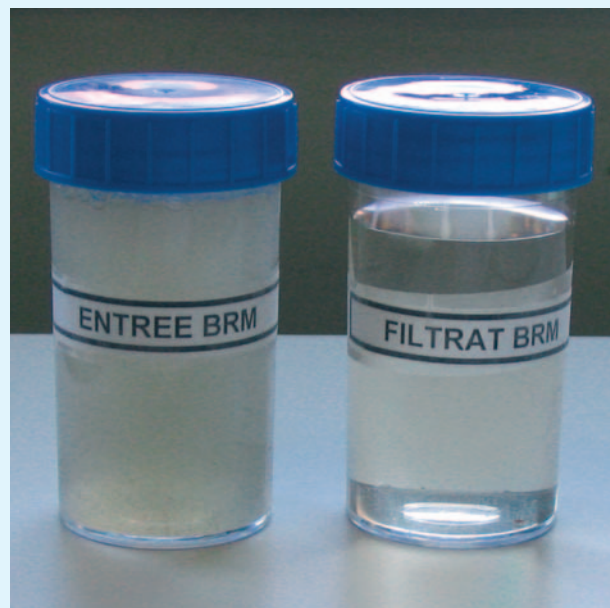
The high biodegradation achieved compares well with previously reported results of submerged MBR treatment of beamhouse effluents.^[5] In the future development of the research programme a subsequent Reverse Osmosis treatment will be applied to enable recycling of high quality water for the processes.

Conclusions

The submerged membrane bioreactor technology has shown to be suitable for the biological treatment of mixed tannery effluents. The permeate concentrations achieved, in terms of COD, BOD and chrome, are below the discharge limits to surface waters. The excellent permeate quality could potentially allow for direct recycling or, if required, for polishing with Nanofiltration or Reverse Osmosis. Further research will be conducted to assess the long-term performance of MBRs and also to test the MBR permeate for leather processing.

Legend

- (1) W2O Environment Ltd, United Kingdom.
- (2) Institut für Siedlungswasserwirtschaft, Aachen University, Germany.
- (3) CTC, France.

Panel 4
Inflow and permeate after MBR treatment


Reference

- [1] Jefferson B., Laine A.L. and Stephenson T. (2000), *Membrane bioreactors and their role in wastewater re-use*. *Water Science and Technology*, Vol. 41, Iss 1, 197-204.
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- [3] Zenon Environmental b.v., Netherlands (1995), *Ultrafiltration, combined with a bioreactor for the treatment of tannery effluent*, *World Leather*, Vol. 8, No 7, 41-42.
- [4] Scholz W., Rougé P., Bodalo A. and Leitz U., (2005) "Desalination of mixed tannery effluent with Membrane Bioreactor and Reverse Osmosis Treatment", *Journal of Environmental Science & Technology*, 39 / 21, p. 8505 – 8511.
- [5] Scholz W. G., Baumgarten S. and Serrarols D. (2006), "Membrane based process water recycling and side stream membrane bioreactor treatment for effluents from the beamhouse process", *II Eurocongress IULTC, Istanbul, May 2006*.

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