

1 mm. The water then enters the biological treatment tanks, consisting of an anoxic and aerobic tank of 450 m³ and 2,650 m³ volume respectively (and thus 31 hours HRT at the average flow rate), where the MLSS concentration is held at 10,000-11,000 mg/L. Chemical dosing with ferric chloride is applied for phosphorus removal.

The sludge is recirculated through the membrane skid at 4 m/s CFV and applied pressures of up to 5 bar. The skid comprises 6 lines of 6 *Compact 27* Pentair modules (Fig. 5-2b), providing a total membrane area of 972 m² and thus a net flux of 103 LMH at the average flow rate. In practice fluxes of up to 140 LMH are attainable. The membranes are chemically cleaned monthly for two hours with 300 mg/L NaOCl and quarterly for four hours with 1 wt% citric acid by forward flushing with the reagent in both cases.

The process removes 94-97% and >99% of the COD and BOD respectively and leaves residual concentrations of 30-50, 1-3, <5 and ~2 mg/L of COD, BOD, TKN and P respectively. The calculated OPEX was between 0.3 and 0.4 EUR/m³ when reviewed in 2009.

5.1.4 Polar brewery, Caracas, Venezuela

Polar beer is the largest and best known brand of beer in Venezuela, the company having been established in 1941. The plant at Caracas generates 2,000 m³/day of effluent, between 30 and 35°C, of which up to 70 m³/h (~1,700 m³/d) is reused following treatment by MBR and RO. The Pentair-based A-L sMBR technology (Section 4.3.1.4, Fig. 5-3a) is similar to that originally applied at Ootmarsum for municipal wastewater treatment (Fig. 5-3b), reconfigured to reduce the footprint. The plant has been in operation since Dec 2008, and on-site reuse duties for the recovered water include CIP water preparation, cooling and steam-raising.

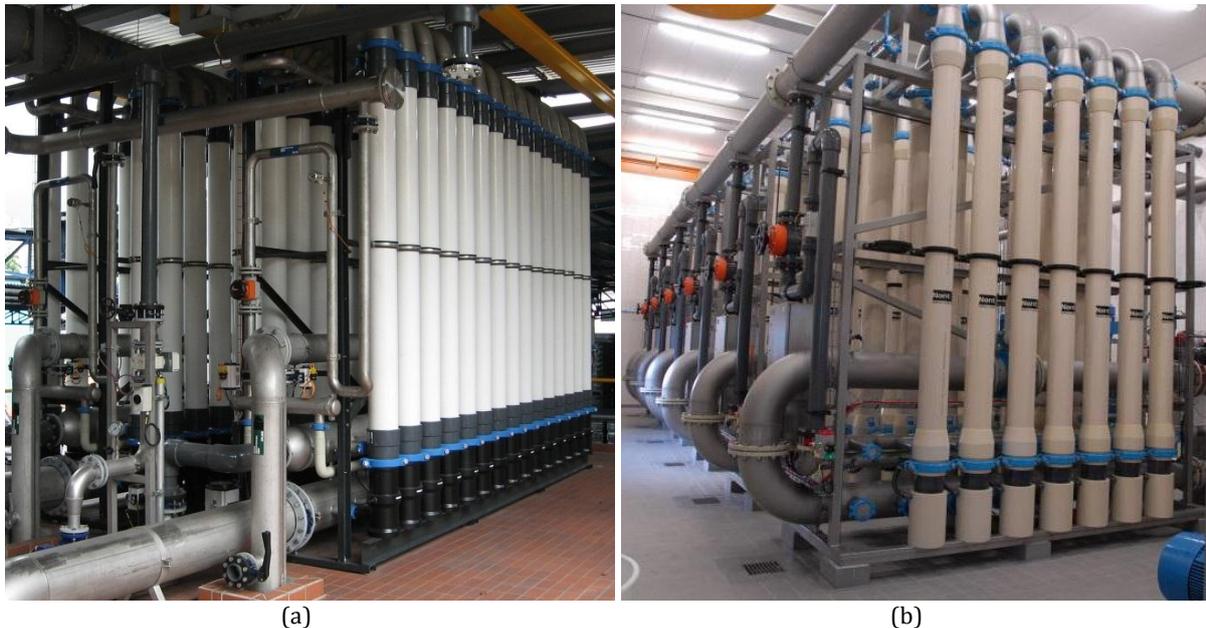


Figure 5-3 The Pentair *Airlift™* technology: (a) Polar, Dec 2008, (b) Ootmarsum, Oct 2007

The MBR feedwater, at around 300 mg/L COD, derives from the outlet of a Paques anaerobic digester, and undergoes equalisation in an existing tank prior to screening using a 2 mm Amiad basket strainer. It then enters a 2,000 m³ aerobic tank held at 10,000–11,000 mg/L MLSS. The sludge is recirculated through a sidestream Pentair *Airlift™* membrane system comprising two skids of 30 *Compact 27* Pentair modules (Fig. 5-3a), giving a total membrane surface area of 1,980 m² and so a net flux of 42 LMH at the average feed flow rate. The sludge is pumped at a crossflow of 0.5 m/s assisted by air-lift at around 0.3 Nm³/(m².h). The membranes are