Water reuse from condensates in the petrochemical industry

I. Veleva, Ghent University, Ghent, Belgium; M. Vanoppen, Ghent University, Ghent, Belgium; C.K.Groot, Dow Benelux BV, Terneuzen, The Netherlands; A.R.D. Verliefde, Ghent University, Ghent, Belgium

As part of a project of the Institute for Sustainable Process Technology and together with all partners (Dow, Ghent University, Evides Industriewater, Sitech, KWR Waterrecycle Institute, Kurita), this research aims to achieve more efficient production of steam in the petro(chemical) industry. Steam is crucial since it is used in many processes e.g., as heat transfer and reaction medium, and even as diluent during crude feed cracking. Because of the very strict boiler feed water quality requirements, more heavily contaminated condensates are deemed as unsuitable for direct reuse in the steam/water cycle and are discharged and treated at the waste water treatment plant. This leads to significant condensate losses, which leaves an open window for development of improved treatment in order to achieve better steam/condensate cycle ratios and an increased water and energy efficiency within plants.

Due to the complex composition of the streams and the emphasis on maximized recovery of heat, two treatment approaches were chosen – membrane distillation and membrane aerated biofilm reactor. Due to the availability of waste heat, membrane distillation was chosen as a first technique for water recovery. Different combinations of key process conditions (ΔT, $T_{average}$, flow rate) at the feed and distillate side of a hydrophobic membrane were applied to study the most optimal set of parameters towards the distillate with the highest quality. Due to the origin of the treated stream, the performance of the system was also evaluated with an oleophobic membrane, which was further compared to the obtained data from the hydrophobic type.

The membrane aerated biofilm system provides biodegradation of contaminants which is accomplished by a biofilm attached to the surface of gas permeable hollow fiber membranes. These not only serve to support the fixed biofilm, but also to directly deliver oxygen to the microorganisms. The efficiency of the treatment was evaluated by monitoring main effluent quality parameters such as total organic carbon, chemical and biological oxygen demand as well as via ion chromatography analyses of cations and anions.

Also, combinations of both technologies in various sequences were considered in order to produce a reusable water stream and reduce the consumption of fresh water.