Membrane filtration in the paper industry

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Membrane filtration can be used in the pulp and paper industry to recover material as well as prevent waste by-products from entering the water course. In addition, depending on the application, membrane systems can be used to remove impurities or to concentrate and purify, either as an aid to recovering valuable raw material or to improve product yields. With increasingly strict legislation on effluent discharge, and the need to remove pollutants from the waste stream, effective filtration is becoming more important to a number of process industries. Pulp and paper manufacturing is no exception. The high cost of conventional effluent treatment plants, either on site or at a municipal water treatment works, makes membrane filtration a viable approach for many paper mills, where large volumes of water are used and where recovery of water or by products is possible. Indeed, the world's largest tubular ultrafiltration membrane effluent treatment plant, designed and manufactured by PCI Membrane Systems, is installed at a Swedish pulp mill.

Membrane filtration can be divided into four broad groups, each determined by the size of particle which can be retained by the membrane material. These range from reverse osmosis which provides the finest level of filtration, through nanofiltration and ultrafiltration to microfiltration which uses the coarsest of membranes. Ultrafiltration, which can separate particles up to a few tenths of a micron in diameter of different molecular weights, is widely used in the forest products industry. Membrane filtration offers a number of benefits to the pulp and paper industry.

Firstly, a small footprint can be achieved because of the high packing density of membrane plants. This saves space on a mill production line.

Secondly, a wide range of membrane materials and geometries have been developed by companies, including PCI. This means that a plant can be built to match the process flow of a paper or pulp mill exactly.

Tubular membranes for example are particularly robust. They are generally able to withstand aggressive chemicals and solvent cleaners and can handle suspended solids without blocking. This means that high throughput and performance can be achieved.

Over the past 15 years, PCI has been supplying membrane filtration plants to solve a variety of problems in the pulp and paper industry. These range from the removal of resins in bleach effluent on a pulp line, to the recovery and reuse of lignosulphate fractions from calcium bisulphite spent liquors.

"Initially, the paper industry turned to membrane filtration as a means of reducing effluent discharge," explained Steve Morris, PCI's forest products specialist. "Colour, COD, BOD and toxicity can all be reduced by passing waste water through a suitable filtration system prior to final discharge. However, more recently the benefits of chemical recovery using membranes has begun to be exploited by mills. Valuable paper coating materials, for example, were being literally poured down the drain because there was no cost effective method available for recovery. Membrane filtration can now be used to significantly reduce chemical wastage."

Membrane technology is being adopted increasingly where manufacturers are closing their mill production process. As different pulp bleaching methods have developed over recent years, membranes have proved to be a viable technology for treating both TCF (total chlorine free) and ECF (elemental chlorine free) bleaching

streams. For TCF bleaching, membranes also provide an effective method of closing the chelating stages and allow the filtrates to be used as bleach plant wash liquors. In many countries, particularly the USA and parts of South East Asia, raw water use represents a significant cost. Paper making machinery generates large quantities of white water, which can be recycled, thereby achieving major savings on water usage. Water for recycling must be of a consistent quality. Any impurities in the recycling stream could have a disastrous effect on product quality. Membrane filtration offers a physical barrier to impurities and combined with the wide range of membrane types allows efficient recycling of water. Stora Nymolla is one of the world¹s largest manufacturers of TCF bleached magnephite pulp. The Swedish mill is currently producing 300,000 tonnes of pulp a year, of which two thirds is then used for its own paper making process. With 300 tonnes of effluent being produced every hour, 50 per cent reductions in the total mass of COD emitted from the mill were sought to ensure that the plant discharge was to a high environmental standard. Not only was the effluent to be cleaned up, it was also desirable to concentrate the retentate sufficiently that it could be disposed of by incineration. PCI developed a process plant after extensive pilot studies, which showed that a polyethersulphone membrane would be most suitable to treat the effluent from oxygen delignification. Two effluent streams had to be treated separately, from hardwood and softwood processes, to ensure that the retentate could be further processed. Separation is achieved using cross flow filtration. Here, liquid flow occurs tangentially to the membrane surface. This inhibits the deposition of material on the membrane surface, which in turn improves the filtration efficiency. At Nymolla, PCI experimented with low cross flow velocities, designed to keep energy consumption to a minimum. This worked well for the softwood stream, but during scale up it became apparent that fouling on the hardwood stream, even at high cross flow velocities, meant that a different membrane material would be required. PCI then set about developing a completely new membrane, since there was no commercially available material with suitable characteristics. The mill now operates a two line, thirteen stage recirculation plant consisting of a total of over 1784 (4600m2) tubular membrane modules. COD has been reduced to such a level that Nymolla were awarded the prestigious Swan mark for their products.

The application of membranes at any particular mill is very site specific and feasibility depends on a number of factors such as the products being manufactured, the location of the mill, available options for effluent disposal and availability of fresh water as a resource. Hence the recommendation of experts is to seek advice from colleagues in the paper and pulp industry, who have already had experience in implementing filtration processes, as well as discussing your plant requirements at an early stage with a company like PCI, who will then undertake feasibility studies and pilot studies on the process stream.