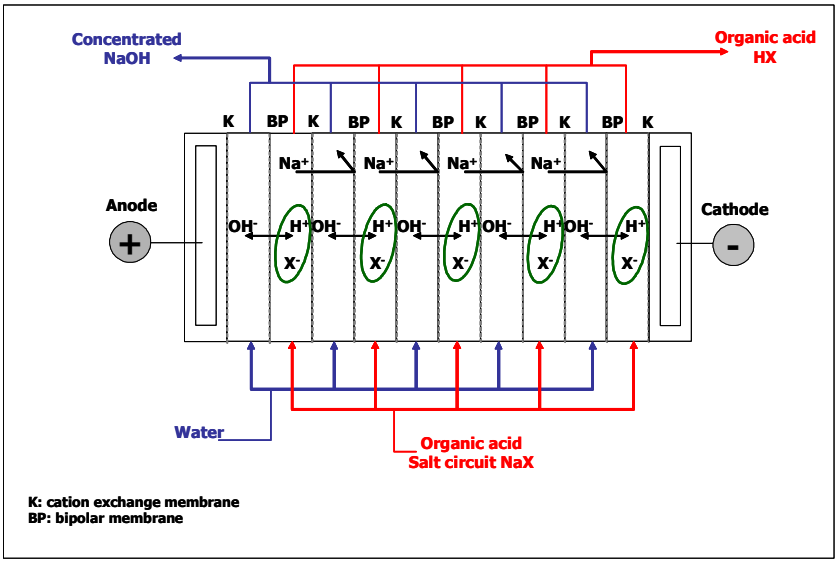
The Eurodia Industrie bipolar membrane electrodialysis unit for the conversion of sodium acetate into reusable acetic acid and caustic soda: More than five years of successful operation (Published in Membrane & Separation Technology News – March 2006)

In early 2003, Eurodia Industrie commissioned a new bipolar membrane electrodialysis (EDBM) unit at the site of a specialty chemical producer in Germany. Its purpose is to convert a by-product stream of Sodium Acetate from the production of vitamins into Acetic Acid that can be reused in the process and Sodium Hydroxide to be used in the waste water treatment facility. As a result, the volume of waste (organic load) is significantly reduced and the acid and base values can be recovered. This article will describe the successful operation of this plant over the last three years.

EDBM combines in an electrodialysis stack conventional ion exchange membranes with bipolar membranes to allow the conversion of aqueous salt streams into the acids and bases. Under the action of a DC current, the bipolar membranes effectively split water molecules into H^+ and OH^- ions. These ions combine with the anion and cation of the salt to form the acid and the base. With a three-compartment configuration using anion-exchange, cation-exchange, and bipolar membranes, three loops are circulating in the stacks: acid, base, and salt such as Sodium Chloride. As shown in the schematic below, the two-compartment configuration with bipolar and cation-exchange membranes is used preferably with the salts of weak acids and strong bases, such as Sodium Acetate. Because organic acids are weakly dissociated it is not possible/practical to have a separate acid loop and no anion-exchange membranes are required. In such stacks, the two product streams are an aqueous solution of NaOH (maximum concentration 8w%) and the organic acid mixed with some remaining organic salt for a sufficient conductivity: the higher the salt feed concentration, the higher the conversion rate that can be achieved. More than a dozen EDBM systems are in operation worldwide, mainly for specialty chemicals applications.



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At the German plant, the Sodium Acetate stream is fed at an average concentration of 22-23 w% and the acid is produced at a concentration of 18-19 w% (3.2-3.5 M). The NaOH is produced at an average concentration of 6-6.5 w%, sufficient for reuse in the water treatment plant. Since there is also a transport of water from the acid into base loop, the conversion rate is above 90%. The unit processes 1.1 to 1.3 m^3/hour of feed and converts more than 400 kg/hour of Sodium Acetate.

Since the feed contains low levels of multivalent cations (Ca, Mg, Fe, Cu, etc.), a pretreatment step is required to reduce the total concentration below 1 ppm to avoid precipitation as hydroxides in the stacks: two ion exchange resin columns have been installed for continuous

operation. The salt is then converted in **two EUR40B-bip** EDBM stacks (see picture below), with a total cell area of 255 m^2 (510 m^2 of membrane area). The EDBM stacks run in an automatic batch mode with the salt/acid conductivity decreasing from 70 mS/cm to 11.5 mA/cm: when the conductivity reaches such minimum, the acid product is pumped to the storage tank. The overall current efficiency is optimized thanks to proprietary designed spacers.

The EDBM unit has been designed and constructed according to CGMP principles and to customer specifications. Commissioning has been completed within a short time and, since, it has met the needs of the customer and always been in operation when required. The automatic operation is controlled by a PLC. The unit has been installed in a stand-alone building while the overall control room is in an adjacent building. In addition, remote camera monitoring allows that an operator must only be in the building for less than 30 minutes per day. The electric cabinets and rectifiers are located in the same building as the EDBM stacks. A dilute NaOH solution is used as the electrolyte solution and a blower allows the safe venting outside the building of the small amount of hydrogen and oxygen gases that are generated at the electrodes. It is possible to install a modem to allow remote monitoring of plant operation and optimization of operating parameters.

It is worthwhile to note that the performance of the system have continuously exceeded the design and guaranteed parameters: especially for the acid concentration and the acid production rate, as well as the power consumption. While a membrane life of 12,000 hours has been guaranteed, the membranes have run for more than 8,000 hours so far with no sign of deterioration. For a similar application at another site, the bipolar membrane life has exceeded 25,000 hours while the life of the cation-exchange membranes is about 15,000 hours. The DC current is set at 340 A (equivalent to 85 mA/cm^2) and the average voltage remains at 185 V per half-stack, or less than 1.7 V/cell. Since cell maintenance and power consumption are the main operating costs, the economic projections show a payback for the customer of less than two years.

The performance of the EDBM unit demonstrates that, with a good design and the adequate pretreatment, users will have a very successful and trouble-free operation. Of course, this equipment requires the same amount of care as any chemical process step and the plant operators have shown their commitment to the technology. From this experience, it is clear that bipolar membrane electrodialysis can be reliably used in chemical processing with the potential of attractive financial returns.