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Preparation steps for cleaning lactic acid from grain

The resultant mix from the fermentation process in the manufacture of lactic acid from grain hydrolysates contains, along with the lactic acid, impurities in the form of sodium lactate which, depending on type and purity requirement of the product, must be removed. Membrane methods are increasingly being applied as alternatives to conventional methods. These include nanofiltration as diafiltration and also electrodialysis. With these methods foreign ions such as chloride ions can be removed from the target product.

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Keywords

Lactic acid, downstreaming, nanofiltration, electrodialysis

Under the term downstreaming is understood the procedural steps required to win an end product following fermentation. Depending on the purity requirements for the product, downstreaming requirements have an important influence on costs. Because of this membrane systems are increasingly used as an alternative to conventional methods [1, 2].

In earlier publications [3, 4, 5] some results from investigations on downstreaming at the Institute for Agricultural Engineering Bornim have already been reported. In the following article further results from the application of the membrane method for the cleaning of fermentation products are given on a technical scale offering alternatives to the conventional system with ionic exchange resins.

Nanofiltration

Nanofiltration membranes have good ion selectivity for single and multiple value ions. On this basis investigations took place into the washing-out of chloride ions through nanofiltration as diafiltration. This resulted in 99.7% of the chloride ions being washed-out of a cell-free sodium lactate solution with a wash liquid amount of 140% of the applied amount of salt solution. The permeability of the other ions was according to their respective molecular weights *(fig. 1)*.

Electrodialysis with monopolar membranes

Electrodialysis is a membrane method for removing, separating and concentrating ions out of highly diluted solutions. With the help of semi-permeable membranes and electric current ions are transferred from a less concentrated solution into a more concentrated one.

In the concentrating of model sodium lactate solutions with a concentration of 51 g/l, a current density of 50 mA/cm^2 led to, after a trial period of just 60 min, 86% of all the chloride ions and 63% of the sulphate ions being transported into the concentrated solution against 34% of the lactic ions. This gives, in relationship to time, a degressive ion transport for the chloride and sulphate ions compared with a linear to progressive one for lactate ions (*fig. 2*). Although sulphate ions, because of their dual value, have a higher transport rate compared with single value chloride ions, the chloride ions with their lesser molecular weight demonstrate a higher permeability. Additionally, with in-

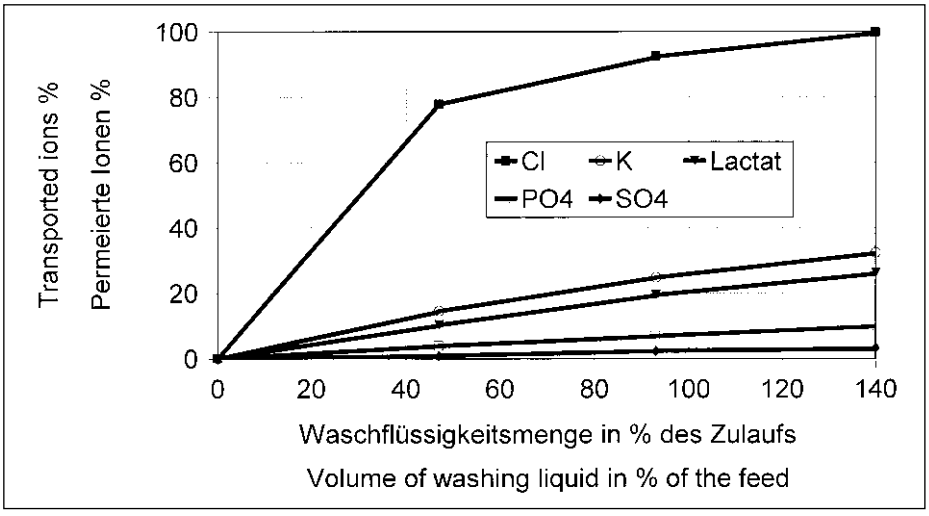

Fig. 1: Ion permeation in diafiltration of cell-free sodium lactate solution with a nanofiltration membrane

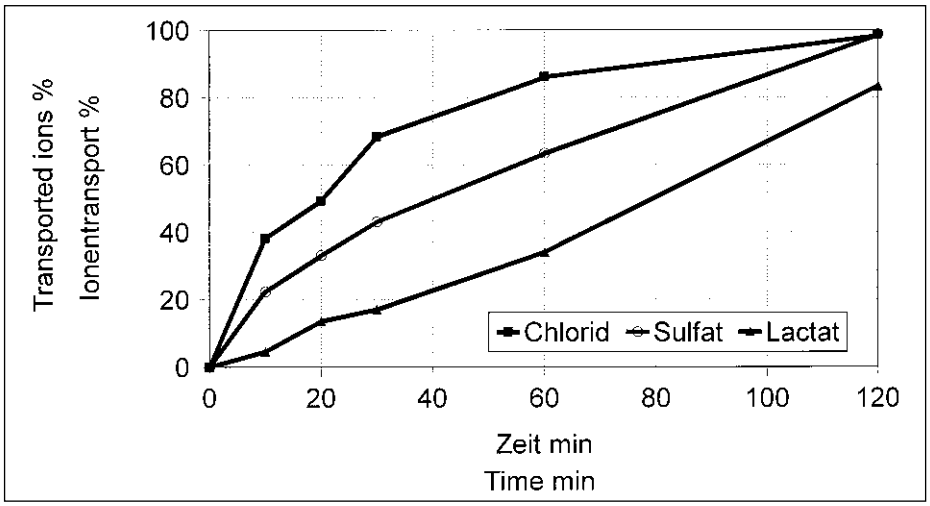

Fig. 2: Alterations of time for ion transport during concentration of model solutions of sodium lactate (NaL) through electrodialysis with monopolar membranes (NaL = 51 g/l; current density = 50 mA/cm²; concentrate volume = 1 l salt solution)

creasing current density a stronger increase in transport velocity for chloride ions compared with lactate ions is to be recorded.

Electrodialysis with bipolar membranes

Bipolar membranes are applied to transfer inorganic and organic salts into their corresponding acids and bases. As for electrodialysis with monopolar membranes, the application of bipolar ones results in a disproportioning of the ion composition through differing transport speeds and permeability. In the conversion of concentrated sodium lactate model solutions with a concentration of 209 g/l in the free lactic acid there would be, with a current density of 50 mA/cm², 85% of the chloride ions and 42% of the sulphate ions compared with 22% of the lactate ions transported (*fig. 3*) even within 60 min. Especially in the first 30 min there is a substantially stronger rise in transport speed of the chloride ions compared with the sulphate and lactate ions.

Conclusions

By exploiting the different permeability of membranes and the differing transport speeds and mobility of ions, membrane systems are suitable as a cleaning procedure in the downstreaming of sodium lactate and lactic acid. Through the separation of chloride ions the application of cost and wastewater intensive ion exchange resins can be minimised.

Literature

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Fig. 3: Alterations in time for transport of ions in conversion of a concentrated model solution of sodium lactate (NaL) in lactic acid through electrodialysis with bipolar membranes (NaL = 209 g/l; current density = 50 mA/cm²)