Potential of Membrane Technology for Improving the Brine Purification Process

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1. INTRODUCTION

Salt for the chemical industry has to meet a high quality standard. Therefore it is necessary to purge a relatively high amount of mother liquor, to produce vacuum evaporated salt from a salt feedstock with a high purity (Jongema, 1993). This purge streams cause on the one hand a loss of salt and on the other hand they represent a big problem in respect of environmental reasons. One way to overcome this problem would be to pretreat the mother liquors prior to their recycling to the raw brine purification. Conventional brine purification processes are discussed e.g. by Kratz and Hoyer, 1993.

2. INVESTIGATIONS WITH MEMBRANES

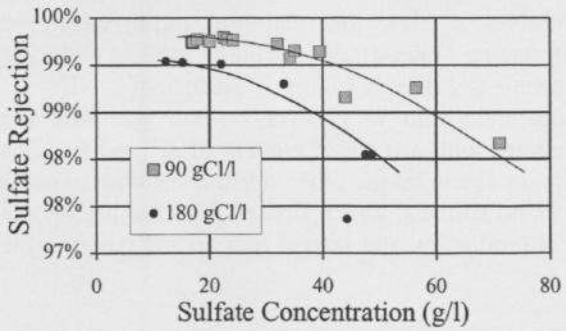
Pressure driven membrane processes are widely used today in different industrial applications. Nanofiltration or NF-membranes are exhibiting a selectivity for separation of ions with different sizes, charges or in their hydration grade. The very specific behaviour of NF-membranes is given with the high rejection for sulfates and a low rejection for Na^+, K^+, Cl^- and Br^- ions which allows the selective recycling of sulfate anions back to the brine treatment in the vacuum salt process.

A part of the collected data from laboratory and field test investigations will be discussed briefly in the following.

The experimental data were elaborated with mother liquors. For the elaboration of the data which will be presented in this paper the operating pressure and the temperature were kept equal during all the test runs to 3 MPa and 30 °C , as a membrane a commercial NF- membrane was applied.

From Figure 1 it can be seen that with the increase of the sulfate concentration the rejection is dropping. This effect is the result of the increasing transmembrane osmotic pressure which also causes a decrease in permeate flux. The influence of sodium chloride on the sulfate rejection in such a concentrated brine solution is additional an effect of an upcoming deficiency in the hydration of the sulfate ions. This causes a weaker rejection which can drop significantly in case of supersaturated solutions. A higher solubility of a specific ion in the membrane or the weaker retention performance can result from a reduced hydration of the respective species.

Figure 1. Sulfate rejection as a function of the sulfate and chloride concentration.



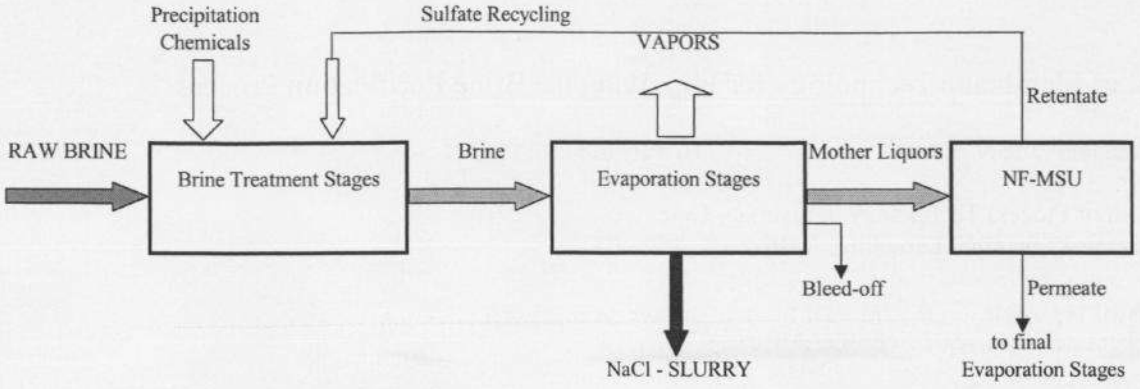


Figure 2. Block diagram of a NF-MSU arrangement within a vacuum salt plant.

The high permeability for sodium chloride is certainly the most important prerequisite for processing such brine solutions. The membrane rejection for sodium chloride has therefore to be very low so that no significant concentration difference is being built up in the separation process between the retentate and permeate side.

In comparison with the chloride performance also bromide ions exhibit a much higher permeability than the chloride ions even though bromide is present only in small amounts in the solution (see Fig. 3).

Further more a negative rejection can be observed for chloride and bromide ions, whereby these outstanding separation properties of NF-membranes make it possible to separate bromides in a much higher extent so that in the retentate recovered sulfates will have a 30 to 40 % lower amount of bromides. This performance is additionally depending on the operating parameters and the recycling ratios of the mother liquors in the process.

3. CONCLUSIONS

The application of NF-membrane process exhibits a high potential for improvement in producing high-grade vacuum salt. A process scheme is shown in Figure 2. The use of a NF separation unit to recover on the one side the sulfates with a reduced content of K^+ and Br^- ions and to obtain on the other side a brine with more or less no sulfates, which first enables the high-grade salt production and second reduces the purge or the bleed-off by using additional evaporator steps. So far it can be stated that NF-membranes have properly performed in the separation of sulfates from mother liquors. Detailed studies are yet necessary and ongoing to investigate the long-term performance of selected NF-membranes in such high ionic strength solutions like brines. A patent has been applied for the application of membrane separation processes, which can be used in new concepts for the vacuum salt production.

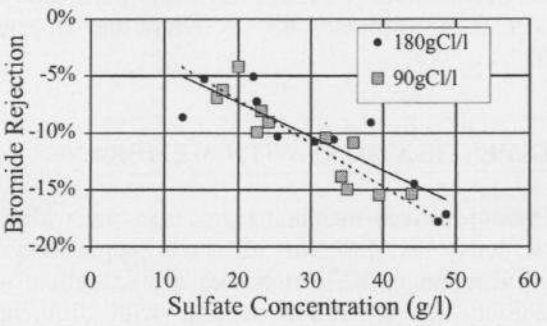


Figure 3. Bromide rejection as a function of the sulfate and chloride concentration.

4. REFERENCES

1. P. Jongema, Production of Low Bromine-Containing Evaporated Salt, 7th Sym-posium on Salt, Vol. II 159-163 (1993).
2. E. Kratz and F. Hoyer, Trends in the Design of Vacuum Salt Plants, 7th Symposium on Salt, Vol. II 101-115 (1993).