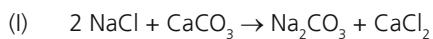


# Water-saving production of soda using electrochemical membrane processes

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Soda and sodium bicarbonate are among the indispensable inorganic basic chemicals. They are used in many areas of daily life (detergents, food) as well as in numerous industrial sectors (e.g. glass and paper production). In Germany, more than 1.2 million tons of these chemicals were recently produced annually; the figure worldwide is around 35 million tons. It is produced either on the basis of naturally occurring trona (USA) or using the Solvay process on the basis of the raw materials brine, coke and limestone (I).



Ammonia is also required in the Solvay process as a carrier for chloride (Cl) and hydrogen carbonate ( $\text{HCO}_3$ ). Table 1 shows the raw material requirements and emissions.

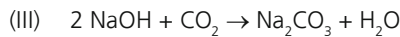
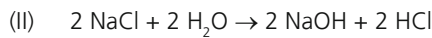
**Emissions in the Solvay process (according to German Environment Agency/VCI/ CSD)**

Material	Emissions kg/t	Emissions t/a
$\text{CO}_2$	800	1,200,000
Cl	564	677,000
$\text{NH}_3$	1.5	1200
Waste brine ( $\text{m}^3$ )	9.4	12,500,000

At least as important as the high  $\text{CO}_2$  emissions in this context are the large quantities of high-salinity  $\text{NaCl}/\text{CaCl}_2$  waste brines that are produced and discharged to the next river. These lead to salinization of the receiving waters, with numerous other negative consequences such as fish mortality at low water levels and increased temperatures.

An alternative process for the production of soda is therefore being developed and tested as part of the BMWK-funded joint project "GreenSoda" (funding code 03EE5121A) with the participation of Stassfurt-based CIECH Soda Deutschland GmbH (CSD) and others. The effort centers around an electrochemical process route with bipolar electrodes. Figure 1 shows a laboratory test rig as a four-circuit system. The electrochemical process route enables the splitting of salt solutions into the corresponding acids and bases – in the case of  $\text{NaCl}$  brines,

the splitting into  $\text{HCl}$  and  $\text{NaOH}$  according to (II).  $\text{NaOH}$  is subsequently carbonized with  $\text{CO}_2$  (III).



The  $\text{CO}_2$  is obtained from combustion gases but also from fermentation processes (biogas production). At present, it is possible to produce an approx. 20 % soda solution based on raw brine from Stassfurt under laboratory conditions.



Figure 1: Bipolar electrodes stack for splitting of  $\text{NaCl}$ .

Neither limestone nor ammonia is required for this production route. This also means that  $\text{CaCl}_2$  waste brines are no longer produced. Now, the process even represents a  $\text{CO}_2$  sink. Fraunhofer IKTS has applied for a patent for this process together with CIECH Soda Deutschland.

The next step will be testing on a pilot-plant scale using purified  $\text{CO}_2$  from combustion processes and investigations on adapted thermal treatment processes. The latter are taken over by another network partner.