Carbon2Chem®

# L-III | Electric Swing Adsorption for Steel Mill Gas Treatment

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**Electric Swing Adsorption (ESA) is a promising technology for dynamic and energy efficient separation of molecules with high adsorption enthalpy. Another advantage is the independence of purge gas flow and heat flow which is not the case in an e.g. steam heated and desorbed TSA process. Within the project Carbon2Chem® the ESA technology is investigated in lab scale with artificial gas mixtures as well as tested in pilot scale for real steel mill gas treatment. One application is the adsorption of hydrocarbons and aromatics from coke oven gas.**

## LAB-SCALE RESEARCH

The lab-scale ESA is used for research on the electrical behavior of the adsorber setup. The work aims on a better understanding of the system and on the identification of correlations between experimental parameters and results like desorbate concentration, purge gas volume or energy demand of the system. For these experiments simple gas mixtures like butane in nitrogen are used.

One goal of the lab-scale research and optimization was to find a suitable electrode setup and operation conditions for the pilot plant. The most promising result was the application of radial electrodes which provide a larger area for the current flow compared to axial electrode setup. This enables a more stable and uniform heating since the heterogeneity of the used activated carbon is balanced. These setup allows the application of adsorbents with higher specific resistance.

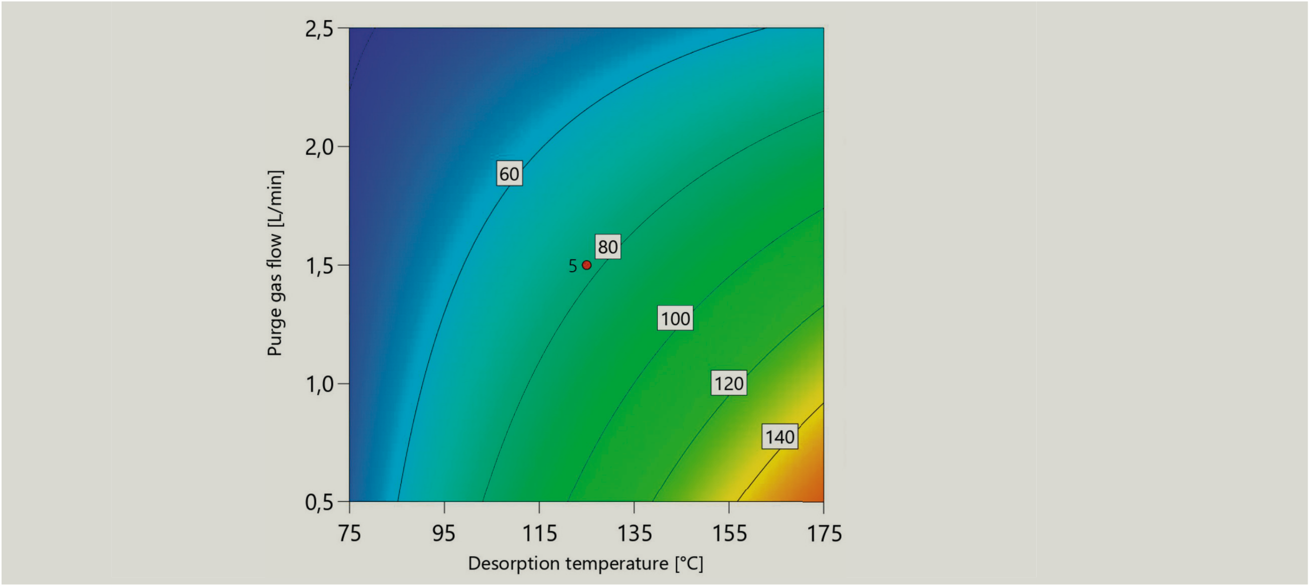
Another result is that the maximum electrical power used for desorption heating has no significant influence on the Energy consumption during desorption. The graph below also shows, that surprisingly a higher purge gas flow results in lower energy demands.

## PILOT PLANT SCALE-UP

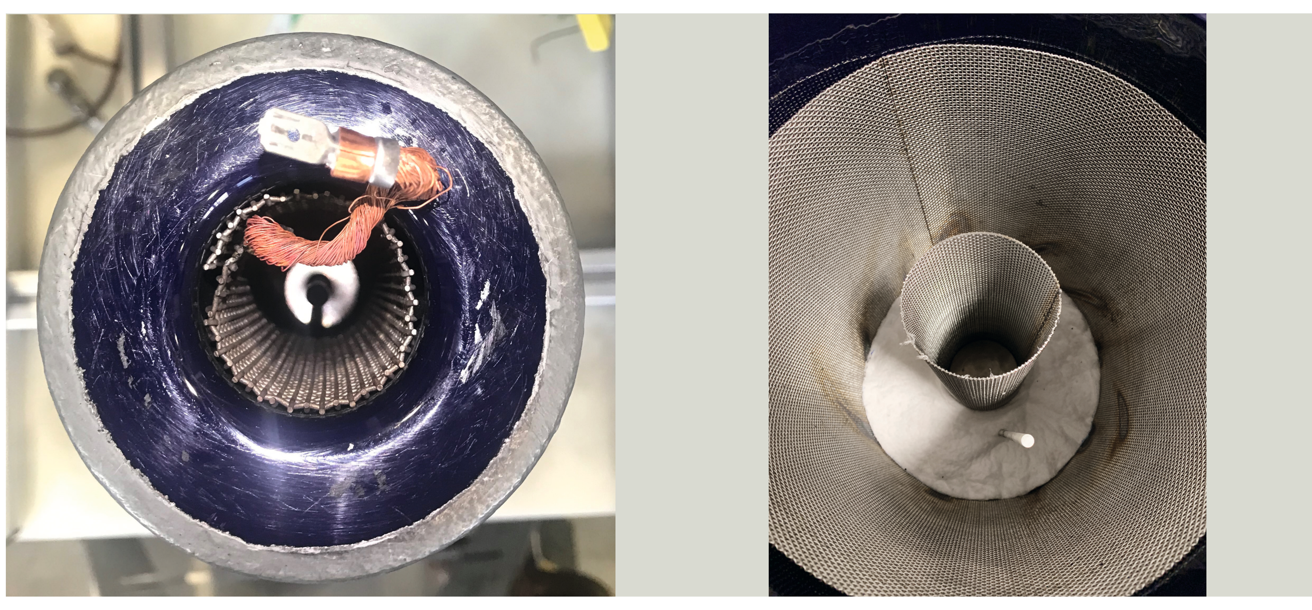
The biggest challenge of ESA plants is the electrical design to maximize the contact area between adsorbent and electrode and avoid shortcuts. In addition measuring devices like thermocouples are needed for process monitoring and control but have to be electrically insulated.

In the pilot plant these requirements are met by using a DN300 enamel-coated tube and 1.25 mm stainless steel mesh as electrodes. Compared to the lab scale adsorber with its DN40 tube, the pilot plant setup is similar but nearly eight times larger. Both tubes are shown in the pictures below. Thermocouples and metal parts are insulated with alumina ceramics.

One difference is the design of the center electrode, which is a 6 mm tube at lab scale. In the pilot plant a mesh cylinder with 100 mm diameter has been chosen. The higher diameter reduces the specific length of the current flow and increases the field density in the annular gab between wall and center electrode. Nevertheless, the inner volume of the mesh cylinder is filled with adsorbent and is not dead volume. In the coming month of the project the pilot plant ESA will be tested with real steel mill gases like coke oven gas. A gas flow up to 9 $m_N^3\ h^{-1}$ can be processed.




Contourdiagram of the energy demand in Wh depending on desorption temperature and purge gas flow.



Internal setup of the lab-scale DN40 (left) and pilot-scale DN300 adsorber (right).

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