

# SO<sub>2</sub> adsorption on active carbon: the effect of certain metals

Paolo Davini

Chemical Engineering Department of Pisa University

Via Diotisalvi, 2 – 56126 Pisa (Italy)

## Introduction

The sorption of SO<sub>2</sub> by active carbons is a very important process for many industrial applications. The sorption process is closely related with the surface characteristics of the carbon itself, as BET surface area, pore size distribution, oxygen content, type of acidic or basic surface sites, ash content and its composition, etc. The presence of certain metal compounds on the carbon surface could influence the total amount of sorbed SO<sub>2</sub> and its development. The goal of this research is to find some relationships between the nature and the content of certain metallic derivatives and the sorption properties of the supported active carbons.

## Experimental

For this investigation a low ash commercial active carbon has been chosen and treated with boiling acidic solutions (in order to minimise its ash content); the obtained sample has been deoxygenated by treatment by H<sub>2</sub> (at 1000°), cooled and maintained in N<sub>2</sub> atmosphere over P<sub>2</sub>O<sub>5</sub>. By heating this carbon in air flow at 300°C or in nitrogen flow (containing 2% of O<sub>2</sub>) at 800°C, new carbon samples showing respectively acidic or basic surface characteristics have been obtained. These last carbons are characterised measuring BET surface area (reported in the table) and then immersed in specific solutions of metallic salts, suitably filtered and dried, obtaining carbon samples supporting certain metallic sulphates (V, Cr, Ni, Fe, Mn) that are submitted to SO<sub>2</sub> adsorption (1000ppm, from a simulated flue gas mixture) at temperature of 100°. This last experimental step has been carried out in a thermogravimetric apparatus. After some adsorption/desorption cycles, BET surface areas have been again detected.

## Results and Discussion

The presence of metals (as derivatives) on the surface of the carbons favours the SO<sub>2</sub> sorption capacity of the carbons themselves (as clearly reported in the figures 1 and 2). In particular, Vanadium and Manganese appears to be the metals giving the carbon a higher SO<sub>2</sub> sorption

capacity (probably in close relation with their strong catalytic activity). It is important to point out that the amount of SO<sub>2</sub> adsorbed by carbons with acidic characteristics and supporting metal derivatives appears to be more enhanced (*ceteribus paribus*) than the similar amount adsorbed by carbons with basic characteristics. Carbon samples containing very similar amount of metals (0.4%), submitted to some processes of cyclic adsorption and desorption of SO<sub>2</sub>, show a very rapid decrease of the sorption characteristics during the said cycles, as extensively reported in the figures 3 and 4. Also in this case, the decrease of the initial sorption characteristics is more marked for supported surface acidic carbons. This behaviour can be explained by the results exposed in the figures 5 and 6, where the variation of the BET surface area values of these carbon samples are reported versus the said adsorption and desorption cycles. The marked decrease of the BET surface area of the carbons, caused probably by the partial destroy of the functional surface oxygenated groups on the carbonaceous matrices and catalysed by the metal presence, causes a strongly degradation of the surface characteristics of the active carbons and then of their SO<sub>2</sub> sorption properties. Naturally, it appears to be more influenced the active carbons having oxygenated acid groups that (for their nature) are more easily removable, as extensively reported in the current literature.

## Conclusion

The presence of some metallic derivatives increase the SO<sub>2</sub> sorption characteristics of active carbons having on their surface acidic oxygenated groups, but of their stability quickly decreases during some SO<sub>2</sub> adsorption – desorption cycles because a marked decrease of their BET surface areas is observed.

## References

- 1) P. Davini, Carbon, 32, 349 (1994)
- 2) J. Klinik and T. Grzybek, Fuel, 1303, 71 (1992)
- 3) Zdenek V, Fuel, 105, 72 (1993)

**Table. BET surface area of the carbon samples**

|                        | BET area (m <sup>2</sup> /g) |
|------------------------|------------------------------|
| Raw carbon             | 1060                         |
| Acidic oxidated carbon | 1120                         |
| Basic oxidated carbon  | 1150                         |

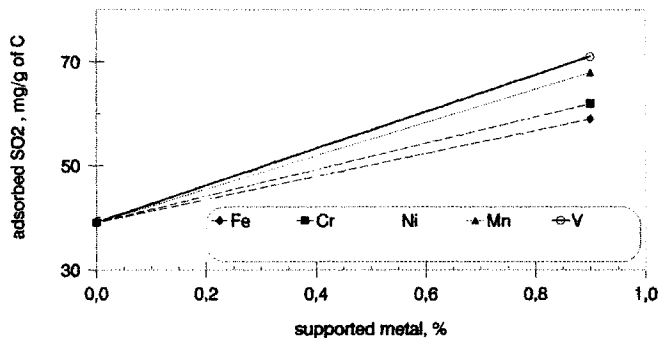


Fig.1 SO2 adsorbed on acidic carbons vs the percentage of metal

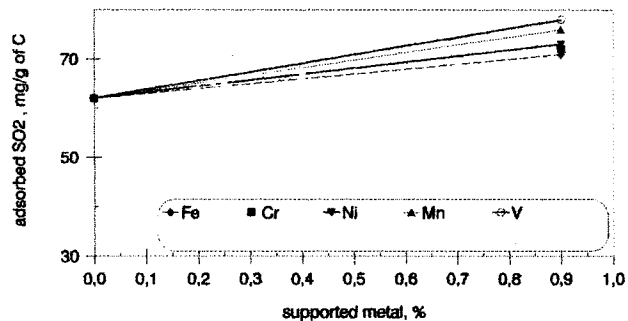


Fig.2 SO2 adsorbed on basic carbons vs the percentage of metal

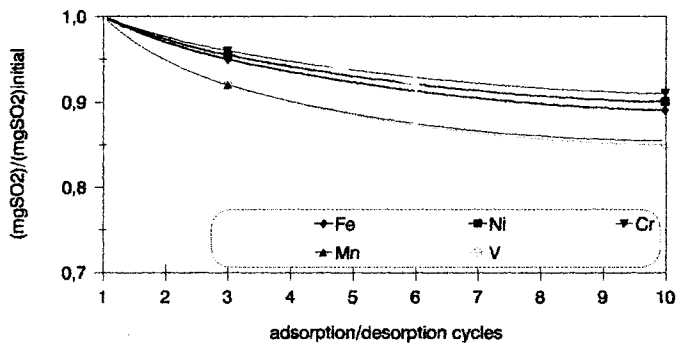


Fig.3 Adsorbed SO2 (as ratio) on acidic carbons vs ads/des cycles

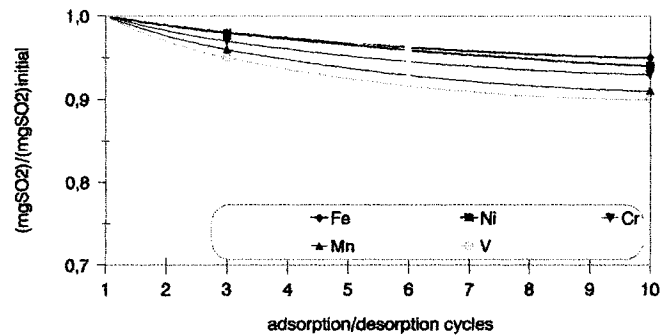


Fig.4 Adsorbed SO2 (as ratio) on basic carbons vs the ads/des cycles

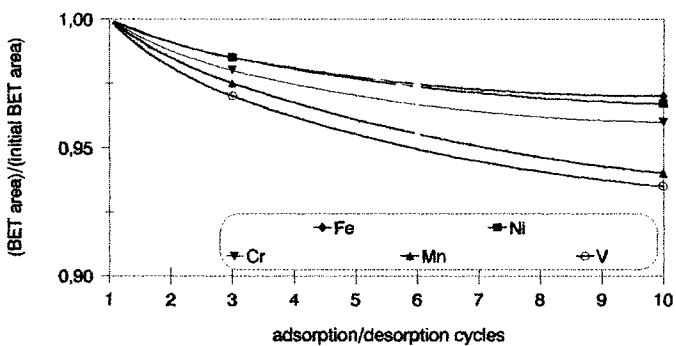


Fig.5 BET surface area (as ratio) of the acidic carbon vs ads/des cycles

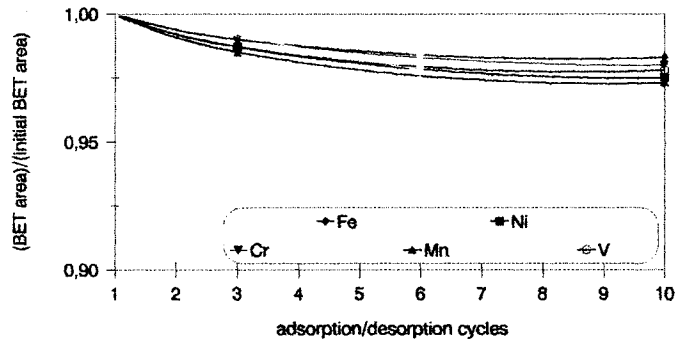


Fig.6 BET surface area (as ratio) of the basic carbon vs ads/des cycles