Unger, L., Ehouarn, P., & Borra, J. P. (2003, 31st Aug.-5th Sept.). *Filtration of submicron sized particles by electro-coagulation.* JAS **34 S1** pp 501-502 Paper presented at the European Aerosol Conference, Madrid.

FILTRATION OF SUBMICRON SIZED PARTICLES BY ELECTRO-COAGULATION

UNGER L., EHOUARN P. , BORRA J.-P.
Laboratoire de Physique des Gaz et des Plasmas, UMR 8578, CNRS,
Equipe Décharges Electriques et Environnement,
Ecole Supélec, Plateau de Moulon, 91192 Gif-sur-Yvette Cedex, France

Keywords: bipolar coagulation, filtration, charged aerosol, EHDA, corona charging

INTRODUCTION

Most existing filtration devices have a lack of efficiency in the submicron size range (between 0.1 and 1 µm). Electrical forces have been proved to be efficient to remove particles from an aerosol flow (for example, in Electro-precipitation), and in particular in the bipolar coagulation process (Eliasson *et al.*, 1991). The aim of this study is to test the feasibility of a wet scrubber, where collectors are highly charged water droplets (50% of the Raleigh limit charge) of 100 µm produced by Electro-Hydrodynamic Atomisation (EHDA), used to collect submicron sized (0.44 µm) particles charged in a corona charger of the opposite polarity.

EXPERIMENTAL SET-UP

The experimental set-up can be divided in three main parts :

- *aerosol production* (Sinclair-Lamer Generator is used to produce a monodisperse DEHS aerosol),
- *charging* of the 0.44µm diameter in a corona discharge (see Unger *et al.*, 2000) and *coagulation* of these particles on 100µm highly charged water droplets of opposite polarity produced by Electro-Hydrodynamic Atomisation (see Borra *et al.*, 1999 and Ehouarn *et al.*, 2001). Both populations are well characterised in term of particles diameter, level of charge, concentration,
- electrical and concentration measurements allow (i) to control electrical discharges and (ii) to measure coagulation efficiency in the coagulation reactor.

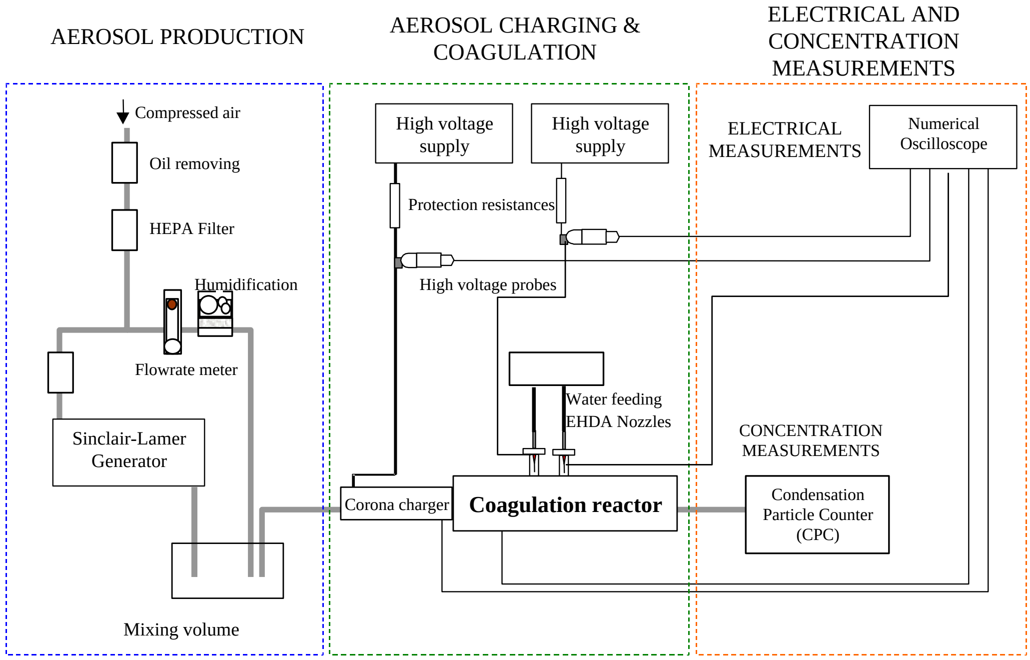

Figure 1 : Experimental set-up for the bipolar coagulation

Coagulation efficiencies are calculated from measured pollutant concentrations before and after the reactor, with both devices ON and/or OFF (which allows to take into account the effect of sprays positive space charge on the effective pollutant concentration at the exit of the corona charger).

RESULTS & DISCUSSION

The influence of the more important parameters on the coagulation efficiency have been measured (electrical level of charge of both collectors and pollutant, particles size, pollutant's concentration and flow rate) in order to show the feasibility of such a filtration device and to be able to size it for given specifications (for example, see figure 2, which shows the influence of pollutant electrical mobility and flow rate. Numerical efficiency of more than 99% have been achieved.

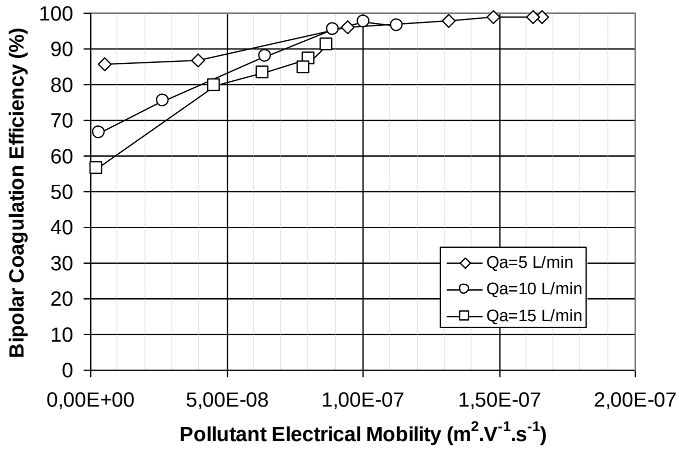

Figure 2 : Bipolar coagulation efficiency as a function of pollutant electrical mobility, for different flow rates in the reactor

It has to be emphasised that, as far as the level of charge of pollutant is strong enough, the flow rate has a weak influence on coagulation efficiency.

CONCLUSIONS

Electro-coagulation was experimentally tested, and efficiency of more than 99% were achieved, with flow-rates of 10L/min, with 0.44µm charged particles (electrical mobility of $\mu_p=1.10^{-7}$ $m^2.V^{-1}.s^{-1}$). A parametric study has been achieved in order to size a prototype. In particular, the influence of pollutant aerosol concentration has been quantified, and shows the decreasing of coagulation efficiency as the concentration diminishes. This allows to calculate the size of the system to be used, as a function of specifications (flow-rate, particles diameter, concentration, efficiency to be reach). At lab scale, this system is an HEPA filtration device, with low liquid consumption (ratio between liquid flow rate to pollutant aerosol flow rate is about 10^{-4}, compared to 10^{-3} which is the value usually found), low pressure drop and low maintenance cost. These results are obtained with controlled characteristics (diameter, electrical charge, concentration) for both collectors and pollutant, and are then useful to a further step of modelling the electro-coagulation process and to validate such a model.

REFERENCES

Ehouarn P., Unger L., Borra J-P. (2001), « Properties of water droplets produced by EHD pulverisation for the collection of particulate plasmas by-products », *Journal of High Temperature Material Processes*, **Vol. 5**, **Issue 3**, pp.333-344.
Borra J-P., Tombette Y., Ehouarn P. (1999), « Influence of electric field profile and polarity on the mode of EHDA related to electric discharge regimes », *Journal of Aerosol Science*, **Vol. 30, N°7**, pp.913-925.
Unger L., Ehouarn P. and Borra J-P., (2000) « Influence of aerosol deposition on the charging efficiency of a corona charger », *European Aerosol Conference*, 3-8 Septembre 2000, Dublin, Ireland, *Journal Of Aerosol Science*, **Vol. 31, Supplement 1**, september 2000
Eliasson B., Egli W., « Bipolar Coagulation - Modeling and Applications ", *J. Aerosol Sci.*, **Vol. 22, No. 4,** pp. 429-440, 1991