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Part B

APPLICATION OF CORONA DISCHARGE AND ULTRASONIC AEROSOLATION TO PLASMOCHEMICAL REACTIONS FOR AIR DEPOLLUTION

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Studies with a laboratory and small scale equipment based on electric discharge working at atmospheric pressure (in combination with ultrasound aerosolisation of water or water solutions) have been directed to the practical elimination of various compounds from exhaust gases of various sources. The process is designed and managed so that degradation products will contain a minimum concentration of greenhouse gases (as CO_2, N_2O) and that additional gas, liquid and solid products are non-toxic. The management of process in equipment is closely connected with energy consumption, material of electrodes and type of additives.

The anomal corona discharge which arises at higher currents after regular dc corona pre-discharge plays an important role in liquidation process. The typical changes connected with anomal corona discharge are spontaneously pulsing „brush-like“ streamer type of discharge with migrating discharge channels and current pulses frequency in kHz accompanied by an intensive sound, fall of voltage and rise of current. The discharge needs serial connected resistance to discharge tube and disposes by lower level of consummated energy (about 8 Wh/Nm^3) compare to glidarc, so only particular destruction of studied compound occurs. The destruction process is followed by further polymerisation of originated radical near or on the LV electrode.

The small scale equipment (15 Nm^3/hour) on by-pass of exhaust pipes from various static exhaust sources was tested. The tested equipment consists of two corona discharge blocks (each contains 12 coaxial corona discharge tubes) with geometry which enables the gas flow rate about 2-5 m/s. The gas flow is directed firstly downwards and then upwards (in U shape). The ultrasonic aerosolator was used for spray of add water or water solution for neutralisation on the inlet of discharge system. The size of sprayed droplets was 0.5-10 μm and applied total amount of liquid between 0,5-2 l/hour. The advanced method of HV electrode cleaning from solid products originated during discharge action was developed and tested. Cross-section of small scale equipment is in Fig.1.

Since following compounds have been investigated up to now (gas oxides such as NO_x, CO, CO_2, SO_2, hydrocarbons such as PAH, VOC, chlorinated hydrocarbons and SiF_4, NH_3 heavy metal oxides (Pb, As), soot, smoke, particles) our attention is now especially directed toward their control.

The qualitative analyses of products were performed using IR analysis (gaseous products) and isokinetic sampling (solid particles) by authorised measuring group. Solid and liquid products from the system were analysed additionally using IR spectrometry with the help of ATR method,

KBr pellet technology and reflection spectra from surface of electrode. For in situ measurements and time development of originated products the special gas cell - discharge tube was developed.

Important part of the research program is the analysis of products, especially in solid and liquid phase. Important efficiency and products were gained especially during measurements on exhaust from glass oven containing NO_x, SiF_4 and heavy metal oxides. The removal efficiencies were 71% for NO_x, 74% for SiF_4 converted to HF, 68% for all Cl containing compounds converted to HCl, 99,2% for Pb, 95,5% for As. The solid products contain fluorosilicates $CaSiF_6$, silane SiH_4, CaF_2, NO_2F and NOF.

Important products were gained also during solvent vapour (VOC) removal, where solid polymer powder in water and other solvents insoluble was produced.

Action of discharge on combustion exhaust in the presence of additional water result main final liquid product ethanol. Detected minority products were: methanol, acids as acetic, malic, tartaric, malonic, carbonic and their esters, aminoacid alanine, nitrogen containing compounds as urea, cyanic, isocyanic, carbamic, cyanuric, isocyanuric, iminocarbonic and barbituric acids. Solid surface products on electrodes were especially polyesteroimides. The process is accompanied by sharp decrease of CO_2.

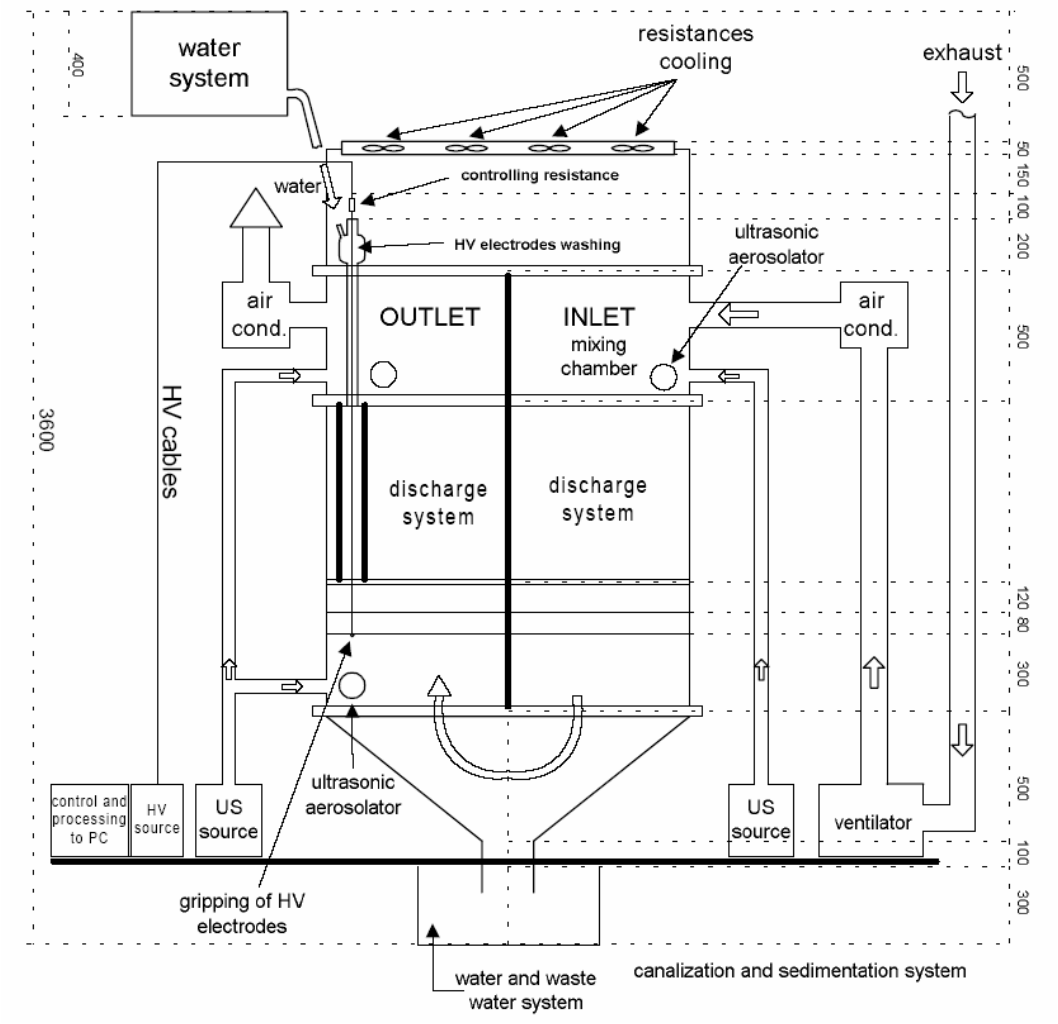

Fig.1.