TOWARDS FINGERPRINTING OF NANOSTRUCTURED PARTICLES EMITTED DURING TRANSIENTS OF FULL-SCALE NATURAL GAS POWER PLANTS

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Natural gas power plants are more versatile than those powered by coal or oil and, thus are becoming the key trade factor by the electric market due to the variability of renewable generation. This turns in a higher frequency of transients than foreseen by design. The relevant trace pollutants are associated with these transient periods, which are characterized by both higher ultrafine and fine carbonaceous aerosol emission. Soot fingerprinting is, in principle possible, due to both characteristic elemental composition and surface functional groups, enabling thus for a first assessment of the individual source contribution.

The core assumption is that soot nanostructure, elemental composition, surface chemistry and sp^2/sp^3 ratio bears an integrated history of growth conditions [1-4]. Here are presented the preliminary results of changing soot characteristics along the transients of a natural gas, combined cycle, power plant. Experiments include the follow-up of gaseous emissions (FTIR) and size distribution (from 30 to 10000 nm by means of an ELPI) as well size-segregated sample collection for further analysis. These samples have been analyzed by TEM/SAED and image analysis as well as XPS.

Functionalized graphitic structures have been observed around the characteristic mode of 330 nm at high NOx. NO2 partially oxidize the soot particle, producing oxygen functional groups. MWCNTs and fullerenic structures were present under high CO concentration, up to 300 nm aerodynamic size). Less than 1.5% in number carbon agglomerates decorated with metal nanoparticles were observed. Both startup and shutdown size distributions present a characteristic mode at 330 nm but differ in a secondary mode at 140 nm probably associated with a transient of high NOx in the early stages of startup. During shutdowns, a secondary and less intense mode is consistently present at 83 nm. A fast shift towards supermicron size ranges is characteristic of the later stages of start-up. The aggregates within this coarse fraction, can contain >1000 primary MWCNTs or multiconcentricfullerenic structures.

These results will be put in connection with the appropriate control requirements, that is specific pollution control techniques and practices [5].

References

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