Morphology and Geochemistry of Coal Combustion Products from Two Thermal Power Plants in India and Environmental Implications

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Combustion processes in coal-fired thermal power plants are responsible for the introduction of large amounts of bottom ash- BA and fly ash- FA materials along with gaseous species into the environment worldwide. In this work feed coal, BA and FA samples, collected from two thermal power plants in Northern India were characterized for morphology and geochemistry (mineralogy, major and trace elements including Rare earth elements-REE). Quartz, kaolinite, siderite and montmorillonite were the major mineral phases in the feed coal samples. At higher furnace temperatures kaolinite and Montmorillonite get transformed to mullite, whereas siderite changed to hematite as evident from FA samples. Rich alumino-silicate matrix irregular in shape containing porous unburnt coal particles as well as unxoidised iron phases features the morphology of BA. Plerospheres (large sphere of particle filled with small spheres) were noticeable in FA samples with no true cenospheric structures. Particle size decreases towards last field FA sample and shape becomes more spherical. All elements show enrichment in BA and FA samples compared to the feed coal due to burning off the carbon barring Fe and Mn, may be due to pyrite left out in the coal. Intra FA sample variations are least for major elements except P whereas trace elements show fair variation excluding Ba and Sr. REEs show LREE enrichment with –ve Eu anomaly and relatively flat HREE pattern with limited variation in abundances among different FA samples. The Relative enrichment (RE= (Element in ash / Element in fuel) X %age ash content in fuel/100) equals o 3-4 fold for trace element; RE for major elements and REE remains less two. The significant correlation among REE and major elements indicate that they are almost uniformly distributed in different FA samples and don't show significant fractionation during combustion process. The trace elements due to their volatile nature exhibit variation to large extent barring Ba and Sr. These elements are significantly enriched from the first-field of electrostatic precipitator to the last field sample of FA compared to BA; their relative enrichment increased with decreasing particle size. Depending upon the pH conditions, these elements can be released to the environment and can pose serious toxic effects.

Keywords: coal combustion products, morphology, mineralogy, elemental chemistry, India