International Workshop on
Environmental Aspects of Coal Ash Utilization
Tel Aviv, Israel
December 15th – 16th 2009

Occupational Hygiene Aspects in the Use of Coal Ash in Israel

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Abstract

The use of coal as a source of energy for electric power in the State of Israel began at the Eighties. The coal-based power stations in Israel consume 12 million tons of coal annually. This consumption results in one million tons of coal ash waste, 70% of which is used in the construction industry after being mixed with cement and other building materials and the rest is used for road construction, rehabilitation of waste disposal sites and agriculture.
The potential occupational hazards of coal ash may be examined through five hazards categories including total suspended particulate matter (airborne) of fly ash which may be further divided into inhalable and respirable dust, heavy metals, polycyclic aromatic hydrocarbons, ionizing radiation inherent in natural radioactive isotopes contained in the coal and free crystalline silica.
Bottom ash comprises of 0.4% - 1.7% of fine particulate mass the particles of which are capable of being deposited in the bronchial section of the respiratory system and the lungs. However, a large share of these particles is not suspensible due to enclosure by coarse particles. The fine mass of particles in fly ash comprises 30% but the majority of them is removed by electrostatic precipitators before reaching the atmosphere. Moreover, the alumino-silicates and other mineral oxides are classified as particulate not otherwise specified (PNOS) or nuisance dust.
Heavy metals in fly ash represent trace concentrations which are higher than those in bottom ash. The level of ionizing radiation emanating from the radionuclides of uranium, thorium and potassium and their daughter products, which are found naturally in coal, is very low despite the enrichment effect in the transition from coal to ash. The measured levels point at addition of 1%-5% above the background radiation of their natural environment, and in any case, these are annual levels three orders of magnitude lower that the occupational standards for permitted exposure (hundredths of millisieverts [mSv] as opposed to a permitted level of 50mSv), lower than the maximum permitted levels for the general population, and similar to those emitted from various types of soil and rocks.
Polycyclic aromatic hydrocarbons are suspected carcinogens. Quantitative data on their exposure potential are not available but their concentration in the air as a result of fly ash dispersion is estimated to be much lower than their level in emissions of fuel combustion.

Apparently, the main hazard raising concern in reference to coal ash is free crystalline silica. Coal, and therefore coal ash, has been classified by regulatory authorities in Israel as "hazardous dust" since the beginning of its use in electric power stations. This terminology has been given in Israel to dusts inheriting pneumoconiotic potential including asbestos, free crystalline silica and talc. Coal has been included in this

category because of its free silica content as quartz. The fibrogenic potential of silica dust, its ability to cause silicosis and the recognition of its carcinogenic potential in humans have encouraged the promulgation of regulations and bans concerning occupational exposure and worker protection. The silica regulations classify silicotic dust as one containing any amount of free crystalline silica including percent content less than 1% by weight which, in other countries, serves as a criterion below which a suspended particulate matter is not classified as a silicotic matter.

Environmental monitoring of coal and coal ash in Israel has been carried out almost solely in the coal-operated power stations. Until recently, the vast majority of airborne silica measurements in these stations corresponded to total dust rather than the respirable fraction of it. About 6% of the total silica samples exceeded the Threshold Limit Value (TLV) set for silica dust, and the percent exceeding the action level (50% of the TLV) was a little bit higher. In a recent study carried out at one of the power stations in Israel, inhalable and respirable airborne samples composed of fly ash were analysed for their quartz content. The content found was in the range of 2.3-4.3% (w/w). The average quartz concentration in the respirable fraction was slightly lower than that in the inhalable fraction (2.7% and 3.3%, respectively). In addition to the air samples, two fractions of particles smaller than 10μ in size were separated from bulk fly ash originating in Colombian coal (La Loma) and South African coal (AKD). A semi-quantitative approximation of the quartz concentration in the Colombian coal fraction yielded 1.5%$\pm$1% while no quartz could be detected in the fraction separated from the South African coal.
Our experiments show, similarly to those of other researchers, that most of the quartz particles in the respirable fraction are coated by amorphous aluminosilicate layers. Coated quartz particles are not considered to have pneumoconiotic effects. Fibrotic effects of quartz are ascribed to particles surface reactions but the combination of low concentration of respirable quartz in the fly ash and the fact that the surface of the embedded particles is not exposed may explain the absence of silicosis and other effects of quartz in epidemiological studies regarding exposure of workers to fly ash. A similar conclusion is drawn in the case of bottom ash where, in general, the mass of the respirable fraction of quartz does not exceed 0.003% the most of which is embeded in the alumino-silicate phase of the ash.
In reference to the above, it is worth noting that observed effects of short term exposure to high airborne levels of coal ash include nose, throat and eyes irritation and dryness. Skin irritation from direct contact with acidic wet ash and mechanical skin rupture from dry ash are also observed. Chronic exposure has been suspected to cause malignant tumors but the risk of cancer has neither been confirmed nor indicated by epidemiological studies.

The issue of classifying coal ash as "nuisance dust" rather than "hazardous dust" in the Israeli regulations is under reevaluation. So far, the recommendation for revision of the classification of bottom ash as nuisance dust has been accepted by the Ministry of Environmental Protection. The revision of the fly ash classification is more complexed and calls for longer time to reevaluate all aspects concerned. The experience of other nations in that matter may certainly contribute to conclusions drawing and decisions making.