

Radiation exposure from radionuclides of natural origin in agricultural uses of coal ash

G. Haquin, J. Koch and Z. Yungrais

Radiation Safety Division, Soreq Nuclear Research Center, Yavne, Israel

Abstract

Coal ash (CA) is produced as by-product in the combustion of coal. It is extensively used in Israel since the early nineties of the last century in the building material industry and since the beginning of the 2000's in agricultural uses as sludge stabilizer and as a component in the growing media.

Coal ash contains higher activity concentration of natural radionuclides than coal and other raw materials used in agriculture for the same purpose.

The main radionuclides of natural origin are radionuclides from the $^{238}\text{U}/^{226}\text{Ra}$ and ^{232}Th decay chains and the radioactive isotope of potassium, ^{40}K . Those radionuclides emit alpha, beta and gamma radiation may cause external radiation exposure by gamma emitting radionuclides and internal radiation exposure due to the ingestion of food and water containing the aforementioned radionuclides and from the inhalation ^{222}Rn gas, and its short lived decay products.

The radiation exposure and environmental impact (in terms of radiation exposure) of agricultural use of coal ash has been assessed. The occupational exposure of the workers and the exposure of the general public consuming crops grown using coal ash as growing media or as sludge stabilizer was assessed.

The occupational assessment is based on an average activity concentration of the CA of 200, 250 and 450 Bq/kg of ^{226}Ra , ^{232}Th and ^{40}K respectively. A conservative approach, assuming continuous exposure during 2000 hrs/y and secular equilibrium of the ^{226}Ra and ^{232}Th decay chains, led to an annual dose of 2.2 μSv which is considered trivial dose by the International Committee of Radiological Protection. The ^{222}Rn gas activity concentration probably exhaled from the CA is diluted in the open air to background ^{222}Rn level.

The general public exposure assessment was performed calculating the additional internal exposure due to the consumption of 1 kg/day of a food basket containing crops grown using coal ash. The activity concentration of several crops were measured at SNRC laboratories and compared to the activity concentration of control crops (not using CA).

None additional activity concentration of radionuclides of natural origins was found in the crops.

The environmental impact of the use of CA in sludge was evaluated performing leaching experiments. In those experiments several sources of CA were used to stabilize sludge and the leachate was analyzed. The soil solution activity concentrations were lower than the limits of the Israel drinking water regulation.

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It can be summarized that the use of CA in agriculture do not enhance the radiation exposure and the annual doses of the workers involved and of the general public, and are considered negligible and far below the environmental levels.