Dependence of the radiation hazard for miners on the aerosol size distribution in the mine air

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In underground hard coal mines natural hazards like the radiation hazard and the dust hazard occur together. Dust particles are generated mainly during technological processes (mining and transport of winning). The radiation hazard is caused mostly by the presence of radon decay products in ventilation air. Occurrence of radioactive radon decay products and the dust in the mine air creates a favourable conditions to the radioactive aerosol formation.

Aerosols' deposition in the human respiratory system depends on aerosol size distribution. The largest particles are catched mainly in the upper part of the human respiratory system, while vast number of the finest particles is able to reach the pulmonary alveoli.

Probability of the deposition of small particles reaching the lungs is relatively high, what makes a contribution of their harmfulness. Small aerosols also spread more easily and remain in the mine air longer by comparison with larger partices. It causes the fact, that smaller particles for longer time and in larger distances from aerosols' sources may be breathed by workers in underground galleries.

Within the investigations, described in doctoral thesis, measurements of aerosol size distributions of dust, occurring in the mine air, were made in Polish coal mines for the first time, including also particles of ultrafine fraction, which have diameter smaller or equal 100 nm. Accordingly to the results of the latest scientific investigations, these particles are harmful for human health, but it is not possible to detect these particles, using the standard methods of dust monitoring, as applied nowadays in hard coal mines. In case of ultrafine fraction particles, the mass criterion, commonly used for dust concentration assessment, does not reflect in satisfactory way the hazard, caused by these partiocles. Even very large number of nanometer-size particles have a very small percentage in the total mass of the dust in the ventilation air. Determination of the occurrence of the ultrafine fraction particles in the mine air and searching for their sources was one of the purposes of the investigations, described in doctoral thesis.

The performed scope of investigations, including the wide range of measurements of particles size distribution (particles of ultrafine, fine, coarse and super coarse fractions), with the simultaneous measurements of potential alpha energy concentration of short-lived radon decay products, allowed to estimate the radioactive aerosol size distributions. In consequence it was possible to determine the exposure-dose conversion coefficients for radon progeny, correlated with the size distribution of aerosols. On this basis the radiation doses, received by miners, working in particular galleries, were estimated more precisely.

Doctoral thesis is a summary of the first investigations of radioactive aerosol size distributions in underground galleries of active hard coal mine in Poland. In theoretical part of the thesis, the radiation hazard and dust hazard have been characterizied as well as the radioactive aerosol formation has been described. The experimental part of the thesis contains detailed description of measurements and interpretation methods, results of performed investigations in underground mine workings and drawn conclusions.

As a result these investigations, it was proved, that aerosols of ultrafine fraction occure in underground galleries of active hard coal mine, and their occurrence is connected with mechanical cutting of rocks, especially those with high hardness. It was also proved, that radiation doses, received by miners, caused by short-lived radon decay products should be calculated with the use of more realistic radioactive aerosol size distribution in mine air. These calculations are giving higher results as compared to doses, calculated with the use of

standard conversion coefficients, given by Polish and international guidelines. In most of galleries, the radiation hazard is low, when the standard conversion coefficient is applied. With the application of new conversion coefficients, estimated on the basis of measured aerosol size distributions, these galleries should be classified as galleries with enhanced radiation hazard (the class B of radiation hazard). Taking into account maximum values of measured concentrations of potential alpha energy, some galleries shoud be classified even to the class A of radiation hazard, requiring the personal dosimetry of miners, working there.