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COMPARATIVE ANALYSIS OF THE FLOW IN THE BOILER DUST SYSTEMS WITH THE ELBOW

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In the case of designing and service of the pneumatic conveying systems for power boilers, presence of the solid particle segregation in some areas is an important problem. The papers concerning this subject contain equations determining linear and local resistances of different elements of the installation. In many cases, in such systems diversification of concentration and out-of-control segregation of particles take place. In a consequence, diversification of propagation, disturbances of the combustion process and accelerated erosion of the installation elements can occur.

The Euler-Lagrange model is usually applied for tests of the multiphase gas-solid particle mixture motion. It provides good quality of the results for volume fractions of solid particles not exceeding 12%. However, from tests of such elements as elbows, separators or cyclone separators it appears that in some of their areas the limit value 12% is exceeded. In such situations, the results obtained according to the Euler-Lagrange model are incorrect, and the error is a result of application of an incorrect method of calculations. In the case of volume fractions of solid particles in gas exceeding 12%, the Euler-Euler method (so-called Euler methods) seems to be more useful.

This paper presents numerical tests of the flow of the air-coal dust mixture through the pipeline with the build-up elbow. The tests were performed in order to qualitative and quantitative comparison of the calculation results for two methods of simulation: the Euler-Lagrange and the Euler-Euler methods. Strong diversification of concentration and particle segregation within the elbow caused diversification of concentration of the mixture silt to the four-path separator located directly above be the elbow. It was a reason of the diversified dust propagation after the separator and accelerated erosion of separators. In order to improve distributions before the separator, a dissipative element was located in the elbow area. Its influence on the particle separation was tested with two methods.

The performed investigations allow to formulate some important conclusions. From analysis of trajectories it appears that the particles of small diameters move along the paths corresponding to the lines of the gaseous phase current, and the particles of big diameters often move along the paths forming a “cord” – this is a reason of the local increase of concentration. The results obtained with the EL method for both diameters of particles prove the increased concentration of particles at the external side of the circle arc in relation to the results obtained with the EE method. The EE method gives more uniform results of concentration calculations for all the tested particle fractions. This difference is a result of including collisions between the dust particles in the EE model, omitted in the EL model. The coefficient of variability of concentration distribution of the solid phase V_s was proposed. Comparison of the variability coefficients allows to state that simulation using the Euler-

Euler method gives the results similar to the test results. Thus, this method can be recommended to the further investigations.

References

BORSUK G., DOBROWOLSKI B., WYDRYCH J., *Gas - solids mixture flow through a two-bend system*, Chemical and Process Engineering, 2006, vol. 27, nr 3/1, 645-656.

DOBROWOLSKI B., POSPOLITA J., WYDRYCH J., *Próba poprawy warunków przepływowych przed rozdzielaczem czterodrogowym w układzie pyłowym kotła BP-1150,* Inżynieria chemiczna i procesowa, 2004, vol. 25 z. 4, 2105-2112.

WYDRYCH J., SZMOLKE N., *Reciprocal correlation in fluid flows*, Int. Conference of Modeling and Simulation – Virtual Forum, Italy , Napoli, 12-26.07.2010.

WYDRYCH J., *Computational and experimental analysis of gas-particle flow in furnance power boiler instalations with respect to erosion phenomena*, Journal of theoretical and applied mechanics, 2007, vol.45, No.3, 513-538.