Prediction of a radioactive particle instantaneous position using RPT

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This report presents a study about radioactive particle tracking (RPT) technique in order to evaluate industrial agitators. Nuclear techniques are widely used in industry to solve problems, as they are non-invasive techniques and, usually, they have a low cost of equipment installation. RPT is one of these nuclear techniques and it is used to: obtain flow field information in fluidized beds [1], reconstruct online flow visualization in multiphase reactors [2] and investigate phase recirculation and turbulence in multiphase systems [3].

The basic principle of RPT is to track a radioactive particle inside a volume of interest, for example inside an industrial agitator. The radioactive particle must have physical properties identical to those of the investigated flux. Currently, radioactive elements such as ^{46}Sc, ^{60}Co or other radioisotope, that emit gamma rays, are widely used to monitor motion in single or multiphase systems [4]. Radiation intensities are measured by detectors disposed in different positions around the volume of interest. Instantaneous particle position is calculated through a reconstruction algorithm that converts the detector counts as a function of coordinates of the particle. In Figure 1 is shown an example of an RPT set up.

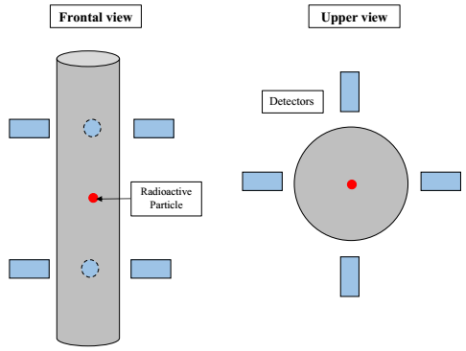

Figure 1. Schematic diagram of RPT set up.

Many reconstruction algorithms have been developed in the past decades. These algorithms include a weighted regression scheme [5], a modified weighted regression scheme [6], cross correlation technique [7], Monte Carlo approach [8] and Artificial Neural Network [2]. RPT methods reconstruct the particle instantaneous position through the solution of a minimization problem between the count measured and a rigorous phenomenological problem [9]. Studies in progress are been made to identify which algorithm is more adequate to evaluate industrial agitators.

References

[1] LARACHI, F.; KENNEDY, G.; CHAOUKI, J. A gamma-ray detection system for 3-D particle tracking in multiphase reactors, **Nuclear Instruments and Methods.in Physics.** Amsterdam, v. 338, n 2/3, p. 568–576, 1994.

[2] GODFROY, L. et. al. On-line flow visualization in multiphase rteactors using neural networks. **Appleied Radiation. and Isotopes**, Amsterdam, v. 48, p. 225 – 235, 1997.

[3] MOSLEMIAN, D.; DEVANATHAN, N.; DUDUKOVIC, M. P. Radioactive particle tracking for investigation of phase recirculation and turbulence in multiphase systems, **Review of Scientific Instruments**, New York, v. 63, n. 10, p. 4361-4372, 1992.

[4] MOSOROV, V.; ABDULLAH, J. MCNP5 code in radioactive particle tracking. **Applied Radiation and Isotopes**, Amsterdam, v. 69, n. 9, p. 1287–1293, 2011.

[5] LIN, J.; CHEN, M.; CHAO, B. A novel radioactive particle tracking facility for measurement of solids motion in gas fluidized beds. **AIChE Journal**, New York, v. 31, n. 3, p. 465-473, 1985.

[6] LUO, H. et al. Analysis of photobioreactors for culturing high-value microalgae and cyanobacteria via an advanced diagnostic technique: CARPT. Chemical Engineering Science, Amasterdam, v. 58, n. 12, p. 2519-2127, 2003.

[7] BHUSARAPU, S. et. al. Experimental study of the solids velocity field in gas–solid risers. **Industrial and Engineering Chemistry Research**, Washington, v.44, n. 25, p. 9739-9749, 2005.

[8] BLET, V. et. al. Radioactive tracing as aid for diagnosing chemical reactors. **Oil & Gas Science and Technology - Revue d'IFP Energies nouvelles**, Rueil-Malmaison, France, v. 55, n. 2, p.171–183, 2000.

[9] BEAM, G. B, et al. Monte-Carlo calculation of efficiencies of right-circular cylindrical Nal detectors for arbitrarily located point sources. **Nuclear. Instruments. And Methods**, Amsterdam, v. 154, n. 3, p. 154-501, 1978.