APPLIED FLUID DYNAMICS AND MIXING

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KEYWORDS: mixing, multi-phase flow, optical techniques, computational fluid dynamics, inertial separation

The Applied Fluid Dynamics and Mixing Group is mainly concerned with the investigation of the behaviour of equipment typically employed in the chemical and process industries.
Special focus has been given to fluid mixing problems, but over the past few years attention has also been extended to fluidised beds, static mixers, membrane modules for gas mixture separations, filter-press and inertial separators for oil and gas applications.
Research efforts have been equally devoted to the development of experimental and computational techniques for the characterization and the prediction of single and multiphase flows in different process equipment. The studies in these areas are based on state-of-art experimental techniques and Computational Fluid Dynamics, on the development of mathematical and/or phenomenological models and on the application of these modelling techniques to the design, rating and optimisation of equipment.
The experimental laboratory of the research group is fully equipped for the fluid dynamic characterization of the apparatuses through two complete Particle Image Velocimetry systems (2D-PIV and Stereo-PIV), that can be used in stereoscopic configuration for the detection of the three components of the velocity fields and that can be also adopted for mixing time measurements (PLIF technique). A PIV systems has been implemented for simultaneous two-phase flow measurements and the other for bubble size and BSD determination. Recently, the investigation of dense multiphase systems based on Electrical Resistance Tomography (ERT) has been started.
For the computational activity, general purpose commercial CFD codes are usually adopted, implemented with in-house developed user functions for the introduction of specific models. As for the computer resources, several up-to-date computers are available, while on specific problems requiring particularly advanced computational resources, the supercomputing facilities of the High Performance Systems Department of CINECA have been used in the recent past.

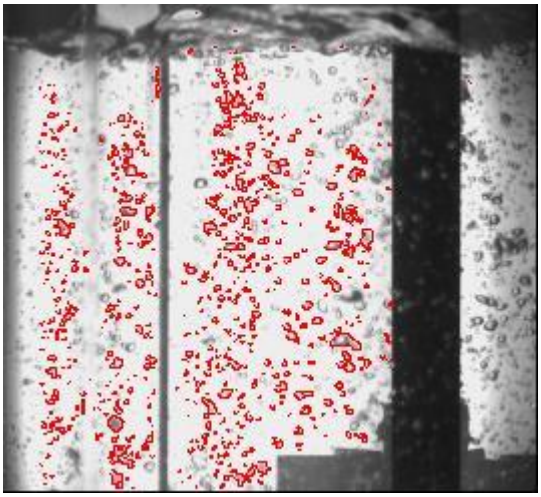

Fig.1 Multiphase stirred tank: bubble size analysis.

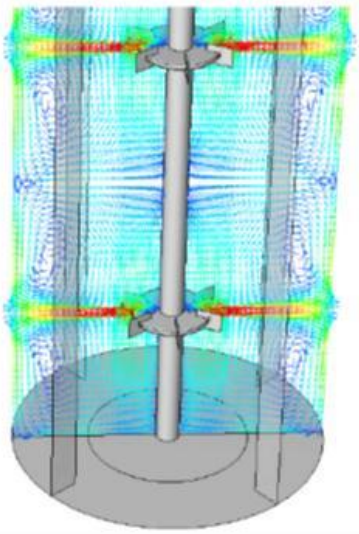

Fig.2 CFD simulation of a stirred tank: the flow field.

MAIN PUBLICATIONS

Montante G., Paglianti A., Magelli F. (2012). Analysis of dilute solid-liquid suspensions in turbulent stirred tanks. *Chemical Engineering Research and Design* 90, 1448-1456.

Montante G., Laurenzi F., Paglianti A., Magelli F. (2011). A study on some effects of a drag-reducing agent on the performance of a stirred vessel. *Chemical Engineering Research and Design* 89, 2262-2267.

Coroneo M., Montante G., Paglianti A., Magelli F. (2011). CFD prediction of fluid flow and mixing in stirred tanks: Numerical issues about the RANS simulations. *Computers and Chemical Engineering* 35, 1959-1968.

Coroneo M., Mazzei L., Lettieri P., Paglianti A., Montante G. (2011). CFD prediction of segregating fluidized bidisperse mixtures of particles differing in size and density in gas-solid fluidized beds. *Chemical Engineering Science* 66, 2317-27.

Coroneo M., Montante G., Paglianti A. (2010). Numerical and experimental fluid-dynamic analysis to improve the mass transfer performances of Pd-Ag membrane modules for hydrogen purification. *Industrial and Engineering Chemistry Research* 49, 9300-9309.

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Frascari D., Zuccaro M., Paglianti A., Pinelli D. (2009). Optimization of mechanical agitation and evaluation of the mass-transfer resistance in the oil transesterification reaction for biodiesel production. *Industrial & Engineering Chemistry Research* 48, 7540-7549.

Coroneo M., Montante G., Catalano J., Paglianti A. (2008). Modelling the effect of operating conditions on hydrodynamics and mass transfer in a Pd-Ag membrane module for H2 purification. *Journal of Membrane Science* 343, 34-41.

Frascari D., Zuccaro M., Pinelli D., Paglianti A. (2008). A pilot-scale study of alkali-catalysed sunflower oil transesterification with static mixing and with mechanical agitation. *Energy & Fuels* 22, 1493–1501.

Laurenzi F., Coroneo M., Montante G., Paglianti A., Magelli F. (2009). Experimental and computational analysis of immiscible liquid-liquid dispersions in stirred vessels. *Chemical Engineering Research and Design* 87, 507-514.

Coroneo M., Montante G., Giacinti Baschetti M., Paglianti A. (2009). CFD modelling of inorganic membrane modules for gas mixture separation. *Chemical Engineering Science* 64, 1085-1094.

RESEARCH PROJECTS

PRIN 2006: Study of the fluid dynamics of mechanically stirred reactors and tubular reactors for the production of nanoparticles or microparticles.

PRIITT 2008 (Regione Emilia Romagna): Analysis on the behavior of bi-phase fluids in filter presses.

Project EU FP6-2004-ID 019829: BIOCARD (Global Process to Improve Cynara cardunculus Exploitation for Energy Applications).

BIOHYDRO Project (Combined production of hydrogen and methane from agro-industrial wastes by biological processes) (2009-2013), financed by the Italian Ministry of Food and Agriculture (MIPAAF).

Industrial projects miscellanea: A2B- Development of a process for the recovery of waste oil (2011), Comart- Fluid-dynamic study of a slug catcher and of the cold finger process (2009), Costacurta- Fluid dynamic analysis of an inertial separator (2008), Pittaluga- Theoretical and experimental study of the fluid dynamic behavior of a static mixer (2008), Saddam Engineering- Pretreatment and anaerobic digestion of stabilized marcs (2012).

CONTACTS

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