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Toroidal Vortex Structure for a Triple Impeller Stirred-Tank at various Rotational Speeds obtained using Time-Resolved PIV

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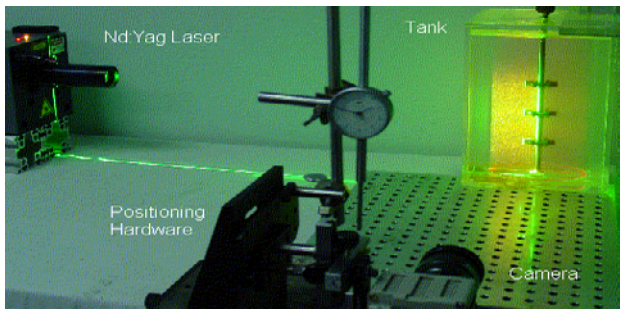
1) Dantec Dynamics, Inc., 777 Corporate Drive, Mahwah, NJ, U.S.A.

(a) 

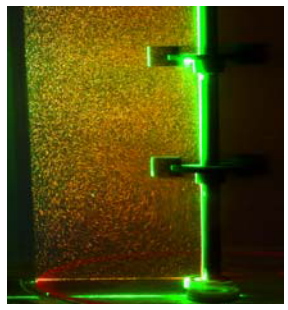
(b) 

Fig. 1. (a) Experimental setup of circular triple impeller stirred tank
(b) Time-lapsed exposure of fluorescent particles within measurement domain

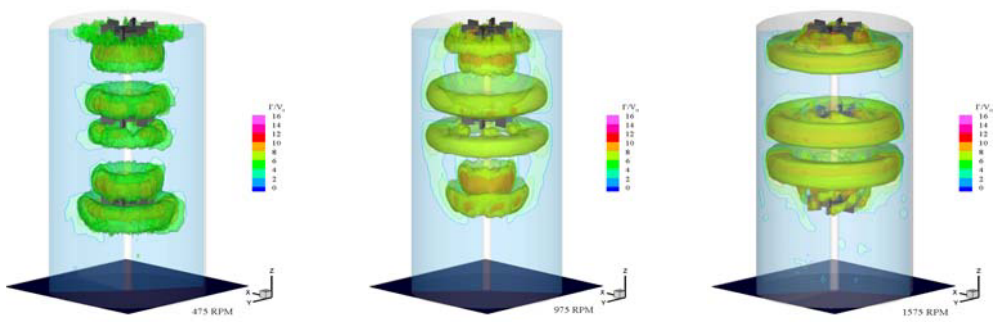


Fig. 2. Circulation strength iso-surfaces emphasizing toroidal vortex structure within the stirred tank for several rotational speeds

Time-Resolved PIV at 1kHz sampling rate was used to acquire particle image data along a vertical plane within a triple impeller stirred tank, as shown in Fig. 1. The working fluid was glycerin at room temperature (20°C), stirred steadily at the rotational speeds indicated in Fig. 2 (see Ref [1] for more information on testing conditions). Fluorescent particles and a high-pass color filter in front of the camera lens were used to eliminate contamination of PIV images by background reflections, and thus give way to high contrast imaging especially close to the turbine blades. Acquisition was performed over several cycles, and at each instant in time the 2D velocity field within the measurement plane was determined. Further processing of the radial (r) and vertical (z) components of velocity yielded the circulation strength of vortical structures within the r-z plane (see Ref[2]). Conversion of time into angular position relative to blade passage yielded the detailed volumetric flow representation shown in Fig. 2 (blade rotation is counter-clockwise looking from the top of the stirred tank). Fig. 2 shows iso-surfaces of the local circulation strength normalized by the blade tip velocity. These iso-surfaces mark the location of toroidal vortices within the stirred tank, and their manifestation as a result of rotational energy addition arising from turbine blade passage.

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1) Papadopoulos, G. and Hammad, K. J., 2003, "Time-resolved PIV measurements within a triple impeller stirred-tank," ASME/JSME Joint Fluids Engineering Summer Meeting, Honolulu, Hawaii, July 6-11.

2) Adrian, J., Christensen, K. T., Z.-C. Liu, 2000, "Analysis and interpretation of instantaneous turbulent velocity fields," *Experiments in Fluids*, Vol. 29, pp. 275-290.