Journal of Visualization, Vol. 6, No. 4 (2003) 323

Visualization of Taylor-Couette Vortex with a Short Annulus

Kawai, H. [1] *and Takahashi, T.* [1]

1) Dept. Mechanical Systems Engineering, Muroran Institute of Technology, 27-1, Mizumoto-cho, Muroran-shi, Hokkaido 050-8585, Japan

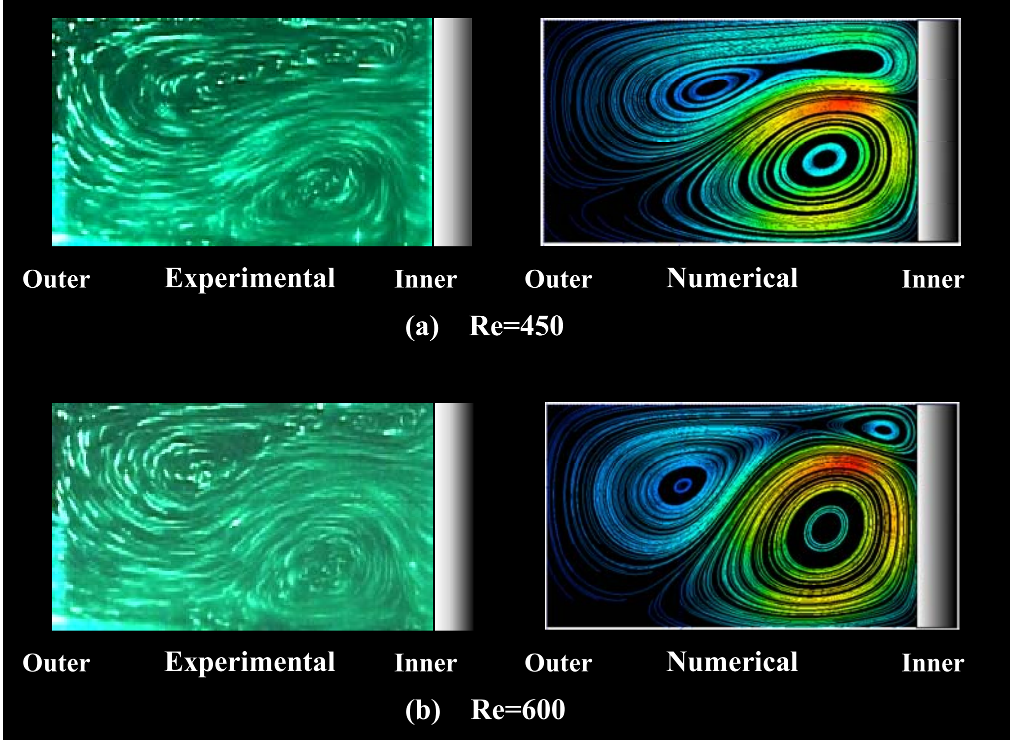


Fig.1 Oscillation flow from the normal 2 cell mode (Γ=0.6)

Upper and lower boundary effects with a short annulus of Taylor-Couette vortex flow are greatly related to the generation of various modes in vortices, which are obtained even in a same Reynolds number (Re). Parameters such as the aspect and radius ratios (Γ and η) defined from the geometry are important factors when the flow bifurcates to these modes.

Fig.1 shows one example of the various modes called 'the oscillating flow' in which a pair of vortices repeats growth and reduction alternately. This mode is developed from the normal two-cell mode and oscillates regularly even when a large disturbance is given in the flow field. The aspect ratio(Γ) and Re are defined as H/d and d W_0/v respectively, where H is the height of the apparatus, d is the clearance between the inner and the outer cylinders, W_0 is the rotational speed of the inner cylinder and v is the kinematic viscosity.

Journal of Visualization, Vol. 6, No. 4 (2003) 324

Enhanced Visualization Methods for Interpretation of Wind Tunnel Data

Mejia, K. M. [1),]*Kihlken, T.* [2)] and *Simon, L. V.* [3)]

1) Boeing Commercial Airplanes

2) Boeing Aircraft & Missiles, St. Louis, MO

3) Iowa State University, Ames, Iowa

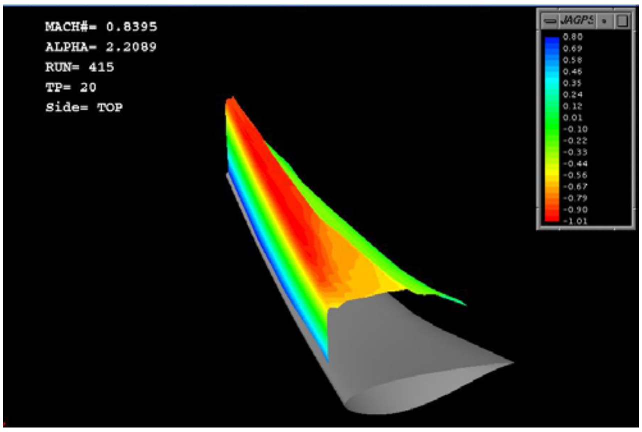


Fig. 1. Enhanced representation of wing Cp data

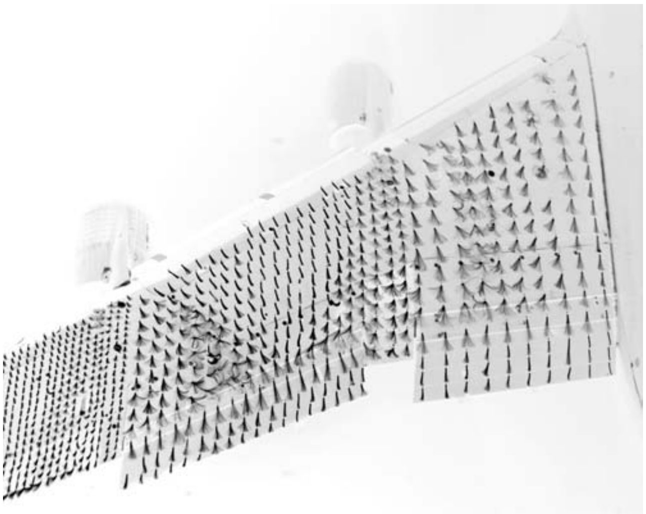


Fig. 2. Enhancement of tuft still image through composite imaging of digital stills

Digital post-processing techniques have been utilized to enhance the presentation of wind tunnel data to facilitate the understanding of flow field phenomena. Fig. 1 presents the full wing pressure distribution for a 777-200 wind tunnel model taken directly from experimental data and presented in a 3-dimensional "mountain" plot. It can be seen that the use of color and perspective presents a much more intuitive representation of the data than traditional 2D sectional plots can provide. Fig. 2 shows the time varying behavior of fluorescent mini tufts on the upper surface of a 747-400 low speed wind tunnel model. This image was constructed by compositing 6 separate still images taken at 10-second intervals into one and then applying a few digital image enhancement filters. The processed image conveys more information about how the tufts behave over time thereby providing an improved qualitative sense of the character of the airflow on the wing.

Journal of Visualization, Vol. 6, No. 4 (2003) 325

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

Papadopoulos, G.[1] and Hammad, K. J.[1]

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

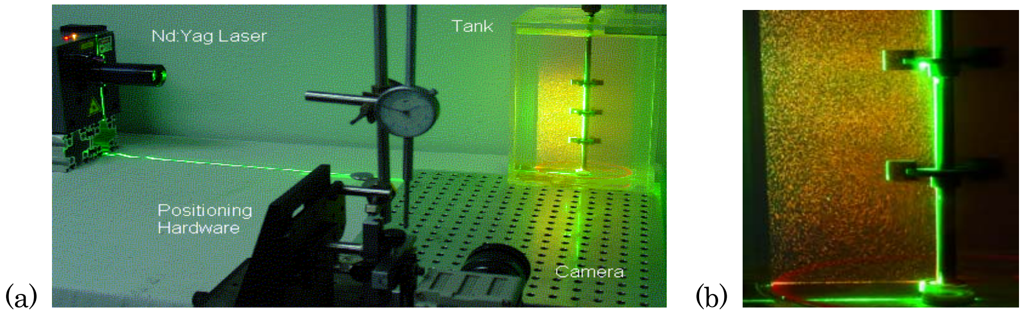


Fig. 1. (a) Experimental setup of circular triple impeller stirred tank
(b) Time-lapsed exposure of fluorescent particles within measurement domain

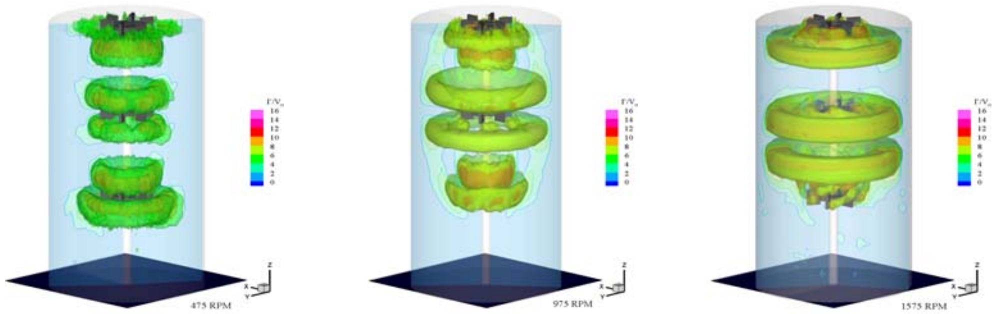


Fig. 2. Circulation strength iso-surfaces emphasizing toroidal vortex structure within the stirred tank for several rotational speeds

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.

---

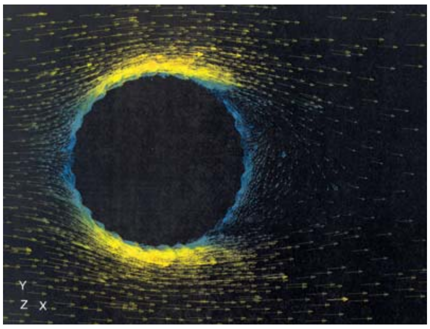
[1]) Papadopoulos, G. and Hammad, K. J., 2003, "Time-resolved PIV measurements within a triple impeller stirred-tank," ASME/JSME Joint Fluids Engineering Summer Meeting, Honolulu, Hawaii, July 6-11.

[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.

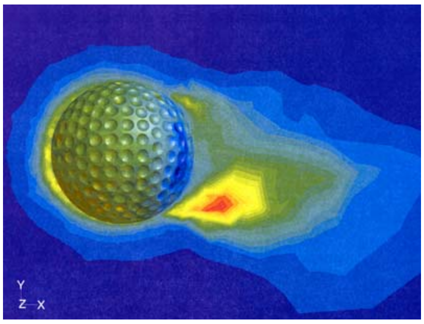
Some Additional CFD Flow Field and Pressure Solution Results for Dimpled Golf Ball with Backspin Rate of 2,000 rpm

Ting, L. L.[1)]

1) LLT & Associates, 3407 Woodlea Drive, Ann Arbor, Michigan 48103, U.S.A.
E-mail: LLTING@aol.com   Phone: 734-995-5070

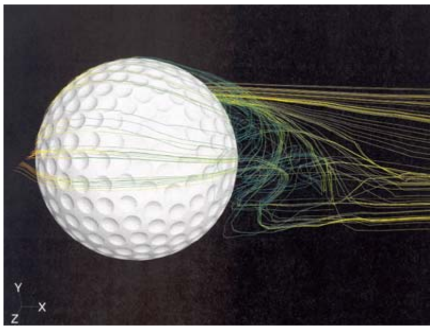


Velocity Vectors



Turbulence Intensity

Total Pressure - Ball Surface



Total Pressure – Path Lines

These figures show some additional golf ball aerodynamic solution results represented by velocity vectors, turbulence intensity, ball surface total pressure distribution, and total pressure path lines, as obtained by using the same CFD method previously reported [1)]. The ball diameter is 43.612 mm, and it has 344 dimples of equal size. The dimple diameter and depth are 3.785 mm and 0.262 mm, respectively. The flow field Reynolds number is 8.5×10^4, and the clockwise direction ball backspin rate about the Z-axis is 2,000 rpm. Reduced intensities of velocity vectors, turbulence intensity, and flow field warpage are obvious comparing with the similar case with the backspin rate of 3,000 rpm[1)]. Ball surface total pressure distribution solution results show the combined static and dynamic pressure magnitudes over the dimple pocket and dimple-free surface areas. Path lines colored by total pressure provide the opportunity for better studying the air flow behavior over the dimples, dimple pockets, as well as in the flow wake region behind the ball. Ball drag and lift coefficients can also be computed using this CFD method.

[1)] L. L. Ting, "Effects of Dimple Size and Depth on Golf Ball Aerodynamic Performance", FEDSM2003-45081, Proceedings of FEDSM'03, 4TH ASME_JSME Joint Fluids Engineering Conference, Honolulu, Hawaii, USA, July 6-11, 2003

3-D Structure of Baiu Front around Japan Simulated by Ultra High Resolution Atmospheric General Circulation Model on the Earth Simulator

Yoshioka, M. K. [1]*, Araki, F.* [1]*, Uehara, H.* [1]*, Enomoto, T.* [2] *and Igarashi, A.*[3]

1) Earth Simulator Center, 3173-25 Showa-machi, Kanazawa-ku, Yokohama-city, Kanagawa 236-0001, Japan

2) Frontier Research System for Global Change, 3173-25 Showa-machi, Kanazawa-ku, Yokohama-city, Kanagawa 236-0001, Japan

3) Kainoa Technologies, Inc., 5-33-7 Shiba, Minato-ku, Tokyo 108-0014, Japan

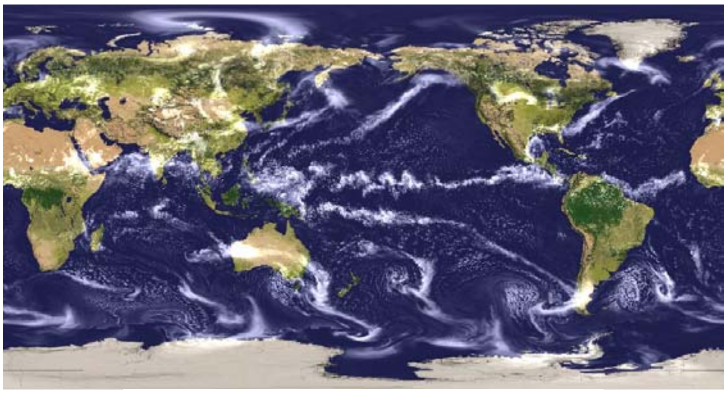


Fig. 1. 2-D distribution of precipitation

Baiu/Meiyu is a rainy season in East Asia that lasts for about a month in early summer. A simulation performed on the Earth Simulator with the global atmospheric model (AFES) at ultra high resolution of T1279L96 (about 10km mesh at the equator), shows typical features of Baiu front. Distribution of the global precipitation shows rainfall along the Baiu front extended from China towards Japan (Fig. 1).

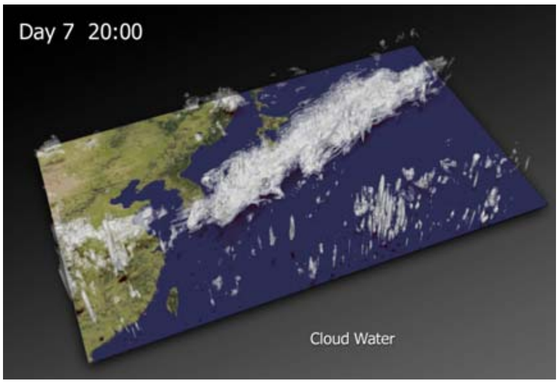


Fig. 2. 3-D distribution of cloud water in Japan region

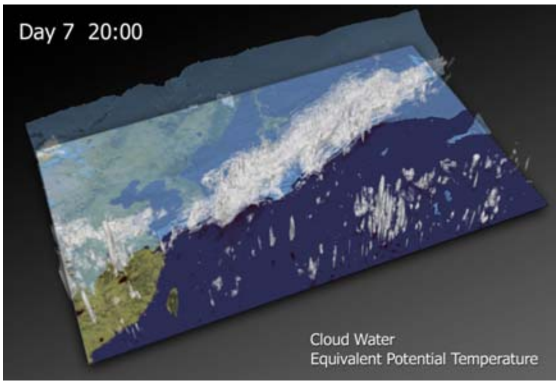


Fig. 3. An isosurface of equivalent potential temperature and cloud water

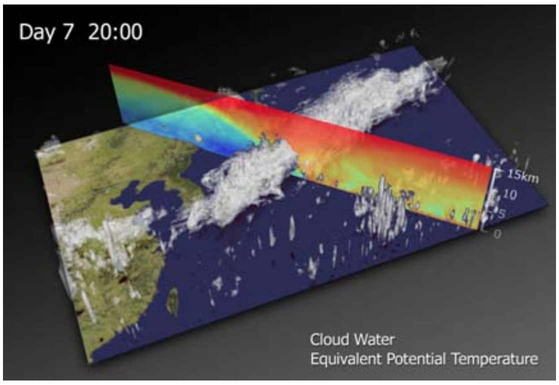


Fig. 4. A vertical section of equivalent potential temperature and cloud water

Figs. 2, 3 and 4 show 3-dimensional structure of the simulated Baiu frontal zone over the Japanese Honshu Island. Strong precipitation represented by black shadow coincides with the distribution of cloud water closely linked to rainfall (Fig. 2). Condensation occurs along the Baiu frontal zone. One of isosurfaces of the equivalent potential temperature represents a boundary between warm-moist and cold-dry air along the Baiu frontal zone (Fig. 3). A vertical cross-section of the equivalent potential temperature clearly shows that the Baiu front is simulated to be very sharp but tilting north-westward to form a “zone” (Fig. 4).

Journal of Visualization, Vol. 6, No. 4 (2003) 328

Flow-Visualizations behind a High Diver

Leder, A.[1] *and Grebin, U.*[1]
1) Department of Fluid Mechanics, University Rostock, Albert-Einstein-Str. 2, 18051 Rostock, Germany
E-mail: alfred.leder@mbst.uni-rostock.de

Fig. 1. Smoke wire flow visualization in the windtunnel

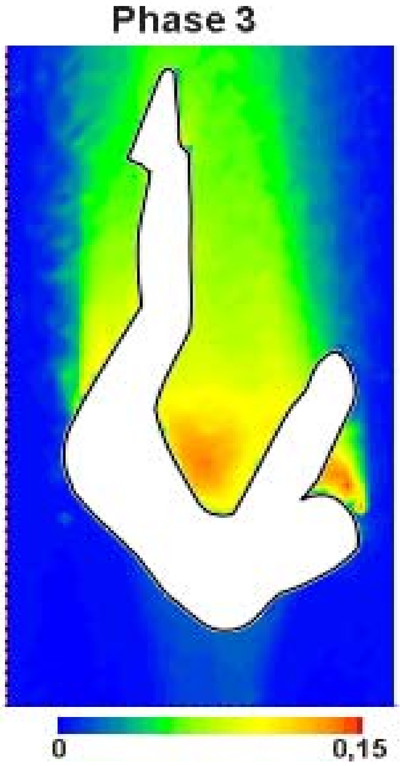


Fig. 2. LDA results of the Reynolds normal stress term u'^2/U_∞^2 in the cavitation tunnel

The figure illustrates exemplary results from a forward rotating jump in rip-technique when the body has already completely entered the water. Visualizations were made by the smoke wire technique in a Goettingen type windtunnel and by Laser-Doppler measurements in a cavitation tunnel at University Rostock. Both experiments clarify that the flow behind a high diver in rip-technique configuration forms a separation bubble from the head to the hip of the model. Secondary splashes can be attributed to this recirculating flow zone. At the left side the flow was visualized by the smoke wire technique. For these windtunnel experiments we used a tungsten wire with a diameter of 200 μm which was coated with white-oil. The wire was heated by a DC current of 4 A. The evaporating and then condensing oil forms white streaklines. It can be observe that the flow is turbulent directly behind the body. At the right side results of the LDA experiments in the cavitation tunnel are plotted in form of Reynolds normal stress component u'^2, normalized with the oncoming flow U_∞^2. The LDA results show high amplitudes for the u'-fluctuations in the head- and hip-region and in the wake flow. Maximum amplitudes (red color) occur directly behind the head and in the hip-region indicating the existence of a separation bubble.