Cover Photo

Visualization of Two-dimensional Flows by a Liquid (Soap) Film Tunnel

Gharib, M. * and Beizaie, M. *

** Graduate Aeronautical Laboratories, California Institute of Technology, 1200 East California Boulevard, Pasadena, CA 91125, USA*

e-mail: mory@caltech.edu

This image represents a two-dimensional jet produced in a soap film tunnel (Gharib and Derango, Physica D, Vol.37 pp.406-416, 1989). The small variation of the film thickness results in interference patterns, thus, providing an excellent means for flow visualization. The figure shows a laminar jet (Re number = 25), but the jet fluid has a lower surface tension than the ambient fluid, which results in a large growth rate for the jet.

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Study of Thermal Patterns on the Heated Wall by Infra-Red Technique

Hetsroni, G. [1] ***, Mosyak, A.*** [1] ***and Rozenblit, R.*** [1]

1) *Faculty of Mechanical Engineering, Technion-Israel Institute of Technology, Haifa, Israel*

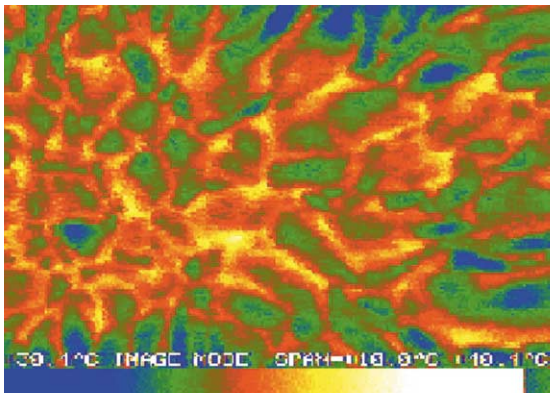

Fig. 1

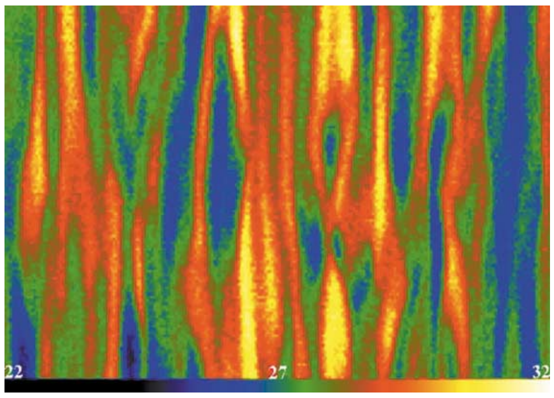

Fig. 2

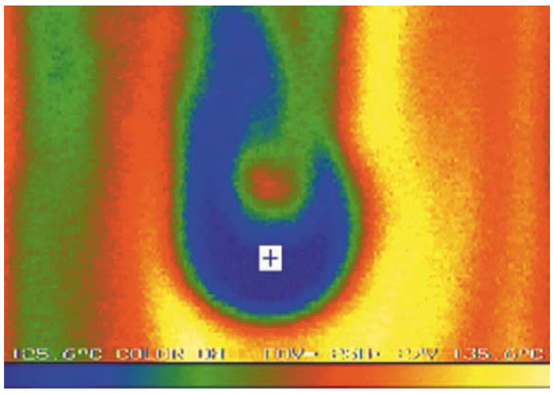

Fig. 3

We used a flume to study the near-wall turbulent structures. A heated test section at the bottom of the flume was made of a constant foil, 50 μm thick. The IR image created on the foil was recorded from below. The experiments were carried out at a constant heat flux from the heated foil.

The temperature distribution on the bottom of the flume can be considered as a trace of the flow structure near the wall, i.e. near-wall structures are the ones that cause the temperature variation on the wall, including the thermal streaks. The typical results of instantaneous temperature fields are shown in Figs. 1-3.

Fig.1 Natural convection in the flume. Rayleigh number $Ra = 3\times 10^7$. Thermal pattern on the heated wall.

Fig. 2 Thermal streaks in forced convection. Reynolds number Re = 5100. The flow is from the bottom to the top.

Fig. 3 Thermal pattern around the single spherical particle attached to the heated bottom of the flume (the particle diameter is d = 4.75 mm, Ra = 5150). The flow direction is from the bottom to the top. The particle is located at "+".

References

Hetsroni, G. and Rozenblit, R., Heat transfer to a liquid-solid mixture in a flume. Int. J. Multiphase Flow, 20, (1994) pp. 671-689.

Hetsroni, G., Mosyak, A. and Yarin, L.P., Effect of surface waves on heat transfer in natural and forced convection., Int. J. Heat Mass Transfer, 40, (1997) pp. 2219-2229.

Hetsroni, G., Rozenblit, R. and Yarin, L.P., The effect of coarse particles on the heat transfer in a turbulent boundary layer, Int. J. Heat Mass Transfer, 40, (1997) pp. 2201-2217.

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Numerical Simulation on Flow-induced Vibration of Square-pitched 4×4 Cylinder Arrays in Cross Flow

***Hishida, H.*[1]*, Adachi, T.*[1] *and Koike, S.*[2]**

1) *Saitama Institute of Technology, 1690 Fusaiji, Okabe-machi, Osato-gun, Saitama 369-0293, Japan*

2) *Mitsubishi Research Institute, Inc., 2-3-6 Otemachi, Chiyodaku, Tokyo 100-8141, Japan*

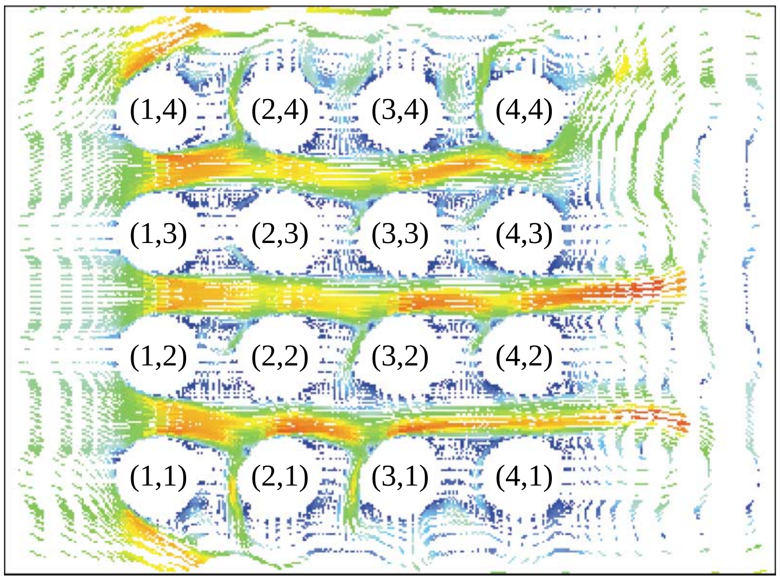

Fig. 1. Flow vector field in the vicinity of a 4×4 square-pitched cylinder array with P/D = 1.5 and Re = 1 000 at t^* = 100.0

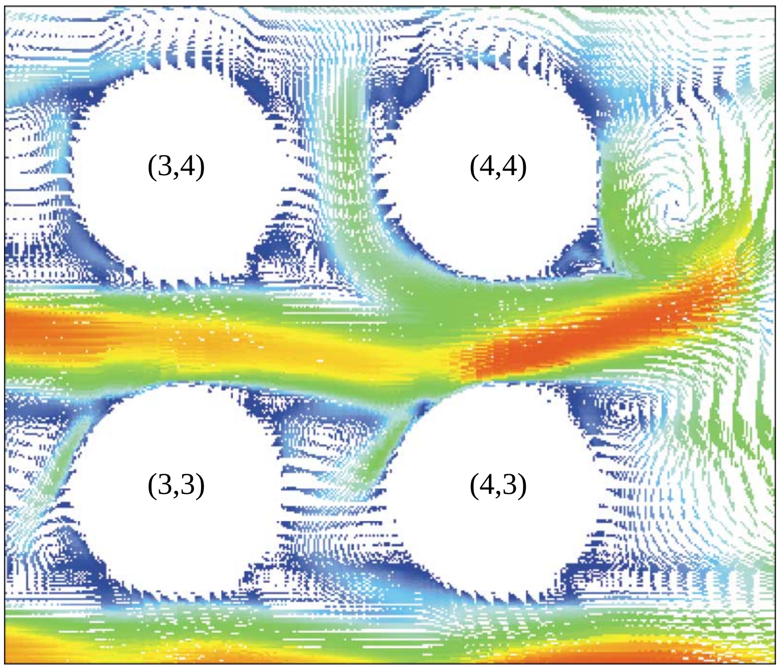

Fig. 2. Flow vector field in the vicinity of cylinders (3,3), (3,4), (4,3) and (4,4) with P/D = 1.5 and Re = 1 000 at t^* = 102.0

The transient characteristics of the lift and the drag on cylinders were numerically evaluated for 4×4 square-pitched circular cylinder arrays elastically supported inline to the cross fluid flow. Figures 1 and 2 show the flow vector fields inside the array at the non-dimensional time t^* = 100.0 and 102.0, where t^* is related to the time t in terms of the cylinder diameter D and the uniform incoming cross flow velocity U such that $t^* = U\,t\,/\,D$. Re and P in figure captions are the Reynolds number and the pitch of the cylinder assembly, respectively.

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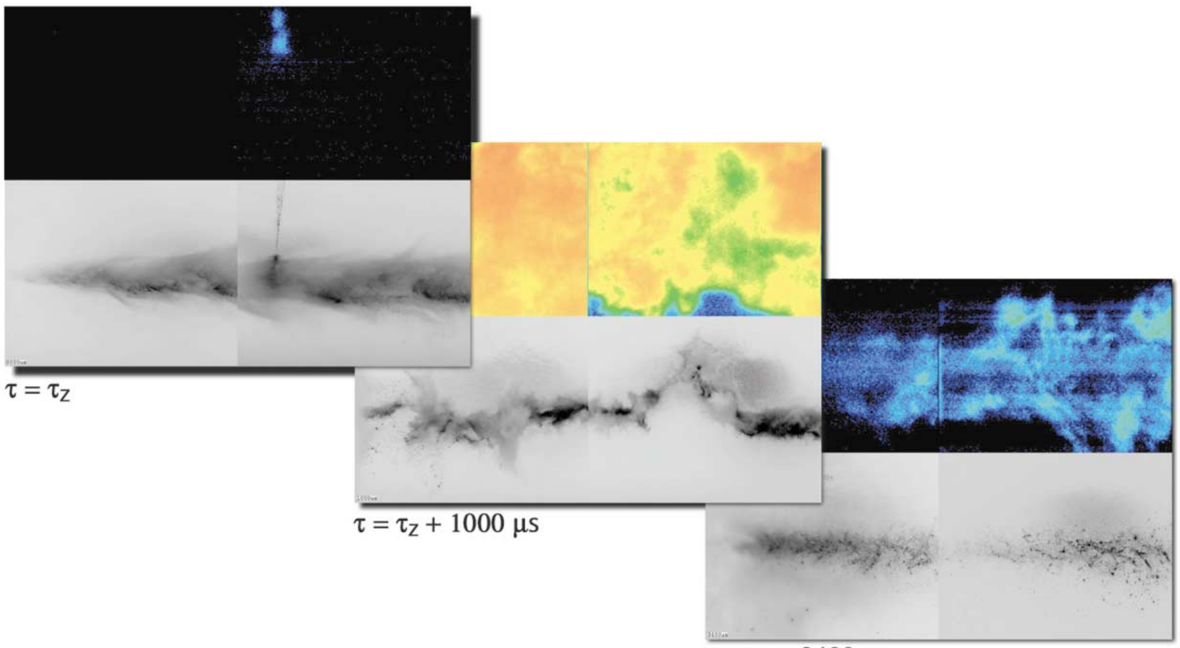
Visualization of High Speed Phenomena during the Ignition Transient of a LOX/GH_2 Coaxial Injected Spray

Schmidt, V.[1]***, Sender, J.***[1] ***and Oschwald, M.***[1]
1) *Space Propulsion, German Aerospace Center (DLR), Langer Grund, D-74239 Hardthausen, Germany*



$\tau = \tau_Z$

$\tau = \tau_Z + 1000\ \mu s$

$\tau = \tau_Z + 3400\ \mu s$

These figures show simultaneously observed images of OH-emission (upper half) and liquid phase distribution (lower half) of near injector region in a cryogenic liquid rocket engine during ignition process initiated by a pulsed Nd:YAG laser. Intensities are shown in logarithmic scales (γ = 3.3). OH-emission intensities are coded using false colour representation. Images are taken at ignition time (τ_z) and at times 1 ms and 3.4 ms after laser induced ignition.

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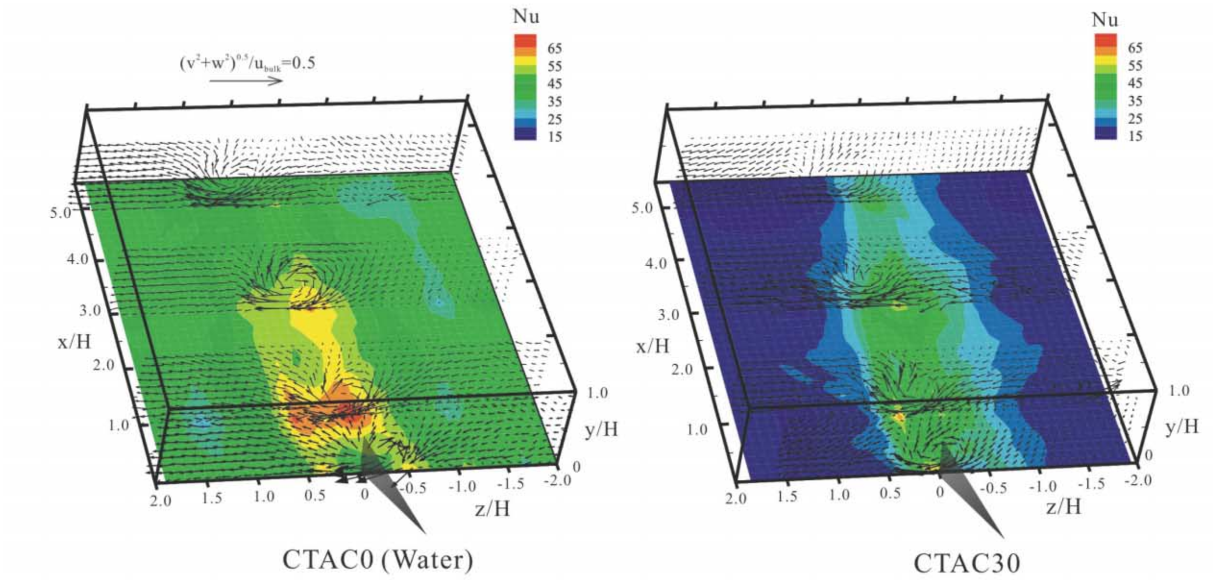
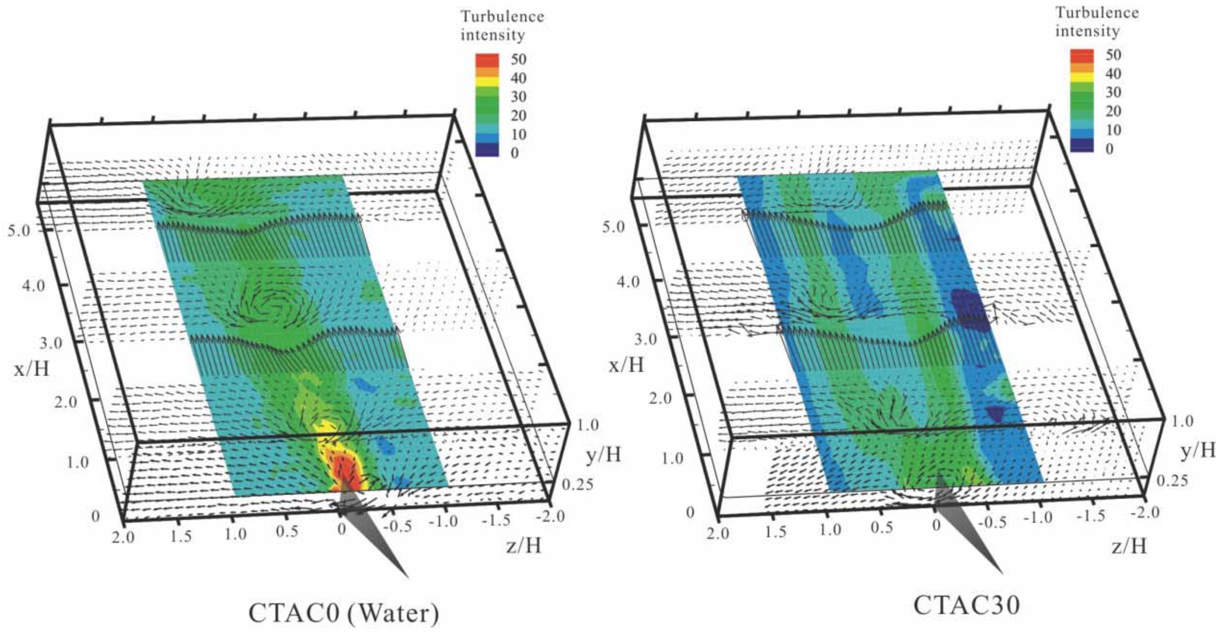
Vortical Structure and Heat Transfer Enhancement in the Wake behind a Wing-Type Vortex Generator in Drag-reducing Surfactant Flow

***Eschenbacher, J.F.*[1], *Nakabe, K.*[1] *and Suzuki, K.*[1]**

1) *Department of Mechanical Engineering, Kyoto University, Kyoto 606-8501, Japan*



(a) Nusselt number distributions and (*v*,*w*)-velocity maps



(b) Turbulence intensity distributions and velocity maps of (*v*,*w*)-and (*u*,*w*)-components

These figures were obtained by two-dimensional PIV measurement and wall heat transfer measurement in the channel flows of water (CTAC0) and surfactant (30 ppm CTAC/NaSal, CTAC30) under $Re = 4{,}500$. The top figures show the wall heat transfer distributions and (*v*, *w*)-velocity fields in several cross-sections, while the bottom ones show the turbulence intensity distributions in the *xz*-plane (*y*/H=0.25) with (*v*, *w*)- and (*u*, *w*)-velocity fields. It is clearly seen that the remarkable heat transfer reduction of CTAC30 is recovered in the regions behind the wing-type vortex generator, where longitudinal vortical flows are generated with relatively high turbulent intensities.

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Visualization of Cavities on Ship Screw Propeller

Gorski, W. [1)]

1) *Ship Design and Research Centre, Ship Hydromechanics Division, 65 Szczecinska Str., 80-392 Gdansk, Poland*

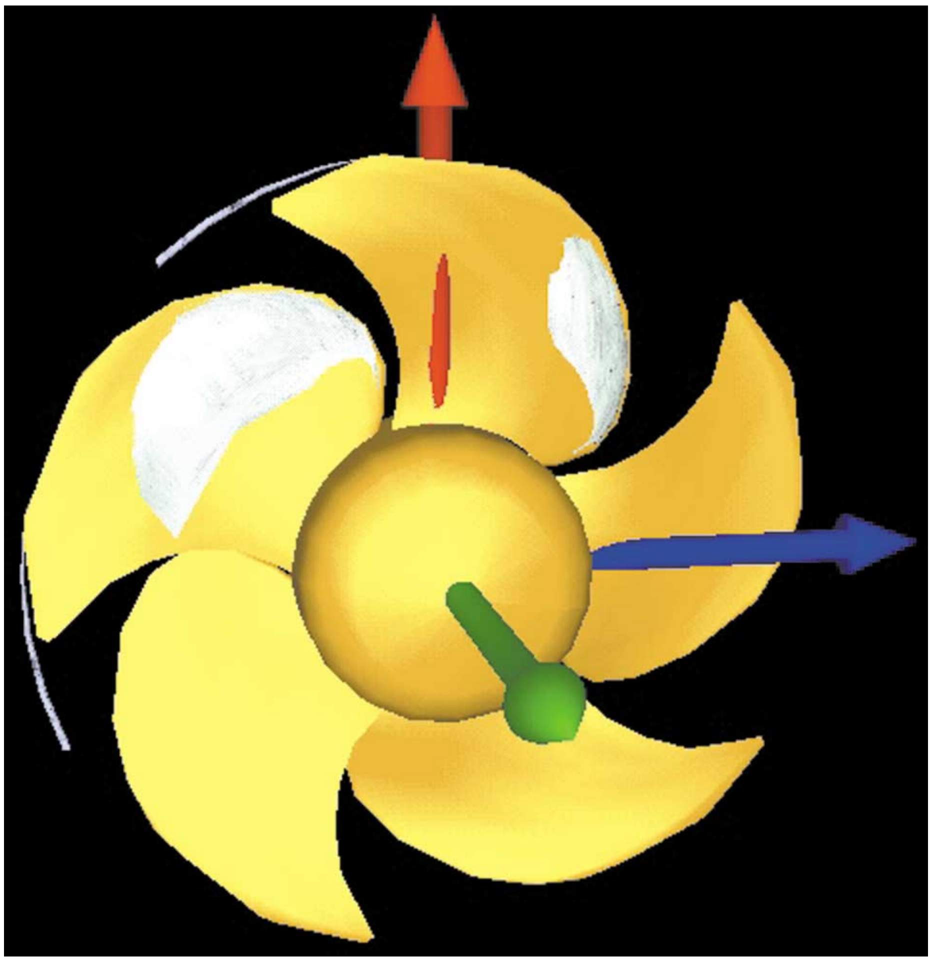
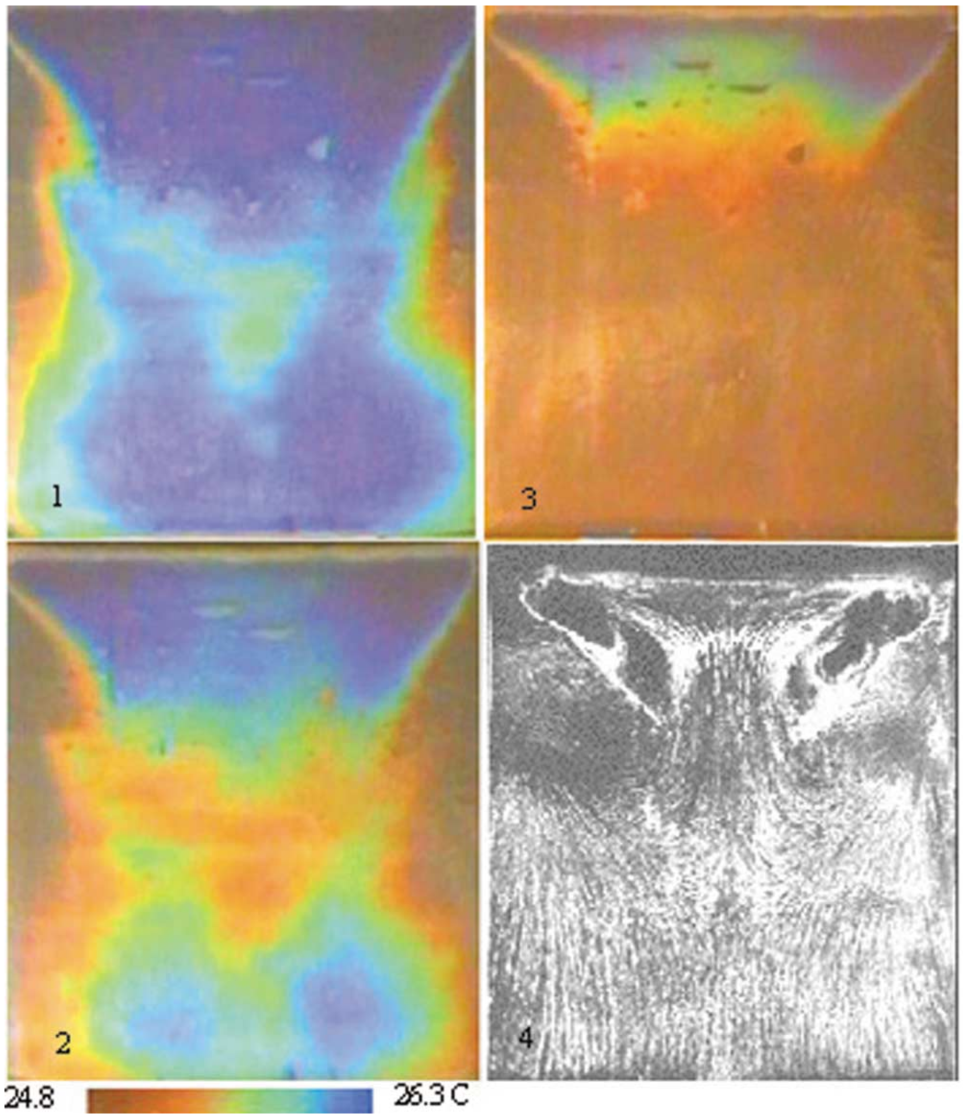


Figure shows visualization of cavitation pattern on screw propeller advancing in ship's wake. Main parameters of the propeller are following: diameter 3.8 m, average pitch ratio 1.08, advance speed 28 knots, shaft speed 212 rpm, twin-screw arrangement. Two types of cavitation may be distinguished at the picture. Large sheet cavity fully developed at 290 deg position that tends to vanish when blade passes its top position and cavitating tip vortex that appears at 250 deg position and closes at 20 deg. Presented visualization is used as a post-processing tool for propeller analysis program used in our facility.

Flow Visualization on a Low Aspect Ratio Wing by Liquid Crystal Thermography

Zharkova, G. M. [1]***, Dovgal, A. V.*** [1]***, Kovrizhina, V. N.*** [1] ***and Zanin, B. Y.*** [1]

1) *Institute of Theoretical and Applied Mechanics, Institutskaya St. 4-1, 630090 Novosibirsk, Russia*



Images (1-3) show a time variation of the surface temperature on lee side of the straight wing obtained by Liquid Crystal Thermography technique. The wing model with symmetric profile and aspect ratio 0.87 was made of wood. The heated model was exposed to the flow and pictures were recorded by a video system. For comparison image 4 shows a flow pattern (limiting streamlines) obtained by liquid film technique (titanium dioxide powder in kerosene).

Chord Reynolds number $Re_c = U_\infty c/\nu$ = 235 000. Angle of attack $\alpha = 27^\circ$. Flow direction is from the top to the bottom.