Particle Image Velocimetry (PIV)

Background

PIV is a technique to measure fluid velocities. A PIV system does this by taking two digital images of a fluid (gas or liquid), seeded with particles in quick succession. The particles within a plane of the fluid are illuminated by two short pulses of laser light as the images are taken.

Computer software interprets the two digital images to measure the distance that each of the particles has travelled and so calculate velocities within the fluid plane.

The principles of PIV are explained in more detail on Dantec Dynamics' Principles of Particle Image Velocimetry page.

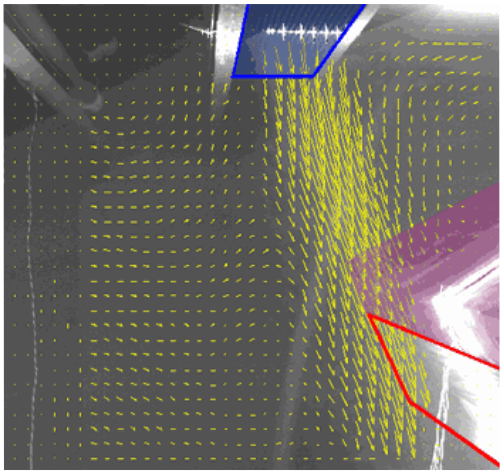
PIV has advantages over other flow measurement methods in that it can capture the velocity and direction information in many points over a plane of fluid almost instantaneously and non-intrusively. There are many situations where it would be almost impossible to do this by other means.

PIV is also an excellent method for validating Computational Fluid Dynamics (CFD) models as it can measure the same level of detail in fluid flows that CFD predicts. For more information on this modelling technique, see the frperc CFD pages.

PIV tests

A 2-D (planar) PIV system was used by Dantec Dynamics at frperc to measure air curtain airflows on a prototype multi-deck refrigerated display cabinet (see image at the top of the page). The PIV system was used to generate images of the airflow over each shelf of the retail display cabinet.

The highlighted areas and lines in the image show the parts of the PIV system and the cabinet. The yellow lines show the plane of the PIV measurements over the shelves and the test packs on the shelves, the area marked in blue is the outlet of the cabinet's air curtain and the red circle and green box indicate the camera and the laser unit on the PIV system.



The PIV computer software can generate a large variety of data additional to the real-time velocity data. The image above shows air flowing out of the cabinet's air curtain grille (marked in blue outline and shaded blue on the image) and past the top shelf (marked in red outline). The mean velocity vectors of the flow near the top shelf are marked as yellow arrows; the longer the arrows, the greater the velocity. The test packs in the plane of the PIV picture are shaded in purple on the image. The glow across the surface of the packs and shelf shows the reflection of the PIV laser light plane.

The figure shows that air is entrained into the air curtain, from the left (outside the cabinet) and that the air curtain is bent into the cabinet, towards the top shelf. A recirculation zone is set up above the top shelf.

A large amount of data was collected in less than a day using the PIV system. Analysing this data has demonstrated several areas where the cabinet airflow could be improved. This was a very quick and effective method for providing this information and far more data was provided in a shorter time than could be achieved using other methods.

How frperc can help

frperc have extensive experience in testing and developing all types of refrigerated cabinets and have dedicated cabinet test rooms where tests can be carried out.

Using PIV on refrigerated cabinets and other systems, either on its own or in combination with CFD models can help to understand the airflows and so highlight any problems that the system may have. Significant improvements in system performance may be possible from these kinds of analyses.

To discuss any aspects of PIV systems or their use in measuring airflows for development of problem solving purposes, please contact us on +44 (0)1472 582400 or email us on frperc@grimsby.ac.uk