



A practical guide to turbulence and flow measurement by thermal anemometry (CTA), laser-Doppler anemometry (LDA) and particle-image velocimetry (PIV)

Part 1: overview and selection of measurement technique

Author: Mr G. Hassall



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* Corresponding Members

The construction and subsequent development of the Data Item were undertaken by

Mr G. Hassall

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A PRACTICAL GUIDE TO TURBULENCE AND FLOW MEASUREMENT BY THERMAL ANEMOMETRY (CTA), LASER-DOPPLER ANEMOMETRY (LDA) AND PARTICLE-IMAGE VELOCIMETRY (PIV)

Part 1: overview and selection of measurement technique

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Part 1: overview and selection of measurement technique

1. INTRODUCTION

The determination of flow conditions in terms of velocity and turbulence plays an important role in many experimental investigations. These parameters can be measured and evaluated by many different techniques. In this Data Item the widely-available methods of hot wire/constant-temperature anemometry (CTA), laser-Doppler anemometry (LDA) and particle-image velocimetry (PIV) are considered; techniques which allow measurement of unsteady flow features and provide reasonable or good spatial resolution.

A brief description of the physical principles, main advantages and disadvantages of each of these techniques is given. In Appendix A, a flow chart is presented to guide the selection of the most appropriate technique for a particular experimental investigation.

This Data Item should be used in conjunction with its accompanying Data Items (References 1, 2 and 3) which give more detailed guidance on the use, practical limitations and pitfalls associated with each of these three measurement techniques.

It should be emphasized that measurement techniques other than those discussed here should also be considered. For example ultrasonic anemometers are particularly applicable to the frequency range and spatial resolution required for typical measurements in the atmospheric boundary layer and, where only relatively low-frequency fluctuations are to be measured, a simple pitot-static tube may also provide a cheap and simple solution. Where the particular features offered by CTA, LDA or PIV are needed, the choice will also be influenced by availability, cost, ease-of-use and likely requirements for future investigations.

This Data Item and References 1, 2 and 3 deal with a wide range of flow-measurement applications but are also appropriate to specialised applications, such as wind-tunnel testing.

2. PRINCIPAL FEATURES OF MEASUREMENT TECHNIQUES

This Section gives a very brief overview of the physical principles of operation of each of the three measurement techniques and their requirements, advantages and disadvantages.

2.1 Hot-Wire/Constant Temperature Anemometry (CTA)¹

2.1.1 Physical principles

The CTA anemometer works on the principle of convective heat transfer from an electrically heated sensor to the surrounding fluid. At a given sensor temperature the transfer of heat from the sensor is principally a function of the fluid flow over the sensor. The sensors are varied, however the most commonly used are fine wires (typically 5 microns in diameter), Figure 2.1, or thin nickel films on quartz substrates.