cannot do this and nor can a twin one such as a double turbine meter since both parts of the meter will change in a similar manner. The consensus of opinion was to see correlation techniques limited to special applications.

The quality of the flow measurement papers to the 9th Congress was varied. It is perhaps inevitable on such occasions that the good intentions of authors become diluted as the dateline for their submission approaches and what is on record in the preprints may sometimes lack the required detail. What was clear from the rain of questions and comments following presentations was that there is no diminution in the demand to have accuracy claims spelled out. While papers in some instances did give brief references to the expected accuracy of the data being presented, none made a serious attempt to analyse systematic and random contributions to the overall uncertainty. The questioners were answered in a fashion but it must be queried whether their demand for such information was based on any full appreciation of the answers they were given. Outside the Congress, users are all too often content to take the manufacturer's statement about the predicted accuracy of his instrument at its face value: indeed they would perhaps prefer to use the claims they are given by the supplier and not look too closely at their own installation and use of the equipment. A relatively brief examination of these will often show that the system is precluded ever reaching anything approaching the accuracy claimed. Nevertheless it is only by such reiterated comments and demands from users that the developers and manufacturers of instruments will be encouraged to test and check their products. It is a sad reflection on quality control throughout the world that instruments are being supplied with inadequate final inspection. The logic of requiring an authorised certificate to be issued is becoming overwhelming.

A subject which came up a number of times was fuel flow measurement for vehicles. The papers concerned stimulated the most lively of the discussions and while the demand of the car manufacturer that such a flowmeter capable of accurate measurement, almost instant response, subject to arduous environmental conditions in terms of temperature, contamination and tilting, should cost less than 30 DM (about £8) leaves one incredulous, nevertheless the urge to save energy could well inspire success in the device even if the price were significantly higher. It is beyond the scope of this note to go into a detailed discussion of the efforts being made to find solutions but it is hoped that a review can be published in a future issue of this Journal.

The Proceedings of the Congress will be published by IMEKO in due course: copies of the preprints may be obtained (price per set DM120) from the VDI in Dusseldorf. Well organised, interesting and above all well-timed and located in Berlin sums up my opinion of the occasion.

E. A. Spencer

18–22 April 1982, London, UK

27th International Gas Turbine Conference

The 27th in ASME's series of annual gas turbine conferences was in London for the second time, after a four year interval. Once again the event was cosponsored by The Institution of Mechanical Engineers.

At this year's conference, 324 papers were presented in 84 sessions, each organised by one of the committees of the ASME Gas Turbine Division. Clearly, the papers likely to be of most interest to readers of this journal were presented in sessions organised by the Turbomachinery and Heat Transfer Committees. The latter are reviewed in detail by Brown in an adjoining report.

The 96 papers submitted through the Turbomachinery Committee covered a wide range of topics including:

1. Advances in computional fluid mechanics of turbomachinery.
2. Aerodynamics of axial flow compressors and turbines.
3. Analysis, design and performance of radial flow machines.
4. Blade boundary layers and wakes.
5. End wall effects and secondary flows.
6. Turbulence effects in turbomachinery.
7. Unsteady flow effects.
8. Losses and effects of design changes on performances.
9. Performance evaluation.

The papers on advanced computational fluid mechanics dealt with time marching techniques, quasi three dimensional finite element analyses, rotational flows, viscous and secondary flow effects, three dimensional turbulent flows, and three dimensional effects in transonic and supersonic flows. Viscous flow effects are covered in detail in the adjoining report by Gregory-Smith. The popularity of radial flow machines was evident from the 20 papers presented in 4 sessions which covered the aero-thermodynamics, design and performance of these machines. Inlet flow distortions in impellers and diffusers, boundary layer and end wall influences, secondary flows and mixing losses were some of the topics covered in the sessions. The papers on the axial flow turbines and compressors were mainly of experimental nature.

Two sessions were devoted to turbomachinery performance. The first included papers on losses resulting from imperfections in hardware, and second on improvements that have been achieved through unconventional design features. Clearances between the stationary and rotating parts, surface finish, thickness of blades, scaling and casing treatment were among the topics covered in the papers. The session on performance evaluation was mainly user orientated. It dealt with such aspects as optimisation of compressor vane and bleed settings, comprehensive study of guide vanes of an axial flow compressor, prototype variable geometry industrial turbines, data handling systems etc.

Unsteady flows in turbomachinery also received considerable attention and 15 papers were presented. The topics covered included measurements of self excited flow oscillations and rotating stall in centrifugal compressors, development of a generalised method for bluff body and stalling aerofoil flows, three dimensional aerodynamic characteristics of oscillating supersonic and transonic annular cascades, interactions of unsteady flow distortions with high Mach number cascades, distorted flow fields, computation of unsteady blade forces by means of potential flow theory and viscous wakes, laminar-turbulent boundary layers disturbed by wakes etc.

The session on blade boundary layers and wakes included papers on wakes from compressor cascades, trailing edge ejection and base pressure in transonic turbine cascade, prediction of blade wakes, turbulent boundary layers, base pressure on a blunt base in transonic flows, and visual studies of boundary layers. Five very interesting papers reported the results of investigations on the end wall and secondary flow phenomena in axial flow turbines and compressors. The session on turbulence effects included four papers which dealt with such topics as coherent structure of the turbulent boundary layers at low and high velocities, influence of free stream turbulence on boundary layer transition, and three dimensional flow field in the tip region of a compressor rotor passage.

The Conference and Exhibition attracted over three thousand visitors; technical sessions were attended by about eleven hundred delegates.

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Viscous flow effects in axial compressors and turbines

D. G. Gregory-Smith*

In the design of axial flow turbomachinery, information about the viscous flow effects is very important. Such information, whether experimentally or theoretically derived, may be used directly or in conjunction with throughflow calculation techniques. Viscous flow information allows the designer not only to avoid gross flow distortions due to boundary layer separations, but also to estimate the aerodynamic losses, and hence the efficiency and power of the machine.

Due to the complexity and importance of viscous flows, a substantial proportion of the papers on axial flow turbomachinery aerodynamics presented at the conference dealt with these flows. With 84 sessions spread over 4 days with up to 12 parallel sessions at any time, inevitable clashes occurred even for one with fairly limited interests. This review, however, attempts to highlight the main points of interest on viscous flows.

The effects of viscous flows may be divided into blade boundary layers distant from the end walls and flows near the end walls including secondary flows, end wall boundary layers and tip clearance effects. This division is not wholly satisfactory, since there are mutual interactions as some of the papers showed. The blade boundary layers give rise to wakes which decay and also affect the following blade rows, and several papers dealt with these aspects. Similarly the effects downstream near the end walls are important, although very complex.

Since the early days of overall empirical correlations, such as those of Howell for compressors and Ainley and Mathieson for turbines, there has been a steady progress towards a more detailed physical understanding of turbomachinery flows. Over the past few years this progress has been accelerated due mainly to the advent of fast computers, of large storage. These have allowed the acquisition, analysis and numerical or graphical presentation of large amounts of data from experiments. Improvements have also been made in instrumentation and flow visualisation techniques. Thus it is not surprising that the majority of papers presented at the conference were reporting mainly experimental work.

Progress in the difficult task of relating the physical understanding to improved theoretical models is slow, although some papers attempted to do this. There were also a few papers dealing with calculation methods for viscous flows in blade passages.

Blade boundary layers

Although boundary layers on blades are considerably less complex than those on the end-walls, they are still subjected to a number of 'unusual' effects, such as large streamwise pressure gradients, radial pressure gradients, unsteady flows and high curvature. Profile losses for reasonably high aspect ratio turbine blades may be predicted with some confidence. Problems arise, however, at low aspect ratios, and for compressor blades, and when details such as transition and local skin friction are considered. The work presented at the conference illustrated these points.

The papers may be subdivided into fundamental studies of boundary layers, and studies of boundary layers on compressor and turbine blades. Among the former were two papers on laminar-

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