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NUMERICAL MODELING OF TURBULENT FLOW

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Three dimensional combustor calculations are currently stretching the computer hardware capabilities and the computing budgets of gas turbine manufacturers. One of the main reasons for this relates to the large number of complex physical processes occuring in the combustor. Airflow, fuel spray, reaction kinetics, flame radiation, and , not the least of which, turbulence must be modeled and the related differential equations solved. Obtaining accuracte solutions to these modeled equations entails another difficulty. Current combustor codes are, generally, based on the SIMPLE algorithem developed by Patankar and Spaulding, ref. 1. One of the key features of this algorithem is the use of hybrid differencing to approximate the convective terms in the governing equations. In most practical calculations this results in the use of first order accurate upwind differencing for most of the flow field. The overly dissipative solutions obtained using this scheme can mask important flow field features, ref. 2. Ideally, this can be overcome through the use of additional grid points. In three dimensional calculations ,however, this becomes impractical since the computational work involved increases greatly as grid points are added.

Other discussions in this conference will address methods to improve the accuracy of combustor flow field calculations and methods to speed the convergence of the modeled equations. This talk will focus on aspects of merging these two new technologies. The improved accuracy discretization schemes have a negative impact on the speed of convergence of the modeled equations that the improved solution algorithems may not overcome. A description of the causes of this problem and potential solutions will be examined.

REFERENCES

1. Patankar, S.V. and Spaulding, D.B., "A Calculation Procedure for Heat, Mass and Momentum Transfer in Three-Dimensional Parabolic Flows," International Journal of Heat and Mass Transfer, Vol.15, No. 10, Oct. 1972.

2. Claus, R.W.,"Analytical Calculation of a Single Jet in Crossflow and Comparison With Experiment," NASA TM83027, 1983.