

分散式叶型梳状五孔针—全台压气机级间参数测量新方案

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作者首次提出分散式叶型梳状五孔针作为全台压气机转子后级间参数测量的新方案, 并进行了实验论证。结果表明其静态特性光滑圆整明显优于球形五孔针而动态频响可提高七倍。

1. 问题的提出 获取各级基元性能是全台压气机新机试验的关键。这对验证三元流设计并作实验修正起重要作用。常规使用沿径提升单点五孔针的办法^[1], 球头直径约可小到 2mm, 支杆迎风宽度 1.5mm, 但进一步减小的潜力有限。全台压气机级间轴向间隙很小, 不允许像单级试验时那样加以拉大, 那会改变性能。故探针必须置于 (或部分置于) 静叶槽道中。高推比的高压压气机均为小叶高大稠度, 故球头及支杆的堵塞很可观。在测叶尖及叶根时, 探针还有临壁效应^[2]。各级都用位移机构还使机构庞杂试验费时。新试验机一般振动大耗时长不利于保护试验机。球形五孔针作动态测量时因无法消除容腔, 故频响很低。这说明有必要另辟途径。

2. 分散式叶型梳状五孔针 分散式叶型梳状五孔针是五个孔分散在五个叶片同一半径上, 再沿径向按等环面布置若干同型测孔, 就由五个叶片组成了梳状五孔针。每一分散式五孔针的五个测孔测的完全是同一叶高的参数, 这在高压转子后特别适用。五孔针的尺寸缩成一根针管直径, 即只为球头的 1/3, 从而迎风面积降为 1/9, 堵塞与临壁效应大为减小。在气流有偏角时, 探针体对测孔测得值的影响减弱 (见图 1), 因此校准特性得到改善。图 2 例示某分散式五孔针



图 1 探针体的影响

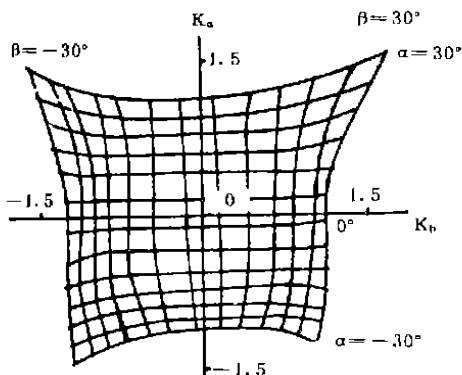


图 2 分散式五孔针的角度特性

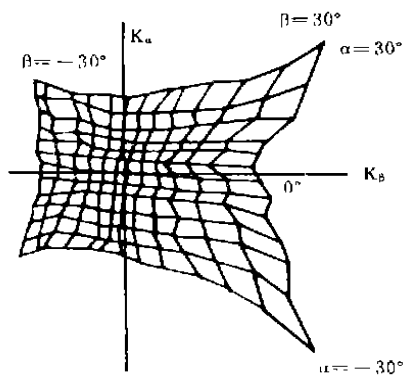


图 3 球形五孔针的角度特性

第一次吹风所得的角度特性, 其中 $K_\alpha = (p^3 - p^1) / [(p^2 - p^1) + (p^2 - p^3)]$, $K_\beta = (p^5 - p^4) / [(p^2 - p^4) + (p^2 - p^5)]$ 。图 3 则是某球形五孔针经几次试吹修制后在同一速度系数下吹风所得的角度特性。可见分散式特性要光滑圆整得多。图 4、图 5 是分散式的总压、速度特性。图 4 中 $K_o = (p_2 - p^*) / [p_2 - (p_1 + p_3 + p_4 + p_5) / 4]$, $K_p = (p_1 - p_3) / [p_2 - (p_1 + p_3 + p_4 + p_5) / 4]$, 图 5 中 $\zeta_s = (1/2) \rho v^2 / (p_2 - p_5)$ 。

采用分散式, 固态传感器就可贴口安装。对于 1、3、4、5 型孔, 只剩下一个三角形小容腔, 见图 6。经激波管实校, 其频响高达 30KHz, 为一般球形针的 7 倍。

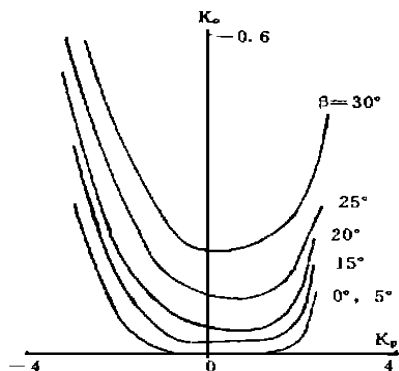


图 4 分散式五孔针的总压特性

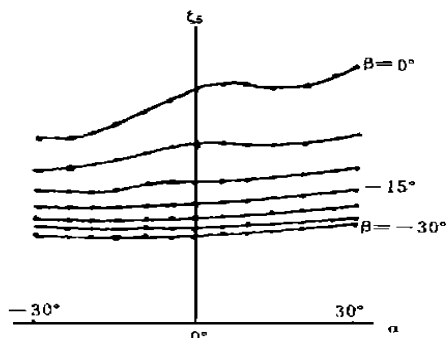


图 5 分散式五孔针的速度特性

分散式的缺点是五个孔虽位于同一半径, 但不位于同一点, 因此需要假定紧挨的五个静

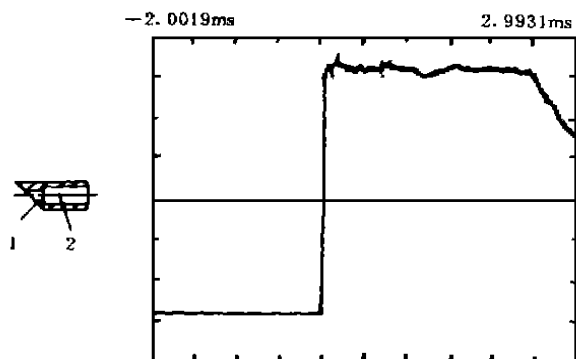


图 6 分散式的容腔与频响 (1. 容腔; 2. 传感器)

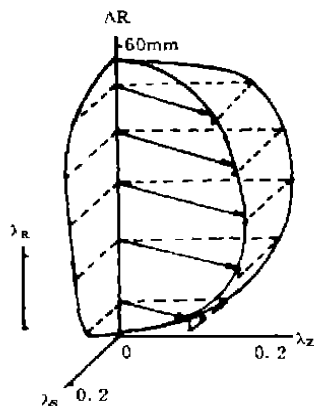


图 7 用分散式五孔针测取的转子后流场

叶区进口流场为轴对称的。不过用球形五孔针时也是假定一定扇形区中流场是轴对称的。图 7 例示用分散式五孔针在我校单级转子后测得的三元流场。实现分散式技术关键是安装定位、校准、数据处理技术、制造工艺。限于篇幅在此不一一赘述。

参 考 文 献

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- [2] M. V. A. Murthy and S. Soundranayagam, “Wall Proximity Effects on the Measuring Accuracy of Wedge Probes”, Proceedings of the Fourth Asian Congress of Fluid Mechanics, Vol. 1, 1989, p50.

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ABSTRACT

An approach, known as Edge Tracking Method, has been developed in particular, which searches out the outer edge and the central spot edge of the coherent image of a particle. The processing procedure of the digital images and its program have been worked out in detail. Finally, the outer size and the central size a particle image are determined by means of the presented technique, then the particle size and its position are calculated by means of the Three-Dimensional Judgement Technique. The results obtained are reasonable.

A DISTRIBUTED FIVE-HOLE PROBE RAKE ON STATOR BLADES FOR ROTOR EXIT MEASUREMENT OF A COMPRESSOR

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ABSTRACT

Each tube of five-holes probe will be placed at the same radius on five different blades of stator. The diameter of the probe and the wall proximity effect are decreased. The distributed five-hole probe rake has been verified experimentally. Its dynamical frequency response is enhanced seven times. Its characteristics are improved. The parameter measurement of each rotor exit in a multistage compressor becomes practicable.

EFFECTS OF ASPECT RATIO ON CASCADE PERFORMANCES

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ABSTRACT

An experimental research of compressor cascade performances has been completed in the conditions of varying aspect ratios (AR). The results show that AR has a significant influence on cascade losses, pressure ratios and blade loads. Furthermore, the correlations of cascade performance parameters with AR, cascade geometric and aerodynamic parameters are derived. The comparative analysis between the calculated results and the experimental data show that the correlation reveals the rules of variation of cascade performance parameters with the aspect ratio.

EFFECT OF ABRUPT INLET DISTORTION ON ENGINE STABILITY

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ABSTRACT

The unsteady response of a compressor to abrupt change of inlet temperature has been calculated by numerical integration with the "actuator-volume" and the second order delay models. The calculated results are compared with flight test data favourably. The unsteady response of the compressor to abrupt change of inlet pressure (or combined with inlet temperature) has also been calculated in the same manner. The calculated results show that the effects of the abrupt inlet pressure on compressor stability cannot be ignored.