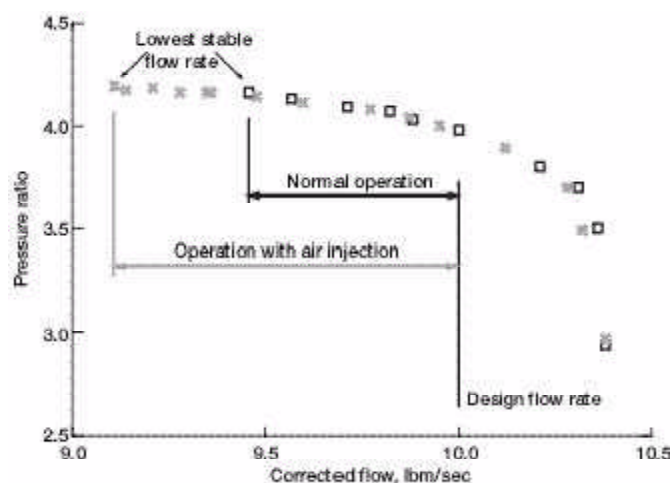


Flow Range of Centrifugal Compressor Being Extended

General Aviation will benefit from turbine engines that are both fuel-efficient and reliable. Current engines fall short of their potential to achieve these attributes. The reason is compressor surge, which is a flow stability problem that develops when the compressor is subjected to conditions that are outside of its operating range. Compressor surge can occur when fuel flow to the engine is increased, temporarily back pressuring the compressor and pushing it past its stability limit, or when the compressor is subjected to inlet flow-field distortions that may occur during takeoff and landing.

Compressor surge can result in the loss of an aircraft. As a result, engine designers include a margin of safety between the operating line of the engine and the stability limit line of the compressor. Unfortunately, the most efficient operating line for the compressor is usually closer to its stability limit line than it is to the line that provides an adequate margin of safety. A wider stable flow range will permit operation along the most efficient operating line of the compressor, improving the specific fuel consumption of the engine and reducing emissions.

The NASA Glenn Research Center is working to extend the stable flow range of the compressor. Significant extension has been achieved in axial compressors (ref. 1) by injecting air upstream of the compressor blade rows. Recently, the technique was successfully applied to a 4:1 pressure ratio centrifugal compressor by injecting streams of air into the diffuser (see the graph). Both steady and controlled unsteady injection were used to inject air through the diffuser shroud surface and extend the range. Future work will evaluate the effect of air injection through the diffuser hub surface and diffuser vanes with the goal of maximizing the range extension while minimizing the amount of injected air that is required.



Stable flow range extension achieved in a 4:1 pressure ratio centrifugal compressor using steady and controlled unsteady air injection.

Reference

1. Suder, Kenneth L, et al.: Compressor Stability Enhancement Using Discrete Tip Injection. The 45th ASME International Gas Turbine & Aero-engine Congress, Exposition and Users Symposium, 2000-GT-0650, 2000.

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