

# Compressor Surge and Stall

A thorough survey and analysis of investigations into instabilities in axial and centrifugal compressors, this book provides a resource for engineers and scientists working in compressor design or wishing to gain an up-to-date understanding of the field. It is suggested for compressor designers and users who appreciate the need for understandable surge lines for a wide range of stall-free, surge-free operation.

## Concept of Compressor Stability

- Introduction
- Definition of Stability
- Operational Stability
- Aerodynamic Stability
- Surge Line Characteristic

## Compressor Stall

- Background
- Axial Compressor Stall
  - Description of Rotating Stall
  - Investigations into Rotating Stall
    - » Progressive Stall
    - » Abrupt Stall
    - » Detailed Axial Compressor Experiments
  - Transient Behavior
  - Flow within Stall Cell
  - Stall Cell Inception
- Centrifugal Compressor Stall
  - Impeller
  - Vaneless Diffuser
  - Vaned Diffuser
- Summary and Closure

### Acknowledgments

### References

### Appendix: Symbols Lists

## Stall Correlations

- Introduction
- Axial Compressors
  - Annulus Blockage
  - Cell Number
  - Cell Propagation Velocity
- Centrifugal Compressors
- Closure

### Acknowledgments & References

## Compressor Surge

- Introduction
- Axial Compressor Surge
- Centrifugal Compressor Surge
- Summary

### Acknowledgments & References

## Multistage Compressors

- Introduction
- Stage Matching
- Multistage Compressor Performance
  - NACA 10-Stage Axial Compressor
  - Effect of Receiver Volume
  - Dynamics of the Surge Cycle
  - Effect of Transients
  - Multistage Interactions

- Interstage Performance
  - Single-Stage Analogy
  - Summary
  - Stage Interaction Study
  - Additional Multistage Axial Compressor Data
    - NACA 15-Stage Axial Compressor
    - NACA 16-Stage Axial Compressor
    - NACA 8-Stage Axial Compressor
    - Commentary
  - Multistage Centrifugal Compressors
- ### Acknowledgments & References

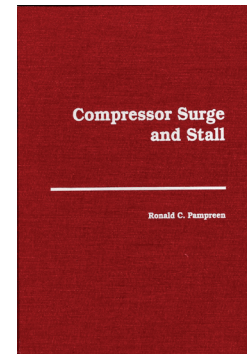
## Surge and Stall Theory

- Introduction
- Cell Propagation Speed
  - Emmons Theory
  - Stenning Theory
    - » Effect of Time Delay
  - Marble Theory
  - Kriebel Theory
  - Sears Theory
  - Fabri and Siestrunk Theory
  - Cumpsty and Greitzer Theory
  - Moore Theory

### Summary

- Emmons, et al. (1955)
  - » Flow Model
  - » Flow Field Assumptions
  - » Mathematical Approach
  - » Commentary
- Stenning, et al. (1955)
  - » Flow Model and Flow Field Assumptions
  - » Mathematical Approach
  - » Commentary
- Marble (1955)
  - » Flow Model and Flow Field Assumptions
  - » Mathematical Approach
- Kriebel (Stenning and Kriebel, 1958; Kriebel, et al., 1958)
  - » Flow Model and Flow Field Assumptions
  - » Mathematical Approach
  - » Commentary
- Sears (1955)
  - » Flow Model and Flow Field Assumptions
  - » Mathematical Approach
  - » Commentary
- Fabri and Siestrunk (1957)
- Cumpsty and Greitzer (1982)
  - » Flow Model and Flow Field Assumptions
  - » Commentary
- Moore (1984)
  - » Flow Model and Flow Field Assumptions
  - » Mathematical Approach
  - » Commentary

### Overall Commentary



## Compressor Surge and Stall

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- System Stability
    - Bullock, Wilcox, and Moses
    - Greitzer
    - McQueen
    - Moore and Greitzer
  - Stall Cell Prediction
  - Stall Inception Prediction
  - Stalled Compressor Performance Prediction
  - Centrifugal Compressor Instability Analyses
    - Vaneless Diffuser Analyses
    - Impeller Analyses
      - » Axial Compressor Stall Inception - Recent Data
      - » Impeller Stall
    - Surge Line Prediction
    - Closure
- ### Acknowledgments & References
- ### Appendix: Symbols Lists

## Methods for Extending Stable Operation

- Introduction
  - Bleed
    - Axial Compressor Bleed
    - Centrifugal Compressor Bleed
  - Variable Inlet Guide Vanes
    - Axial Compressors
    - Centrifugal Compressors
  - Other Approaches
    - Diffuser and Rotor Variations
    - Inlet Blockage
    - Casing Treatment
    - Shock Waves
  - Twin Spooling
  - Closure
- ### Acknowledgments & References

## Bibliography