An Approach Towards Reed Valve Geometry Design

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Outline

- Performance of a compressor
- Compressor losses
- Effect of valves on compressor
- Valve design criteria
- Geometrical design approach
- Results
- Conclusions
Performance of a compressor

Standardized at 32 °C ambient

Affected by system losses

Obtained from calorimeter tests

\[ EER = \frac{\text{Cooling capacity (Btu/hr)}}{\text{Power input (Watts)}} \]
Compressor losses

Thermal
- Pump
- Muffler
- Valves
- Shell

Suction

Discharge

Shell

Pump

Motor

Lube oil

Friction
- Piston-cylinder
- Crankshaft bearing
- Connecting rod - crankshaft
- Oil pumping

Fluid
- Valve
- Piston-cylinder

Electrical
- Motor
- Power electronics
Valve Losses

Effect of valves on compressor performance

P-V map for compressors

- Over-pressure for discharge process
- Discharge Pressure = 10 bar
- Suction Pressure = 1 bar
- Under-pressure for suction process

Valve Operation (ideal)

- Discharge valve
- Suction valve

Valve Operation (Actual)
Valve Design Criteria

- **Stiffness**
  - Dictated by yield strength

- **Impact Velocity**
  - Dictated by Hardness

- **Material**
  - Over Pr. $E$, $bdth.$, $thk.$, $len.$, $k$, $\rho$, $m$, $f$, Yield strength, $\delta$, $\sigma$, Hardness, HV
  - Material Properties
  - Design Parameters
  - Geometry Parameters

- **Root stress**
  - Dictated by yield strength

- **Flow area**
  - Dictates geometry
Reed geometry design: 3-beam model

Assumptions
- Valve → 3 subsections
  - Root
  - Neck
  - Tip
- Tip area same as port area

Validation
- Tip deflection match
Reed geometry design: Results

Geometric properties & stiffness of cases satisfying +/- 5% design mass

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>Stiffness (N/m)</th>
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<tbody>
<tr>
<td>2.8 - 3.0</td>
<td>1000 - 2000</td>
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<table>
<thead>
<tr>
<th>Root Stress (N/m²)</th>
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<tbody>
<tr>
<td>5 x 10³</td>
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<table>
<thead>
<tr>
<th>B₁ (m)</th>
<th>L₁ (m)</th>
<th>B₂ (m)</th>
<th>L₂ (m)</th>
<th>B₃ (m)</th>
<th>L₃ (mm)</th>
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<tbody>
<tr>
<td>4.2</td>
<td>0.01</td>
<td>5.5</td>
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<td>8.6392</td>
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<td>4.86</td>
<td>0.02</td>
<td>15</td>
<td>30</td>
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Fundamental valve shapes for selected Geometric properties
Conclusions

- Designers have multiple geometry options satisfying design criteria
- Design assessment of various geometry options
  - Root stress
  - Deflection limits
- Starting geometry to design for efficient fluid flow
Thank You