FANS GENERAL PRESENTATION
Centrifugal fans and axial fans

Performance Curves

- Pressure, flow rate and absorbed power are the main features of a fan
- Combined together, performance curves can be traced
- The intersection of performance curves and the so-called "resistive circuit" represent the working point
- Performance curves are traced basing on experimental data for a certain speed
- Resistive circuit is evaluated using the formula: \[ \frac{P}{P_w} = \left( \frac{Q}{Q_w} \right)^2 \]
Centrifugal fans and axial fans

Surging zone

• For a centrifugal fan with airfoil blade, the working point has to lie on certain range of the curve, otherwise surging (unstable points) or low efficiency can occur.
Centrifugal fans and axial fans

Application fields

- Different type of fans have different features; it’s impossible to say which one is better
- Axial fans and centrifugal fans have different application field
- Even though overlapping is possible, factor cost has to be evaluated

Comparison between fans with similar absorbed power (10 kW)
Centrifugal fans and axial fans

Application fields

- If we were forced to define different types of fans with only two words, we would said:

<table>
<thead>
<tr>
<th>Centrifugal fans</th>
<th>Medium flow rate</th>
<th>High pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial fans</td>
<td>High flow rate</td>
<td>Low pressure</td>
</tr>
</tbody>
</table>

- In oil & gas field, pressure values can be reached more easily with centrifugal fans; flow rate is not a discriminant. Both of them can always reach the same flow rate but not the same pressure
Centrifugal fans and axial fans

High pressure axial fans

- High pressure axial flow fans can be realized; the fan hub has to be 50 - 70% of the diameter because, otherwise, structural problem can occur. High pressure values and high flow rate values can be reached only with big fans (bigger than centrifugals)

- For their intrinsic characteristics, axial fans are more suitable for application like, for example, wind tunnels or cooling systems
**Centrifugal fans and axial fans**

**Structural limits**

- An axial fan blade can be seen as a one-time blocked beam on which centrifugal force and flow pressure are applied.
Centrifugal fans and axial fans

Structural limits

- A centrifugal fan blade can be seen as a two times blocked beam on which centrifugal force and flow pressure are applied.
Centrifugal fans and axial fans

Regulation limits

- The weak point of axial fans is the regulation. Fine regulation cannot be achieved, even using IGV (inlet guide vane) damper.

- Good results could be achieved using moving blades system; this device is delicate and not affordable and has a relevant cost impact even on small fans.

- A Good regulation can be reached using almost all the type of dampers with centrifugal fans (radial blade dampers, parallel blade dampers, inverter).

- Often, API Standards (American Petroleum Institute) cannot be matched with axial fans. Sleeve bearings cannot be mounted, due to the particular configuration of the fan and due to the fact that sleeve bearing allow a (small) assessment moving in vertical direction; a modification of the tip clearance has a big impact on pressure performance of axial fans (see below).

<table>
<thead>
<tr>
<th>Tip clearance</th>
<th>0.1</th>
<th>0.2</th>
<th>0.25</th>
<th>0.3</th>
<th>0.4</th>
<th>0.6</th>
<th>1.0</th>
<th>% respect diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>114</td>
<td>104</td>
<td>100</td>
<td>97</td>
<td>92</td>
<td>85</td>
<td>75</td>
<td>% respect max value</td>
</tr>
</tbody>
</table>
Centrifugal fans and axial fans
Summarizing – Axial fan weak points

- In general, low pressure machines
- Difficulties on regulation (inefficiency and instability)
- Structural problems in comparison with centrifugal fan
- API requirement cannot be easily matched
Centrifugal fans and axial fans

Centrifugal fans: main features
Centrifugal fans and axial fans

Centrifugal fans: general arrangements

Drive Arrangements for Centrifugal Fans
Reprinted from Publication 99-2404-79 with the express written permission of the Air Movement and Control Association, Inc., 32 W. University Drive, Addison, Illinois, 60101-1885

SW - Single Width
SI - Single Inlet
DW - Double Width
DI - Double Inlet

Arrangements 1, 3, 7 and 8 are also available with bearings mounted on pedestal or base set independent of the fan housing.

For designation of rotation and discharge, see 99-2406.
For motor position, belt or chain drive, see 99-2407.
For designation of position of inlet boxes, see 99-2406.

ARR. 1 SWSI
For belt drive or direct connection. Impeller overhung.
Two bearings on base.

ARR. 2 SWSI
For belt drive or direct connection. Impeller overhung. Bearings in bracket supported by fan housing.

ARR. 3 SWSI
For belt drive or direct connection. One bearing on each side and supported by fan housing.

ARR. 4 SWSI
For direct drive. Impeller overhung on prime mover shaft. No bearings on fan. Prime mover base mounted or integrally directly connected.

ARR. 7 SWSI
For belt drive or direct connection. Arrangement 3 plus base for prime mover.

ARR. 8 SWSI
For belt drive or direct connection. Arrangement 1 plus extended base for prime mover.

ARR. 9 SWSI
For belt drive. Impeller overhung, two bearings, with prime mover outside base.

ARR. 10 SWSI
For belt drive. Impeller overhung, two bearings, with prime mover inside base.
Centrifugal fans and axial fans

Centrifugal fans: common arrangements

- Arrangement 3 (API 560 and 673)
- Arrangement 7 (API 560 and 673)
Centrifugal fans and axial fans

Centrifugal fans: common arrangements

• Arrangement 8

• Arrangement 9
Centrifugal fans and axial fans

Centrifugal fans: common arrangements

- Arrangement 4
- Arrangement 12

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Centrifugal fans and axial fans

Centrifugal fans: blade shape classification

- Airfoil profile
- Medium handled: clean air, very high efficiency
Centrifugal fans and axial fans

Centrifugal fans: blade shape classification

• Flat blades, backward inclined

• Medium handled: clean air, medium efficiency
Centrifugal fans and axial fans

Centrifugal fans: blade shape classification

- Blades backward inclined
- Medium handled: clean air, high efficiency
Centrifugal fans and axial fans
Centrifugal fans: blade shape classification

- Radial tip

- Medium handled: dirty air, low efficiency

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Centrifugal fans and axial fans
Centrifugal fan accessories

Air intake
Coupling
Bearings
Centrifugal fans and axial fans

Centrifugal fan accessories: couplings

- **FLEXIBLE DISCS**
  - **NON LUBRICATED TYPE**
  - **METASTREAM**
  - API 560
  - API 763
  - VSD

- **TAPPERED GRID**
  - Not applicable for API 560
  - API 763
  - VSD

- **STEELFLEX TYPE**
  - **FALK**
  - Not applicable for API 560
  - API 763

- **GEAR TYPE**
  - Not applicable for API 560
  - API 763
Centrifugal fans and axial fans
Centrifugal fan accessories: bearings

<table>
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<tr>
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<th>API 560</th>
<th>API 673</th>
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<tbody>
<tr>
<td>Gas temperature</td>
<td>-</td>
<td>&lt; 200 °C</td>
</tr>
<tr>
<td>Motor power</td>
<td>&lt; 120 kW</td>
<td>&lt; 225 kW</td>
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**RING OIL BEARINGS**

Sometimes a cooling system and a forced lubrication is needed

**OIL SPLASH or GREASE**

Grease lubrication shall not be provided without purchaser’s approval

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Centrifugal fans and axial fans

Centrifugal fan accessories: bearings

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SLEEVE BEARINGS

OIL SPLASH or GREASE

Oil lubricated pillow blocks are indicated for high RPM

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