FAN FUNDAMENTALS
ABOUT SYSTEMAIRE

• Over 25 Years in WA’s HVAC market.
• Local sales team for Fantech fans and attenuation products.
• Engineers with extensive hands-on HVAC project experience.
• Part of the Elta Group, a family of businesses with operations in six countries on four continents which, together with a network of international distributors, provides quality fans and related air movement equipment to customers worldwide.
OVERVIEW

- Fundamentals – what’s important to you?
- Fan types & applications
- Fan selection
- The Fan Laws
- Speed Control
- System Effects
- Case studies
What is important to you?
Power?
Location?
Size?
Cost?
Noise?
The trade-off...
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<tr>
<th>Fan Types</th>
<th>Cost</th>
<th>Volume</th>
<th>Pressure</th>
<th>Sound</th>
<th>Non Overloading</th>
<th>Efficiency</th>
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The fan.
PROPELLOR FANS

Cost: low
Volume: high
Pressure: low
Sound: loud
Efficiency: low

Common uses:
• Transformer rooms
• Switch rooms
• Bin Store, etc.
AXIAL FLOW FANS

Cost: medium
Volume: high
Pressure: medium
Sound: loud
Efficiency: medium

Common uses:
• Just about anything...
CENTRIFUGAL FANS

Cost: **high**
Volume: **medium**
Pressure: **high**
Sound: **low**
Efficiency: **high**

Common uses:
- AHU’s to Kitchen
- Just about Anything!
MIXED FLOW FANS

Cost: medium
Volume: medium
Pressure: medium
Sound: medium
Efficiency: medium

Common uses:
• Outside / Exhaust Air
• Classrooms
• Apartments, etc.
Consider water pouring from a tap into a bucket...
TO CONSIDER...

- Power supply (eg. 415V, 240V, 50Hz)
- Motor enclosure type. (eg. IP55, IP20)
- Gas to be handled. (eg. Paint fumes, Air)
- Where a roof ventilator is required. Is discharge to be vertical or horizontal.
FINDING THE RIGHT FAN

- All = 4344 fans
- Duty (1000l/s @ 150Pa) = 727 fans
- Power (3 phase) = 665 fans
- Mounting (in line) = 71 fans
- Noise = 58 db(A) @3m max = 19 fans
- Compliant? (Yes) = 12 fans (6 safe)
- Cost vs. Safety vs. Size
FAN DUTY

• Require an AP adjustable pitch axial fan.
• Look at 500 diameter, 4 Pole, 10 Blades.
• Need 1800 L/s at 120 Pa Static Pressure.
• 1800 L/s = 1.8 m³/s.
Select a fan to do 1800 L/s @ 120 Pa

1800 L/s = 1.8 m³/s

Fan needs to be set to 25 degrees pitch angle

Next largest motor above 0.52 kW is 0.55 kW. Therefore need a 0.55 kW motor.
SELECTION TIPS

• Keep away from extremities.
• Try to select in the centre of a fan curve when looking at AP fans.
FAN STALL

- When fan stalls, it can’t produce as much lift.
- Therefore the airflow drops dramatically.
- Can create vibration in stall.
- Fan sounds “rough”, may pulse. Tonal sounds can increase.
WE HAVE THE TECHNOLOGY
THE FAN LAWS
FAN (SCALING) LAWS

- Useful for noting the effect of changes in size and speed
- Valid for fans ‘geometrically similar’
- Applies to fans Airflow, Pressure Generated, Power Absorbed and Noise Output
FAN LAW: AIRFLOW

Volume Flow, \( q \propto n \times d^3 \)

Air volume, \( q_{v2} = q_{v1} \times \left( \frac{n_2}{n_1} \right) \times \left( \frac{d_2}{d_1} \right)^3 \)
FAN LAW: PRESSURE

Pressure, \( p \propto e \times n^2 \times d^2 \)

Pressure, \( p_2 = p_1 \times \left( \frac{e_2}{e_1} \right) \times \left( \frac{n_2}{n_1} \right)^2 \times \left( \frac{d_2}{d_1} \right)^2 \)
FAN LAW: ABS. POWER

Absorbed Power, \( P_R \propto \varepsilon \times n^3 \times d^5 \)

Power, \( P_{R2} = P_{R1} \times \left( \frac{\varepsilon_2}{\varepsilon_1} \right) \times \left( \frac{n_2}{n_1} \right)^3 \times \left( \frac{d_2}{d_1} \right)^5 \)
FAN LAW: NOISE

Sound Power Level, \( PWL_2 = PWL_1 + 70 \log_{10} \left( \frac{d_2}{d_1} \right) + 55 \log_{10} \left( \frac{n_2}{n_1} \right) + 20 \log_{10} \left( \frac{e_2}{e_1} \right) \)
FAN SCALING: 10% SPEED +

Airflow

\[
q_{v2} = q_{v1} \times \left( \frac{n_2}{n_1} \right) = q_{v1} \times \left( \frac{1.1}{1.0} \right) = 1.1q_{v1}
\]

Pressure

\[
p_2 = p_1 \times \left( \frac{n_2}{n_1} \right)^2 = p_1 \times \left( \frac{1.1}{1.0} \right)^2 = 1.21p_1
\]

Power

\[
P_{R2} = P_{R1} \times \left( \frac{n_2}{n_1} \right)^3 = P_{R1} \times \left( \frac{1.1}{1.0} \right)^3 = 1.33P_{R1}
\]
For every litre/second of air that is unnecessarily moved through a building, around 2 watts of power are wasted.
Single Phase

**SPEED CONTROL**

Electronic Speed Controller

100% down to approximately 30%

Power consumption is reduced by up to 70%
Three Phase
SPEED CONTROL

Variable Speed Drives
Sinusoidal Filter?
VSD Shielding?
Variable Speed Fans
sensors & controls direct
BMS integration
FANS & SYSTEM EFFECTS
THINK OUTSIDE THE FLANGES
TYPE A
Free inlet
Free outlet

TYPE C
Ducted inlet
Free outlet

TYPE B
Free inlet
Ducted outlet

TYPE D
Ducted inlet
Ducted outlet
FAN NOT PERFORMING?!

• Fan rotation / wiring?
• Receiving uniform air?
• System resistance under estimated?
• System design?
CASE STUDY 1

Tunnel fans
Fan 1 not performing to specification.

- Fan not pulling full Amps
- Fan performance 80% of design
- Fan sounded like it was hunting eg in stall
- Initial diagnoses was uneven air on conditions due to transition pieces
- Damper in front of fans disruption air flow on to blades
CONCLUSION

• While there were installation issues the real problem was the Type arrangement being Type “D” not Type “A”
• Increased blade pitch angle will increase load on motor and satisfy client of performance.
• Air velocities in the tunnel are to spec before pitch change.
CASE STUDY 2

Building the *Education Revolution (BER)* program
Fan did not perform even when new.
Service tech could not find any problem.
Possible fan too small.
Very quiet operation.
Client adamant there was a fan problem.
CONCLUSION

• Install the fan!