“It’s What’s Inside that Counts”
Drive Basics

Adjustable Frequency Drive Description:

- Solid State Device
- Controls the Frequency and Voltage
- Speed Range Depends on the Motor
- HP Range - Fractional to 10,000
Drive Basics

Why Use Adjustable Speed Drives?

- Soft Start Capability
- Allows for Process Changes
- Improves Product Quality
Drive Basics

Adjustable Frequency Drive Definition (AFD):

- An Adjustable Frequency Drive controls an AC motor. It converts the incoming line constant voltage and frequency to an adjustable voltage and frequency. The adjustable voltage and frequency is applied to a squirrel cage induction motor.
Drive Basics

AFD Capabilities:

- Controllable Acceleration
- Controllable Deceleration
- Controllable Speed
- Torque Limiting
- Inrush Current Limiting
Drive Basics

AFD Capabilities (Continued)

- Controlled Jog / Thread
- Electronic Overload
- Programmable Settings
- Output Contacts and Signals
- Multiple Control Methods
Drive Basics

How Do Induction Motors Work With Drives?

- Control of Speed and Torque
- Control of Frequency and Voltage
Drive Basics

Advantages:

- Uses Squirrel Cage Motor
- High Input Power Factor
- Low Operating Cost
- Soft Start and Stop
- Easy to Retrofit
Drive Basics

Advantages (continued):

- Multiple Motor Capability
- Electronic Reversing
- Master Reference Capability
- Closed Loop Capability
- Bypass Capability
Drive Basics

Why Use Adjustable Speed Drives?

- Reduced Energy Consumption
- Improved Process Control / Efficiency
- Increased Product Quality
- Expanded Automation / Integration
- Broader Equipment Flexibility / Versatility
- Increased Reliability / Availability
- Reduced Maintenance
Drive Basics

Typical Adjustable Speed Drive Configuration

Variable speed is used to replace inefficient mechanical regulator devices such as valves, dampers, clutches, etc.
VS Drives  Process Advantages

- Speed vs. mechanical control ⇒
  Increased process efficiency,
  Reduced energy usage,
  Lower operating costs

- Accurate speed regulation ⇒
  Increased flow / volume accuracy,
  Product quality improvement

- Dynamic Speed Response ⇒
  Minimized process disturbances,
  Product quality improvement

- Higher input power factor ⇒
  Lower operating costs
Applications, Types

- Constant Torque
- Constant Horsepower
- Variable Torque

Primary Focus
Applications, **Types**

**Variable Torque Loads**

- Fans
- Centrifugal Pumps
- Centrifugal Blowers
- Mixers (material dependent)
Applications, Types

Variable Torque

- Flow varies linearly with speed.
- Torque requirement varies as the square of speed.
- Power requirement varies as the cube of speed.

Frequency (Hz)

% Flow, % Torque, % Power
Applications, Types

Conventional Flow Control

Bypass

Outlet

Outlet Device
(pumps, fans, and blowers)

Inlet

Suction

To Service

Variable Inlet Guide Vanes
(fans and blowers)

Inlet Vane

Inlet Damper
(fans and blowers)
Applications, **Fans and Blowers**

Outlet Control - Operating Points

- Throttled System Curves
- Operating Points
- Fan Curve
- Design System Curve
Applications, **Fans and Blowers**

Outlet Control - Power Requirement

- **Input Power (% Flow):**
  - 100
  - 80
  - 60
  - 40
  - 20
  - 0

- **Relatively small decrease in power requirement for large decrease in flow**

% Flow:
- 20
- 40
- 60
- 80
- 100
- 120
Applications, **Fans and Blowers**

Variable Speed - Operating Points

- **Design System Curve**
- **Rated Speed Fan Curve**
- **Reduced Speed Fan Curves**

The graph shows the relationship between % Flow and % Pressure for different speed conditions, illustrating how operating points are determined.
Applications, **Fans and Blowers**

**Variable Speed - Power Requirement**

Large decrease in power requirement for relatively small decrease in flow.
Applications, **Fans and Blowers**

**Power Requirement Comparisons**

- Outlet
- Inlet Vane
- Variable Speed

![Graph showing power requirement comparisons with outlet, inlet vane, and variable speed on a graph with % Flow on the x-axis and % Input Power on the y-axis.](image-url)
Applications, Economic Justification

Representative Sample:
- Fan, Variable Speed vs. Damper Control

Three Criteria:
- Energy Usage
- Efficiency Improvement
- Annual Savings
Applications, **Economic Justification**

Base Assumptions:

- Full rated flow = 178,000 CFM @ 3 "H\textsubscript{2}O"
- Fan / blower efficiency = 85%
- Motor efficiency = 94%
- Drive efficiency = 98%
- Rated shaft power = 100 hp
- Cost per kWh = $ 0.10
Applications, Economic Justification

Fan Energy Usage
Variable Speed vs. Damper Control

Energy Usage (MWh)

Flow

- Variable Speed
- Damper

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Product Overview
Applications, Economic Justification

Fan Efficiency Improvement
Variable Speed vs. Damper Control

Efficiency Improvement

Flow

(10%)
Applications, Economic Justification

Fan Annual Savings
Variable Speed vs. Damper Control

<table>
<thead>
<tr>
<th>Flow</th>
<th>Savings</th>
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<tr>
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($5,000)
“It’s What’s Inside that Counts”