Session CT 434
10 Reasons Every Motor Deserves a Drive

Exploring the Benefits of Using a Drive with your AC Motor
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Top 10 Reasons Every Motor Deserves a Drive

1. Reduce Peak Demand
2. Torque Limiting
3. Reduce Mechanical Wear
4. Simplify Mechanics
5. Optimized Torque / Speed
6. Energy Savings (Fan / Pump)
7. Direction Control
8. Process Control
9. Process Data
10. Predictive Maintenance
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1. Reduce Peak Demand

- Reduced Starting Current while Maintaining Torque Output
- No wasted reactive current
- Keep power line from sagging – no light dimming
**$VFD Starting Saves on Peak Demand$$**

- **Squirrel Cage Induction Motors (line started)**
- **Peak Electrical Demand $$$$**
- **Peak Torque Produced**
- **% Current and % Torque**
- **Current**
- **Break down torque (peak Torque)**
- **Rated Torque at rated FLA**
- **Synchronous speed**
- **Base speed**

**VFD Keeps Starting Current at or below this Area . . . Which means You avoid 600% starting Current, thus eliminating Large Peak Demand charges.**
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2. Controlled Starting Torque, Limiting Torque

- Drive torque limited to the level needed for acceleration
- Torque can be further limited to prevent machine damage
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3. Reduce Mechanical Wear

- Less Stress on Bearings, couplings, transmission shafts *(Torque Limits)*
- No dampers or valves to replace or maintain *(Reduce Speed)*
- ATL: 175-225% Torque when start a motor
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4. Simplify Mechanics

- Use Drive to
  - Reduce speed
  - Increase speed
  - Match to load requirements
- Eliminate Gearbox & Pulleys
- Note: Gear box may still be required for torque amplification
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5. Torque or Speed Optimization
Fully Utilizing Motor Capacity

- Ability to run above base speed
  - Paper Dryer
- Can run to max torque and float speed with load
  - Offshore Oil Pump
- SLAT mode (Speed Limited Adjustable Torque)
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6. Energy Savings with Fans & Pumps

- Affinity laws
  - Power is exponentially proportional to flow
  - A small reduction in flow yields a large decrease in power (varies as the cube of speed)
  - Tools to calculate ROI
6. Energy Savings is Critical to HVAC & Pumps

The Affinity Law

- In centrifugal applications such as fans and pumps a reduction in speed translates to a proportional reduction in flow
  - Pressure (head) varies as the square of speed
- A reduction in speed also translates into a reduction in energy
  - Power varies as the cube of speed
- Therefore a flow rate of 50% equates to a power requirement of only 12.5%
Variable Speed Curves

- Dramatic energy savings by reducing speed
- Power varies as the cube of speed
- Reducing the flow by 20% will save you 50% in energy

![Graph showing variable speed curves with pressure, flow, and power percentages]
Pump Formulas

\[ \frac{Q_2}{Q_1} = \frac{N_2}{N_1} \]
\[ \frac{P_2}{P_1} = \left( \frac{N_2}{N_1} \right)^2 \]
\[ \frac{HP_2}{HP_1} = \left( \frac{N_2}{N_1} \right)^3 \]

Where:
- \( N \) = Pump Speed
- \( Q \) = Flow (CFM)
- \( P \) = Pressure (Feet of Head)
- \( HP \) = Horsepower

Water HP

\[ \text{Water HP} = \frac{\text{Flow} \times Q \times \text{TDHead} \times \text{Sp.Gr.}}{3960} \]

Brake HP

\[ \text{Brake HP} = \frac{\text{Flow} \times Q \times \text{TDHead} \times \text{Sp. Gr.}}{3960 \times \text{Pump Efficiency}} \]
Fan Formulas

• Takes advantage of change in fan curve
• Affinity laws where:
  
  \[ \frac{N_2}{N_1} = \frac{Q_2}{Q_1} \quad \frac{P_2}{P_1} = \left( \frac{N_2}{N_1} \right)^2 \quad \frac{HP_2}{HP_1} = \left( \frac{N_2}{N_1} \right)^3 \]
FAN Energy Savings With VFD’s

Outlet Dampers

Inlet Vanes

VFD’s
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7. Direction Control / Flying Start
8. Process Control
9. Process Data
10. Predictive Maintenance
7. Controlled Direction / Stopping / Flying Start

- Direction: No need for reversing contactor
- Flying Start: Will pick up and run with load at any speed (start into a running motor)
  - Example fan idling reverse due to backdraft
  - Centrifuge (long coast time)
- Dynamic Braking
Drives Offer Dynamic Braking

The Laws of physics say energy can never be lost or gained. You need a way to handle the regenerative energy.
Dynamic Braking Regeneration

A typical 460 volt AC drive would provide approximately 680 volts DC on the bus during normal operation. The Dynamic Brake Unit (DBU) or Chopper would not be active until needed.

During regeneration, the control circuits sense a voltage rise on the DC Bus.

When the bus reaches 750 VDC the control circuits turn on the IGBT causing current to flow through the brake resistor.

The current flow through the resistor causes the Regenerated energy to be converted to heat. The DBU remains active until the voltage on the bus drops to 735 VDC.
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- Control Flow for fan or pump
  - PID loop.
  - No PLC Required
- Adjust speed or torque.
- Fixed Precise Accel / Decel Times
- S – Curve for soft start and stop (bottling lines or people movers)
- Full Holding Torque at 0 Speed (Encoder Recommended)
  - Hoist (Torque Proving)
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9. Process Data Feedback

- Information Available from the Drive
  - Speed
  - Current
  - Run Time
  - Bus Voltage
  - Output Frequency
  - Output Voltage
  - Fault Log
  - Torque Output
  - Current Limit
  - Aux Faults
  - Shear Pin
  - Motor Overload / Drive Overload count
  - More
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10. Predictive Maintenance with PowerFlex 750 Series Drives

- PF 755 and 755T can flag upcoming need for maintenance
  - With Network connection.
  - Or using digital output or him display.
    - Grease motor and machine bearings
    - Replace output relays
    - Change DC bus capacitors
    - Replace fan filters
    - Custom configurable items
- Programmable for
  - % Life
  - Warning or Fault
- Proactive / Planned Shutdown / Eliminate Downtime
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Thank You

- Any Questions?