When is it More Efficient to Use Electric Actuators and When Are Pneumatics Better?

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Product Marketing Manager – Electric
Agenda

• Criteria to Consider
  • Pneumatic
    • Performance
    • Costs
    • Best application scenario
  • Electric
    • Performance
    • Costs
    • Best application scenario
• Case Study: Pneumatic Over Electric
• Case Study: Electric Over Pneumatic
• Freebie: Pneumatic versus Electric Cost Calculator
• Power Monitoring:
  • Electronic Power Monitoring Devices
  • DoE Qualified Energy Services Company (ESCO)
• Q&A
Criteria to consider

- Performance advantages and disadvantages
  - Pneumatics Actuators
  - Electric Actuators
- Installation and maintenance costs
- Operating (power) costs
- Productivity gains
  - Reduced Set-up time
  - Increased capacity
  - Labor savings
  - Less Waste
Pneumatic actuator performance characteristics

- High force and speed
- Force and speed are independent and easily adjusted
- Economical to oversize
- Small footprint
- Simple implementation
- Extend and retract only
  - Typically fixed motion processes
- System requirements:
  - Compressor
  - Air lines
  - Fittings
  - Valves
  - Flow Controls
  - Filters
  - Regulators
  - Lubricators
  - Shut-off valve
  - Pressure Gauge
  - Tubing
  - Dryers
  
  ...which limit where it can be deployed
Pneumatic Actuator Costs

• Component costs are low; system costs may vary
  • May be able to take advantage of “sunken costs” (compressor, Air Prep, etc), where electric you have to start from scratch to build system
• Operating costs dominated by compressor power consumption - Electricity (~76%)
  • Efficiency is lower at idle
  • Idling at no load wastes electric power consumption
  • Oversized cylinders and compressors waste money
• Other Equipment and Installation and maintenance costs account for.. (~24%)
• Best scenario for pneumatic:
  • Large scale deployment
  • Efficiently sized compressor
  • Sunken investment costs already exist
  • No labor savings or production downtime savings are achievable

Typical Lifetime Compressed Air Costs in Perspective*

- Electricity (76%)
- Maintenance (12%)
- Equipment & Installation (12%)

*- Source: DOE/GO-102000-0986 December 2000 Compressed Air Tip Sheet #1
Electric actuator performance characteristics

- **Advantages to Electric:**
  - Precise control and positioning
  - Adapt machines to flexible processes
    - Flexible
    - Scalable
    - Adaptability
    - Repeatable
  - “Portable” – install anywhere electric power is available
  - Quiet, smooth and repeatable
  - Networking and Communication available
    - Predictive Maintenance
    - Preventive Maintenance
    - Diagnostics
    - Management Visibility
- **Points to Consider:**
  - More complex to implement
    - More flexibility and control leads to more complex implementation
  - Accurate sizing is critical
    - Over sizing is expensive
    - Under sized actuators will not perform
    - Force and speed limits are locked in by design
  - Trade speed for thrust and thrust for speed
Electric Actuator Costs

- High unit cost ~ $300 - $2000 or more depending on design and electronics
  - Stepper motor and/or Drive
  - Stepper motor with encoder
  - Servo motor & Drive
- High replacement cost
  - Modular designs help minimize replacement costs
  - Mechanical wear parts – 3 year life
  - Electrical components – 5 to 10 year life
- Low power consumption
- Flexibility can yield cost savings
  - Reduce costly set-up time & change over time
  - Not automatic – needs to be designed in
- Best scenario
  - Smaller scale deployment
  - Effects process improvements or cost savings through automation
Efficiency Example – Electric/Manual/Pneumatic Guide rail

✓ This example moved customer from manual to electric solution
✓ Customer considered 3-position Position Pneumatic but preferred multiple position solution
✓ Customer considered PFC but price approached electric costs and requires need for PLC

Conveyor Guide Rail Adjust System

- OEM is providing new 100 ft. conveyor system to F&B customer
  - Customer spent 30 minutes each morning adjusting rail system
  - Two technicians at a cost of $65/hr. make necessary adjustments
  - Manual rail adjustments are difficult to precisely align
  - Often two or more variations of product are processed each day

- Customer cost under current system include...
  - Min. $130/day labor
  - 260 work days/yr. → $33.8K labor cost
  - 25% of days 2 products are processed → Additional $8.5K cost
  - $8.5K additional cost for multiple part runs
  - Cost of downtime while adjustments are made → $1K/day
  - Annual downtime cost → $260K annually

- Solution Savings
  - 70 pcs. Actuator (w/ motor/drive) @ $900 → $63K
  - ROI = 3 months!
Pneumatic or electric actuators? Electricity Costs

Cost Calculator will use Kilo-watt-hour (kWh) in its calculations.

What is a Kilo-watt-hour (kWh)? Electric Utility charges by the kWh. Wattage x hours Used / 1000 x price per kWh = Cost of Electricity

For example, let's say you leave a 100-watt bulb running continuously (730 hours a month), and you're paying 15¢/kWh. Your cost to run the bulb all month is 100 x 730 ÷ 1000 x 15¢ = $10.95.

• Average retail price: 12 cents per kilowatt-hour (kWh)*
  • Residential: 12¢ per kWh
  • Transportation: 10.7¢ per kWh
  • Commercial: 10.4¢ per kWh
  • Industrial: 6.8¢ per kWh
• Highest average price of electricity:
  • Hawaii (36¢ per kWh)
  • Connecticut (16.95¢ per kWh)
  • New York (16.74¢ per kWh)
• Lowest average price:
  • West Virginia (5.59¢ per kWh)
  • Wyoming (5.68¢ per kWh)
  • Idaho (5.70¢ per kWh)

* Source: http://www.eia.gov/totalenergy/data/annual/index.cfm
### Table 5.3. Average Retail Price of Electricity to Ultimate Customers:

Total by End-Use Sector, 2002-August 2012 (Cents per Kilowatthour)

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<thead>
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<th>Period</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Transportation</th>
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Sources: US Energy Information Administration (eia) Electric Power Monthly with Data for August 2012, October 2012
Compressor Sizing Calculations

Inputs:
- Average bore size
- Average stroke length
- Average time for stroke
- Number of cylinders
- % of cylinders that actuate simultaneously

Output:
- CFM required
- Find compressor HP using the CFM number and the manufacturer’s specifications
Bimba now features a Pneumatic versus Electric Actuator cost evaluation spreadsheet, which is available for download from bimba.com. This spreadsheet allows a person to estimate pneumatic and electric costs, facilitating a comparison and selecting the correct actuator depending upon the application.

Let's have a look at the calculator and conduct some calculations to demonstrate the value of reviewing costs in advance of making a decision. And then let’s manipulate some of the numbers.

![Cost Evaluation Calculator](attachment:image.png)

<table>
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<tr>
<th>Description</th>
<th>Value</th>
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<td>Annual kWh Cost</td>
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<td>Annual Load</td>
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<td>Annual kWh</td>
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<td>Annual Replacement Cost</td>
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<td>Total Annual Pneumatic System Cost</td>
<td>$44,737</td>
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<tr>
<td>Cost per Pneumatic Device per Year</td>
<td>$298</td>
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Pneumatic or electric actuators?

Case study

Pneumatic solution

- 200 HP compressor
  - 2000 hours per year at full load, 93% efficiency ($0.10/kWh)
  - When not in use it is off
- 150 pneumatic actuators deployed
  - Average unit cost: $50
  - Life expectancy: 3 years

Electric solution

- 150 electric actuators deployed
  - All-in-one design: includes drive and controller but not DC power supply
  - Average unit cost: $1200
  - Life expectancy: 3 years
- Actuator draws 6A fully loaded at 48 VDC; fully loaded 30% of the time
- Actuator draws 3A at 48 VDC 70% of the time
- Power supplies draw 6A at 120 VAC fully loaded, producing 9A at 48 VDC
Case study Pneumatics over Electrics

- **Pneumatic solution**
  - Annual cost of compressed air: $42,237
  - **Replacement cost of actuators:** $2,500 per year
  - Total annual cost: $44,737
  - Total annual cost per actuator: $298

- **Electric solution**
  - Annual cost at full load: $4,320
  - **Annual cost at idle:** $5,040
  - Annual operating cost: $9,360
  - **Replacement cost of actuators:** $60,000 per year
  - Total annual cost: $69,360
  - Total annual cost per actuator: $462
Case study
Pneumatics over Electrics

Pneumatic Costs

Electric Costs
Electrics over Pneumatics

- **Pneumatic solution**
  - 100 HP compressor
    - 2000 hours per year at full load, 90% efficiency ($0.10/kWh)
    - When not in use it is idling at 25% power and 85% efficiency
  - 20 pneumatic actuators deployed
    - Average unit cost: $50
    - Life expectancy: 3 years

- **Electric solution**
  - 20 electric actuators deployed
    - Modular: Motor/actuator and separate controllers
    - Average unit cost: $900 for actuator and $1200 for electronics
    - Life expectancy: 3 years for actuators, 10 years for electronics
  - Actuator draws 6A fully loaded at 48 VDC; fully loaded 30% of the time
  - Actuator draws 3A at 48 VDC 70% of the time
  - Power supplies draws 6A at 120 VAC fully loaded, producing 9A at 48 VDC
  - Process improvement: Automates a line change
    - Saves 2 hours every week for 2 employees at $30/hr each
    - Saves 2 hours of lost production: 100 products/hr, $1 per product
Electrics over Pneumatics

- Pneumatic solution
  - Annual cost of compressed air: $21,882 full load
  - Annual cost of compressed air: $19,351 at 25% power
  - Replacement cost of actuators: $333 per year
  - Total annual cost: $41,506
  - Total annual cost per actuator: $2,075

- Electric solution
  - Annual cost at full load: $576
  - Annual cost at idle: $672
  - Annual operating cost: $1,248
  - Replacement cost of electronics: $2,400 per year
  - Replacement cost of actuators: $6,000 per year
  - Total annual cost: $9,648

- Savings, changeover labor: $6,240
- Savings, lost production: $10,400
- Net results of deployment: $6,992 COST REDUCTION!
Case study
Electrics over Pneumatics

![Graph showing Pneumatic Costs and Electric Costs]
Power Monitoring

• If you can measure it, you can manage it
• Electronic Tool to help monitor, reduce and save energy and cost.
  • Measures actual operating parameters; V, I, Power Factor, real power, Active Power, reactive power, energy consumption (kWh), freq. (Hz.)
  • Facilitates awarenesss via cumulative readings with graphing, trending, etc
  • Can be used to help identify air leaks
• Offers visual about how much a compressor contributes to overall utility costs
  • Motivates you to decrease consumption → use less energy
  • Motivates you to use energy at “lower-cost” times of day
  • Can help avoid peak cost charges
  • Allows one to compare energy costs to baseline or projected costs
• Supports energy audits and leads to energy cost savings $ improvements
• Reduces carbon footprint → Supports Green initiatives.
What is an ESCO? Energy Service Company, develops, installs, and arranges projects designed to improve the energy efficiency and maintenance costs for facilities over a time period.

- develop, design, implement energy efficiency projects;
- install and maintain the energy efficient equipment involved;
- measure, monitor, and verify the project's energy savings; and
- assume the risk that the project will save the amount of energy guaranteed.

What does an ESCO offer?

- Energy saving measures…Education, HE Lighting, HF HVAC, eff. Motors, VSD
- Measure and verify rather than estimate
- Economic Benefits via energy cost savings
- Often costly retrofits cost savings are tied to debt payments

Organizations offering ESCO?

- Siemens
- Eaton
- Honeywell
Conclusions

• Many costs must be considered when selecting actuators
  • Initial Electric Cost can be misleading
  • Hidden energy costs of pneumatics can quite high
• Adequate Pneumatic sizing can help control energy costs
  • Shut down during non operating time can help
  • Smaller Compressor
• Electric Actuator costs can help be minimized by performing an appropriate sizing evaluation
• Performance advantages should be included to quantify savings
• A thorough upfront estimated assessment can produce considerable energy savings → Energy Calculator
• Power monitoring can offer a live real energy use assessment
• ESCO companies can offer services to help an organization complete detailed assessments, and suggested improvements including retrofitting existing equipment
Questions
Thank you for attending!

Bimba.com
800-44-Bimba