Electric Rod Actuators vs. Hydraulic Cylinders

Which is best for your application?

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Director of Marketing

Tolomatic

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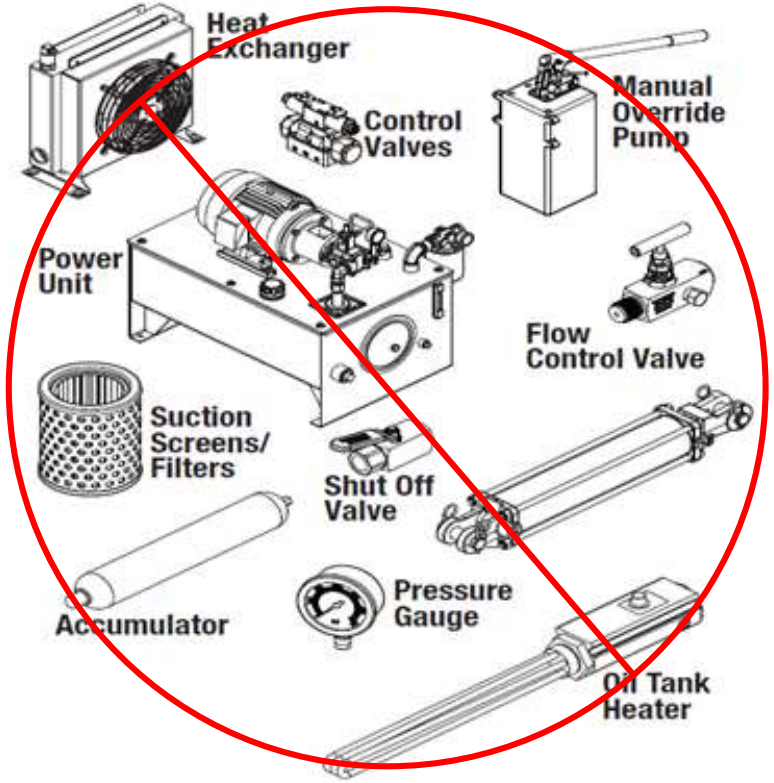
Agenda: Electric vs. Hydraulic Cylinders

- Electric Value Proposition vs. Hydraulic
- Total Cost of Ownership
- Motion Control Capabilities
- System Footprint & Components
- Force & Speed Capabilities
- Hot & Cold Temperature Operation
- Service Life & Maintenance
- Data Collection
- Efficiency & Electric Utility Costs
- Environment, Contamination & Leaks
- Tolomatic Overview
- Questions

Value Proposition: Electric vs. Hydraulic

Hydraulic Cylinder Systems



Electric Actuator Systems

- Precise position, speed, acceleration, and force control
- Infinite positioning flexibility
- Superior accuracy & repeatability
- Elimination of multiple components
- No risk of contamination
- No messy / costly leaks
- Energy efficient / “green” operation
- No or little maintenance
- Quiet operation
- Hot & Cold weather operation

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Interesting Hydraulic Facts

“Energy put into a hydraulic system comes out as work or **loss in the form of heat**”

“the system efficiency of the pressure compensated pump is approximately 25 percent while the fixed pump with load sensing achieves about 44 percent efficiency.”

“many leaks identified in hydraulic systems are left to drip away the profits of a company - profits lost with unnecessary energy consumption, reduced equipment performance, decreased reliability, increased fluid costs, increased housekeeping costs, etc.”

Source 1: *Press Master—Manufacturer of hydraulic presses—12 Fascintating Facts About Hydraulics*

Source 2: *Design Engineering article—Maximizing Hydraulic Efficiency*

Source 3: *Machinery Lubriciation—Detecting and Managing Hydraulic Systems Leakage*

Total Cost Of Ownership (TCO)

TCO = Initial Purchase Cost +

Years of Service * Yearly costs of operation (YCO)

YCO = electric utility costs +

maintenance costs +

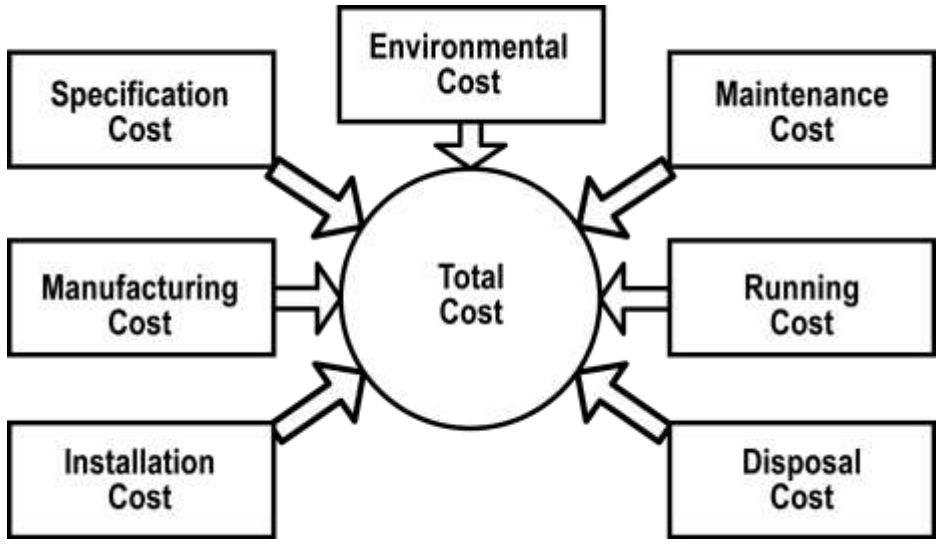
replacement costs +

manufactured product scrap / yield +

clean-up costs

Why do so many companies not consider yearly costs of operation (YCO) in their capital equipment purchases?

Lowest Total Cost of Ownership for Your Customers!



+**Lower Energy Costs!**
+**Increased Flexibility!**
+**Increased Production!**
+**Better Process Control (lower product waste)**
+**Increased Product Quality!**
+**Lower Maintenance Costs!**
+**Shorter Changeover Time!**
+**No environmental issues!**
+**Faster ROI**
=**<u>Increased Customer Profits</u>**

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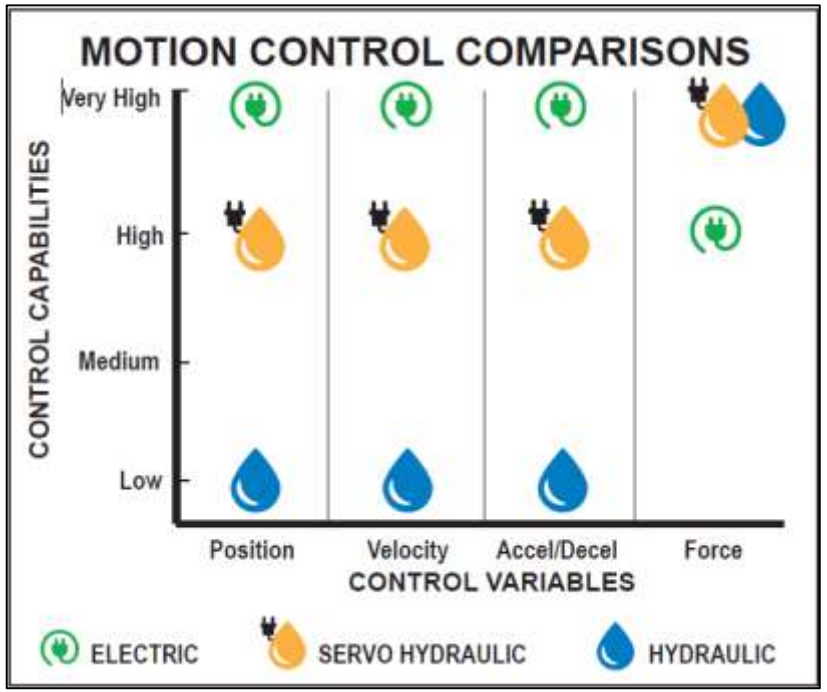
Motion Control Capabilities

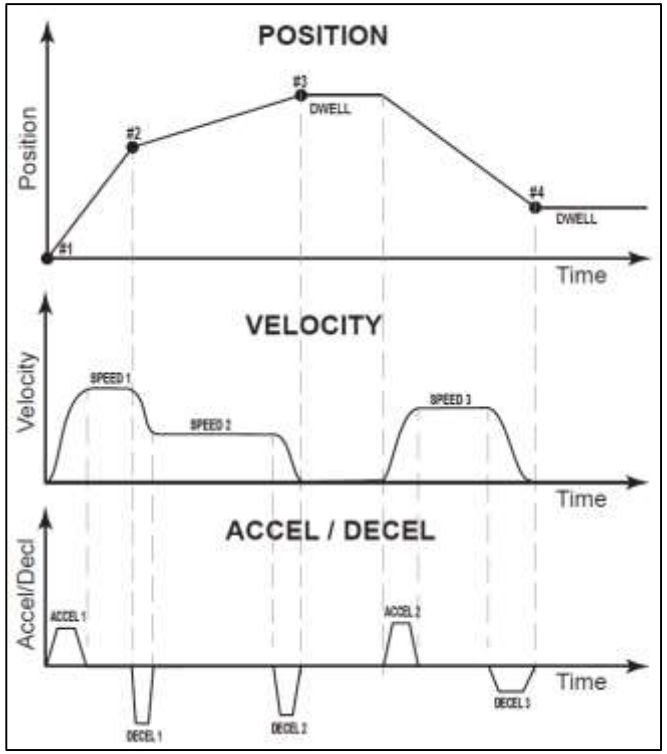
Hydraulic Cylinder System

- Limited motion control capabilities
- Require Servo-Hydraulic system to achieve better motion control capabilities
  - Adds Cost & Complexity



Electric Actuator System

- Full control over Position, Velocity, Accel / Decel & Current



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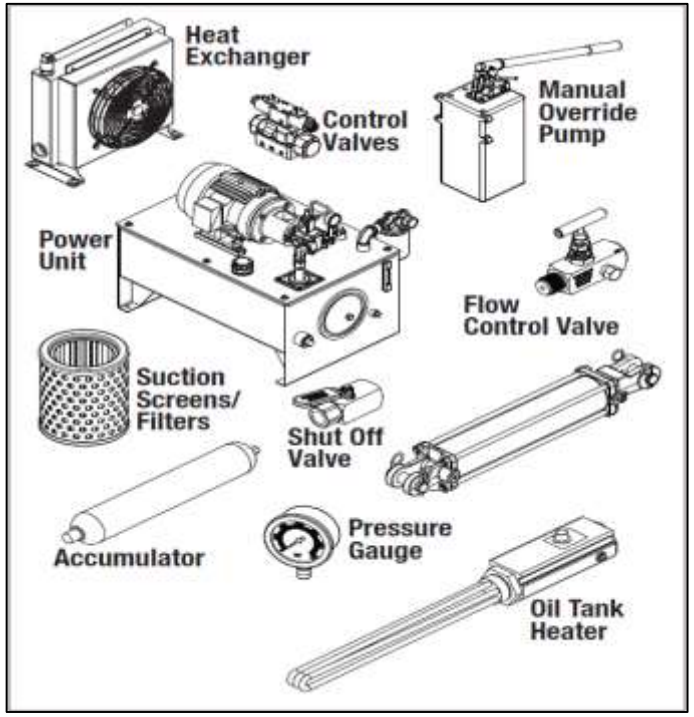
System Components & Overall Footprint

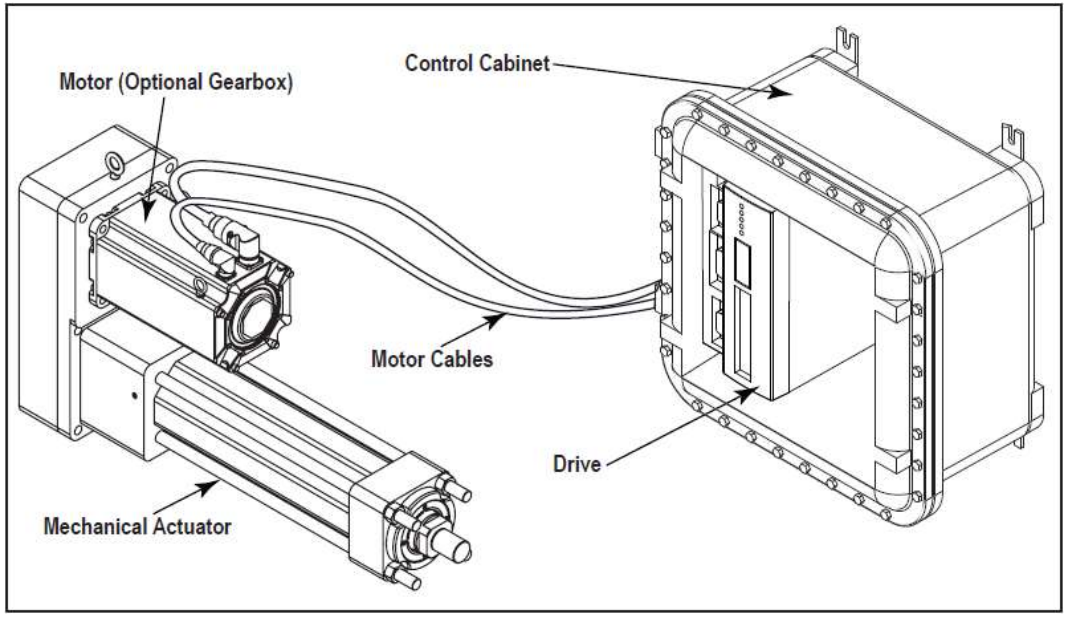
Hydraulic Cylinder System

- Smaller cylinder size
- Larger overall system footprint
- More components to purchase / maintain



Electric Actuator System

- Longer electric actuator
- Smaller overall footprint
- Fewer components & simplified installation



Force Capabilities

Hydraulic Cylinder System

- Force = pressure x area
- High force density per cylinder size
- Pressure fluctuations affects repeatability
- Requires constant pressure (stored energy)

Electric Actuator System

- Force = current in servo motor (torque)
- Medium force density per cylinder size
- Current control = very repeatable
- Instantaneous electric current (On demand)

Velocity (speed) Capabilities

Hydraulic Cylinder System

- Factor of volume of pressurized oil volume in system → accumulators
- Multiple cylinders on one system can create problems or limitations with high speed simultaneous moves → pressurized oil starvation
- Possible issues with banging end of stroke at higher speeds (uncontrolled decel)
- Without Servo-Hydraulic controls, accumulators store excess energy (force x velocity) in an open loop system which is highly inefficient.

Electric Actuator System

- Factor of screw lead & motor RPM / torque
- Precise control of speed and deceleration gives smooth, non-violent motion in system
- Combination of higher speeds and higher forces can require much larger electric actuator than thought which leads to higher system costs

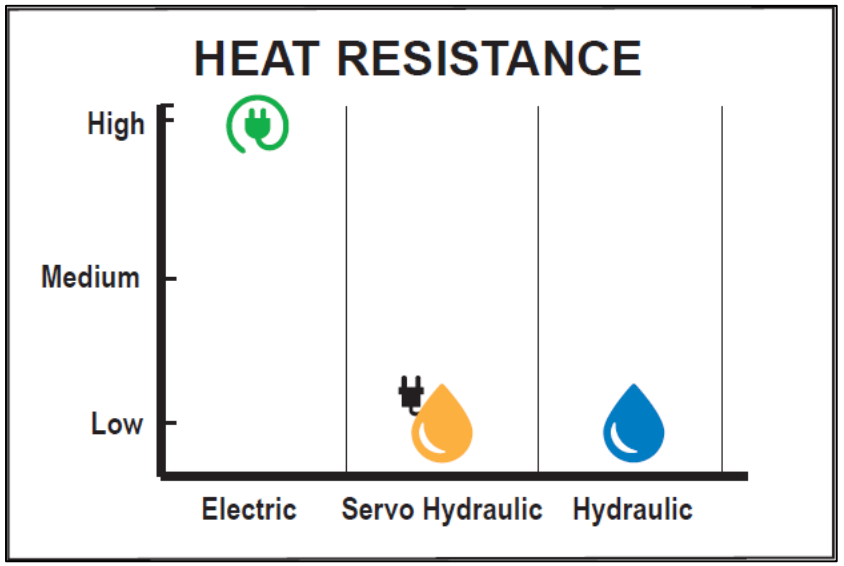
Temperature (Heat)

Hydraulic Cylinder System

- Heat → Major hydraulic problem
  - Inefficiencies cause heat / overheating
  - Damages seals
  - Degrades oil
  - Add reservoir & heat exchanger
  - Requires constant attention / maintenance

Electric Actuator System

- Higher efficient electric systems have much less problems with heat → properly sized
  - High / low temp grease
  - Limits continuous force limits of servo motors



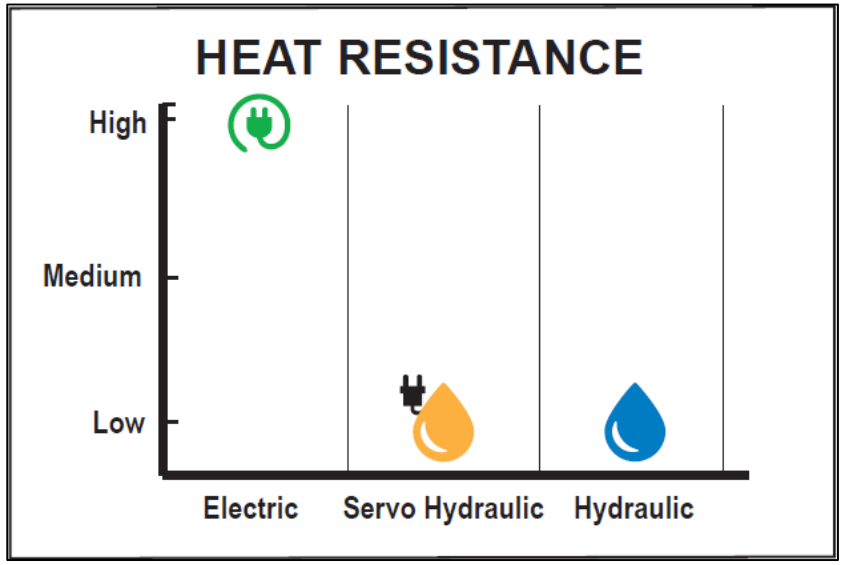
Temperature (Cold)

Hydraulic Cylinder System

- Sluggish operation
- Inconsistent operation (repeatability)
- Hot to cold cycles damage rod seals
- Add oil tank heaters

Electric Actuator System

- Quick, effective cold weather starts
- High / low temp grease
- Slight performance (repeatability) difference from cold to warm/hot temperatures



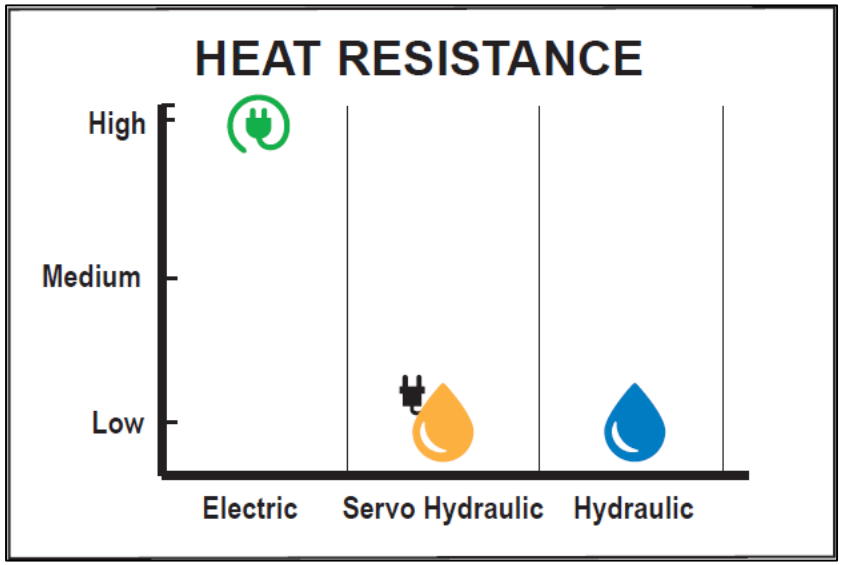
Service Life & Maintenance

Hydraulic Cylinder System

- Long service life → frequent maintenance
- Seal integrity (rod / piston)
  - Pressure fluctuations → force
  - “blow by” → speed
- Oil change → fluids & filters
- Neglecting maintenance → contamination, leaks and component failure

Electric Actuator System

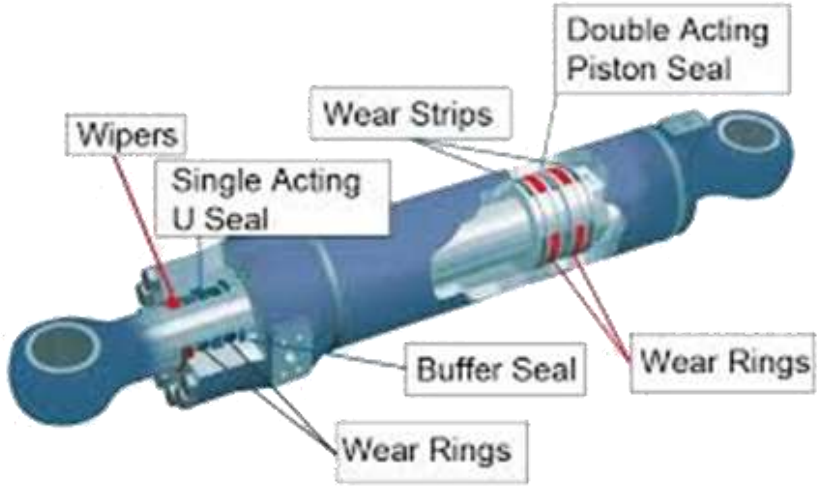
- Sized for life of application
  - L10 calculation
  - Dynamic Load Rating (DLR) of power screw
- Greased for life
- Seal integrity (rod)
  - Only for IP rating / not for performance



Service Life & Maintenance: Hydraulic Seal Integrity

Tight seals required for proper operation

- Force output
- Speed output
- Responsiveness
- Consistent, repeatable operation
- Oil Leaks 



Service Life & Maintenance: Hydraulic Maintenance $

Maintenance **Labor** Costs

- Regulator adjustment (force/pressure) & Flow control adjustment (speed)
  - Both adjustments factor into cylinder responsiveness & repeatable operation

How does this affect product quality?

How does this affect uptime / downtime?

- Continual operator & maintenance labor hours adjusting equipment to get proper, consistent cylinder operation
  - Compensates for system variations – (temp, oil quality, component wear)
  - This labor adds to the total cost of machine operation

How much does this labor cost?

Is this labor cost really considered?

Service Life & Maintenance: Hydraulic Replacement $

Maintenance **Labor** Costs

- Replacement Scheduling & Labor

How much does this really cost?

Is this cost really considered?

- Continual operator & maintenance labor hours adjusting equipment to get proper, consistent cylinder operation
  - Compensates for system variations – (temp, oil quality, component wear)
  - This labor adds to the total cost of machine operation

What does this cost?

Is this cost considered?

Service Life & Maintenance: Manufacturing Scrap / Yield

- Seals wear → Consistent, repeatable operation
  → Process control →Manufacturing Yield Suffers

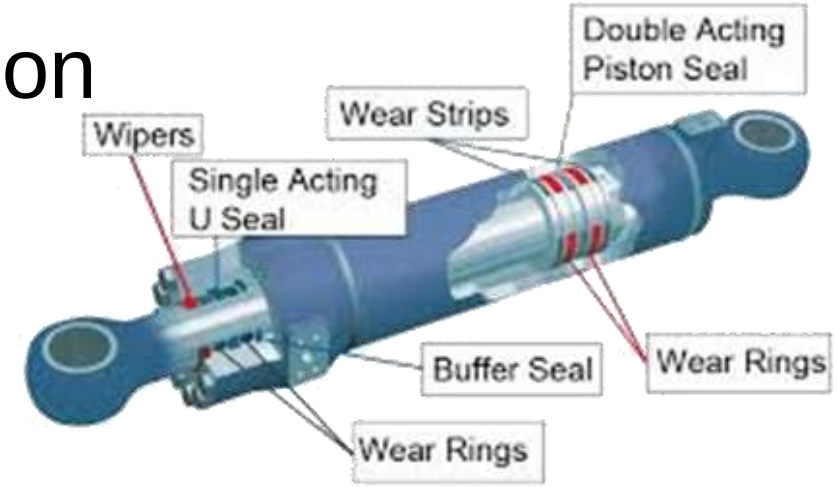
What is the cost of identifying scrap & removing it?

How much does it cost to produce product that must be scrapped?

Service Life & Maintenance: Electric Cylinder Maintenance

Sized for life of application

No seal replacement

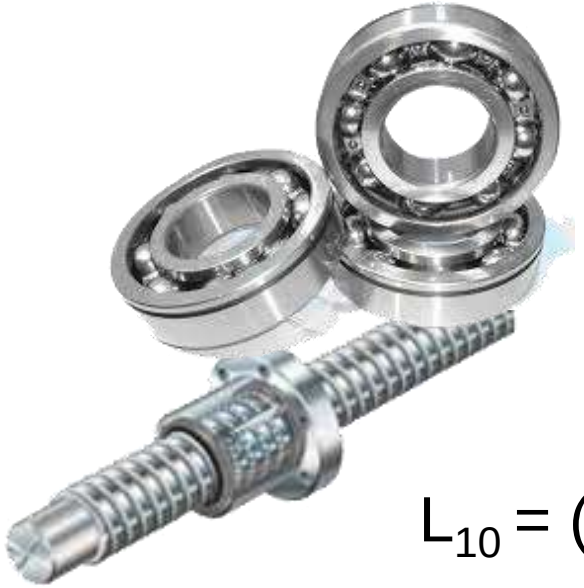


Lubricated for life

Consistent, repeatable operation

Service Life & Maintenance: Electric Replacement Costs

L10 life estimation



Labor & Hardware

$L_{10} = (C/P)^3$ (ball screws / bearings)

L_{10} = basic rating life in millions of revolutions with 10% failure probability (90% reliability).

C = dynamic load rating

P = equivalent bearing load

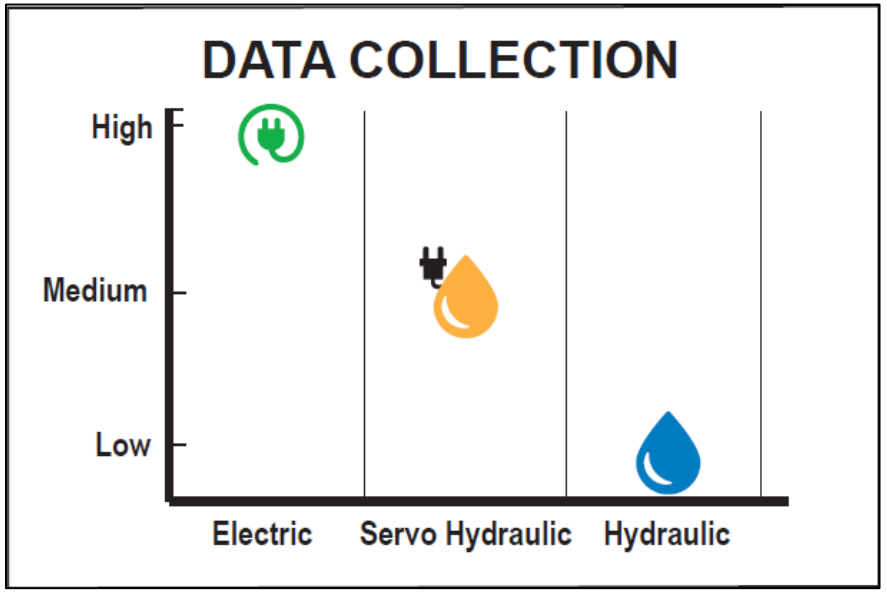
Data Collection

Hydraulic Cylinder System

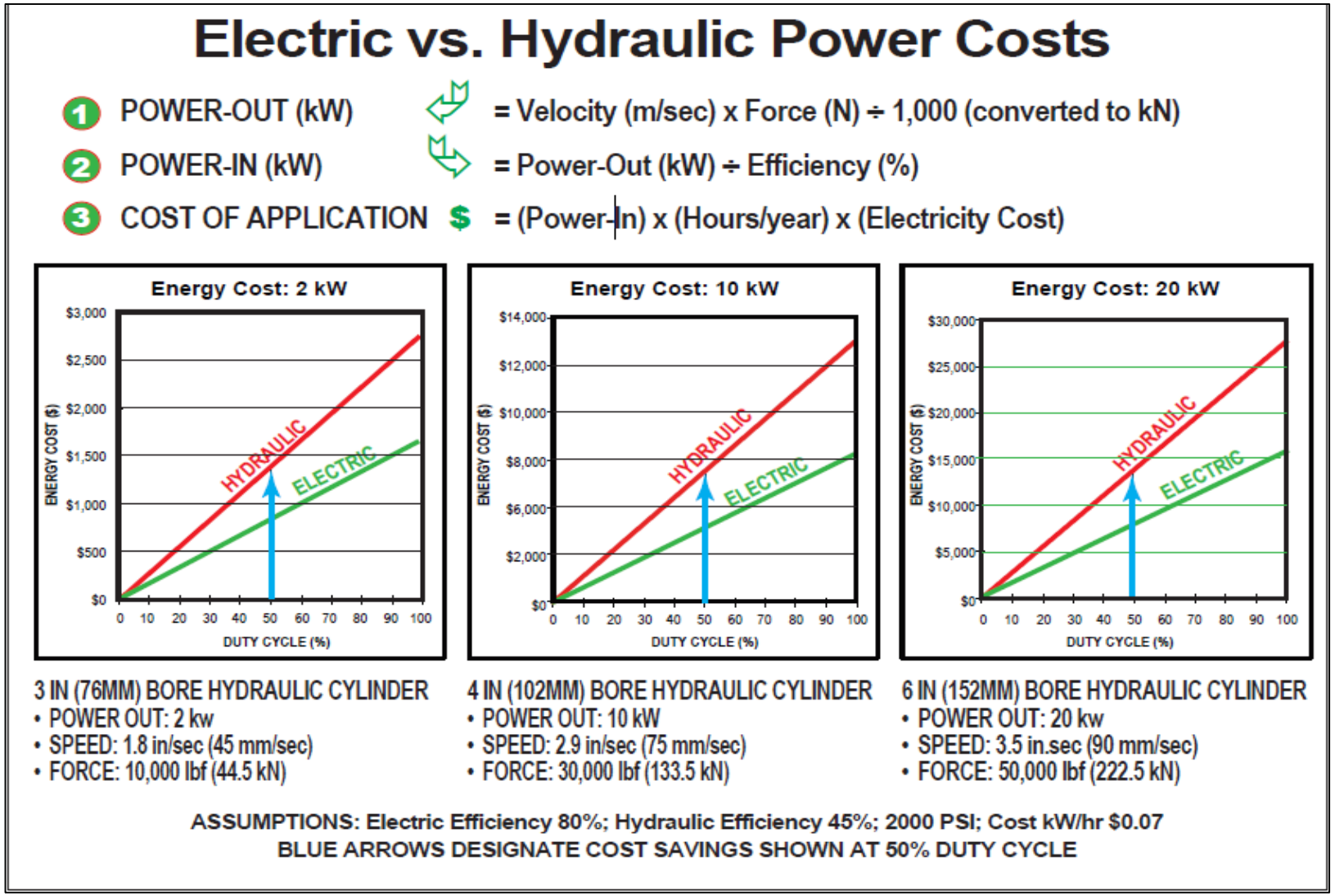
- Requires expensive Servo-Hydraulic system with additional sensors
- More complex system, with more components → higher probability of system issues

Electric Actuator System

- Built into electric actuator system
- Electric current → force
- Encoder / Feedback → Position, velocity, accel / decel



Efficiency and Electric Utility Costs



- Simple Estimation
- Assumptions
  - Electric Eff. 80%
  - Hydraulic Eff. 45%
  - 2000 PSI (138 bar)
  - Cost kW/hr: $0.07
- → 50% duty cycle

Environmental, Contamination & Oil Leak Concerns

National Oceanic and Atmospheric Administration (NOAA), more than 700 million gal (2.65 billion liters!) of petroleum products enter the environment each year. Around half of this volume comes from irresponsible and illegal disposal. Hydraulics' contribution is about 98 million gal (370 million liters).*

"Its not a matter of IF but WHEN that a hydraulic system will leak"

*Source 1: *From Hydraulics & Pneumatics, Eliminate those Hydraulic Oil Leaks, February 2015*

Source 2: *Tolomatic Hydraulic Distributor*

Shock Loads & Side Loading

Hydraulic Cylinder System

SHOCK LOADS

- Handle shock loads better as it is a fluid power system.

SIDE LOADING

- Side loading will prematurely wear the piston seal and may cause cylinder failure / blow-by.
- Side loading may also prematurely wear the front bushing / seal which will cause leaks / degrade performance and allow external water / particulate to enter the actuator.

Electric Actuator System

SHOCK LOADS

- Power screws like roller screws can help better withstand shocks vs. ball screws

SIDE LOADING

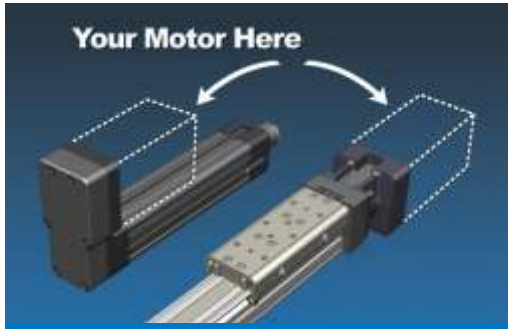
- Side loading will diminish life of any ball screw or roller screw.
- Side loading may also prematurely wear the front bushing / seal and invalidate the IP rating

The Tolomatic Difference!

Innovative products

Fast delivery

Sizing Software



Your Motor Here

Online CAD

Excellent customer service

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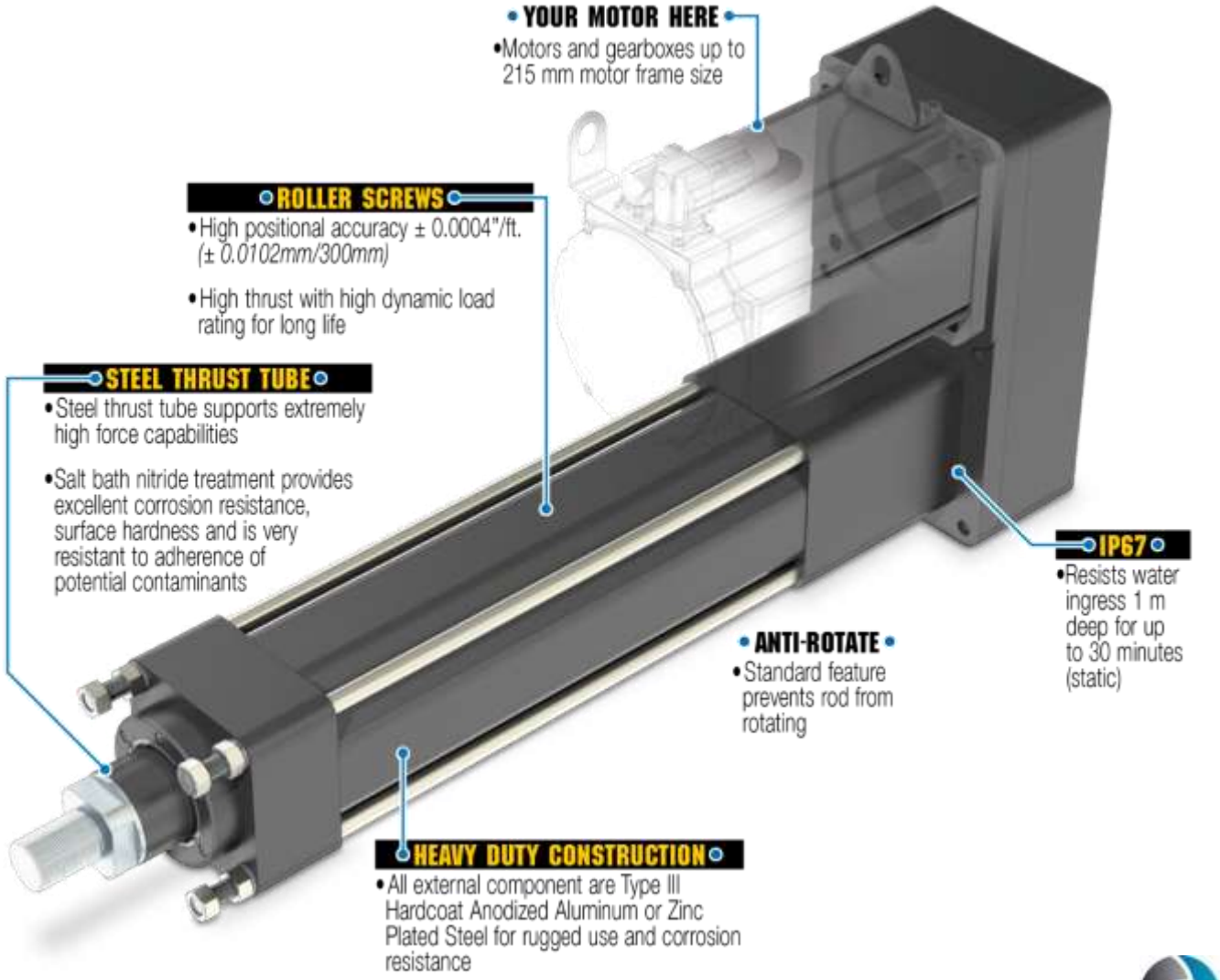
Extreme Force, Hydraulic-Class Electric Actuator: RSX096

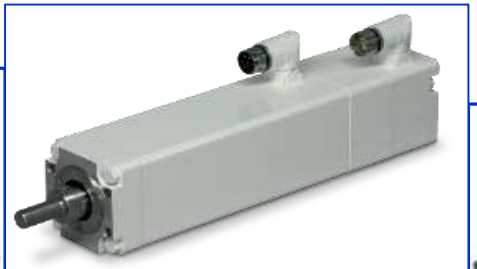


Widest Range of Industrial Electric Rod Actuators

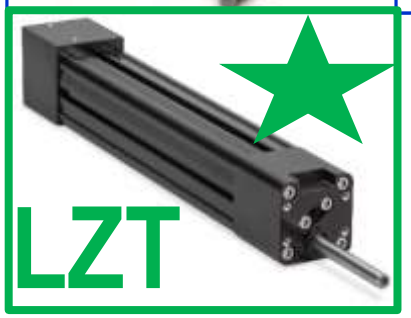
ERD

ERD Hygienic

IMA & ServoWeld



RSA & GSA



50 lbf

& everything in between

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