



A HYBRID PNEUMATIC DRIVELINE FOR HEAVY DUTY VEHICLES

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Harris Proprietary

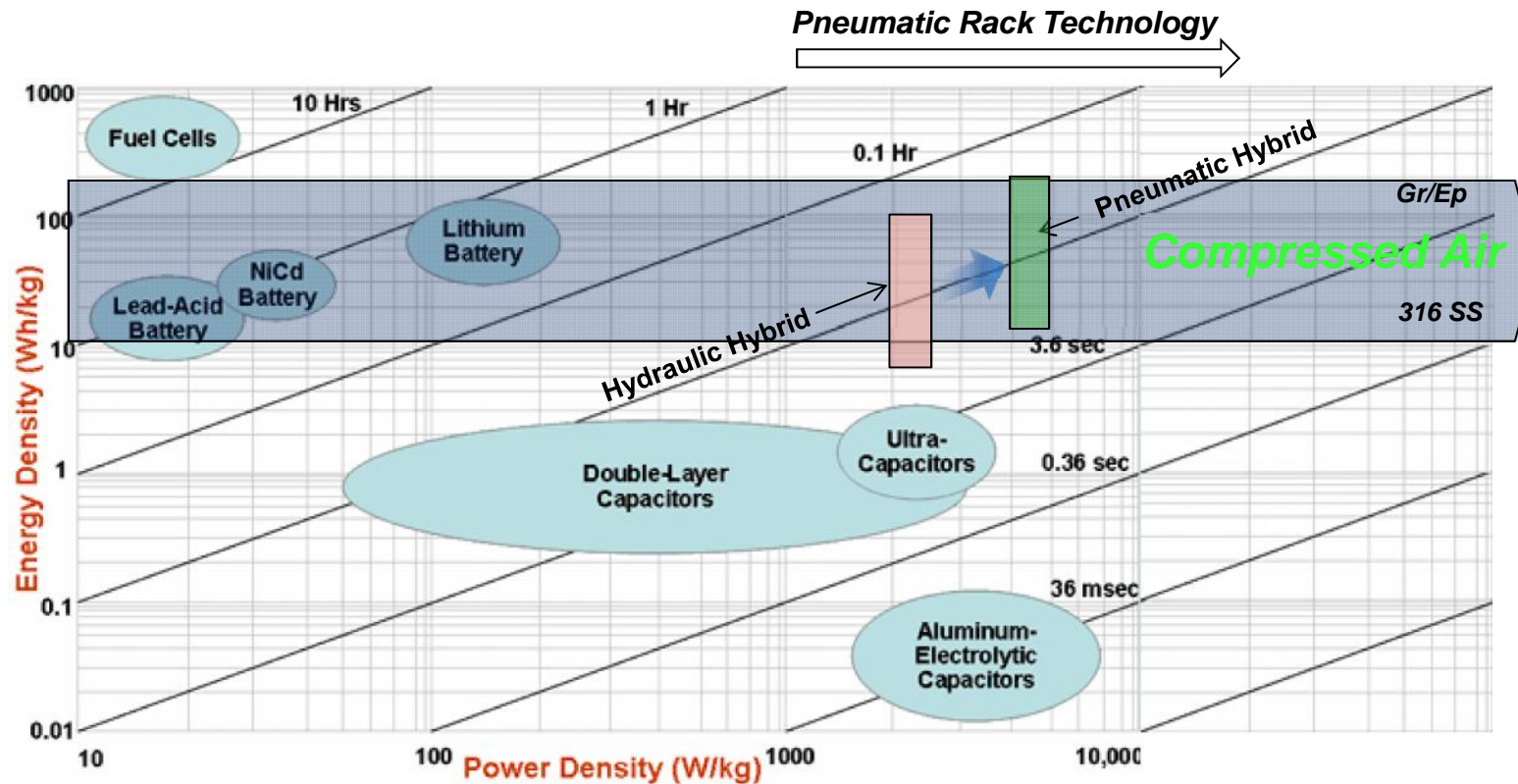
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Hybrid Pneumatic | 1

Why Pneumatics?



Technology Comparison: Power Density vs Energy Density



Source US Defence Logistics Agency

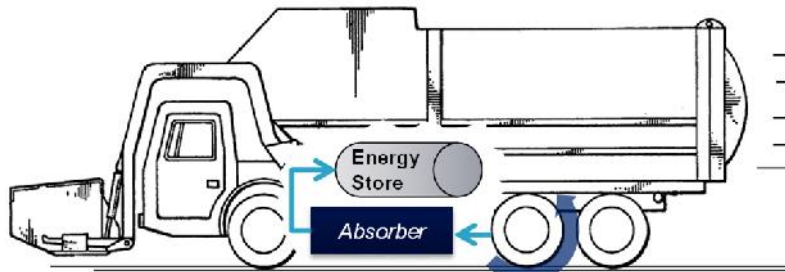
Energy density = Capacity / Power density = Speed of Delivery

Pneumatic Energy Storage Has A Fundamental Physics Advantage !

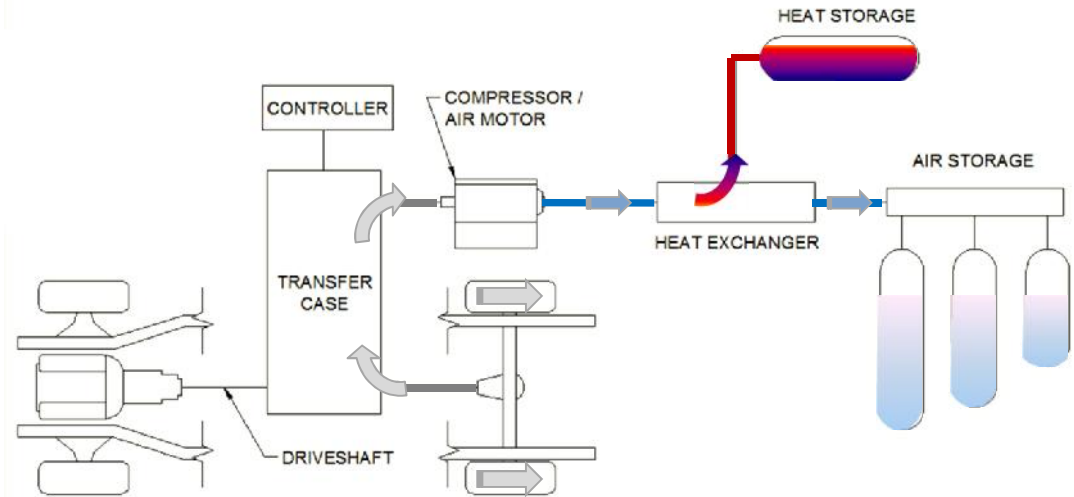
The System - How It Works



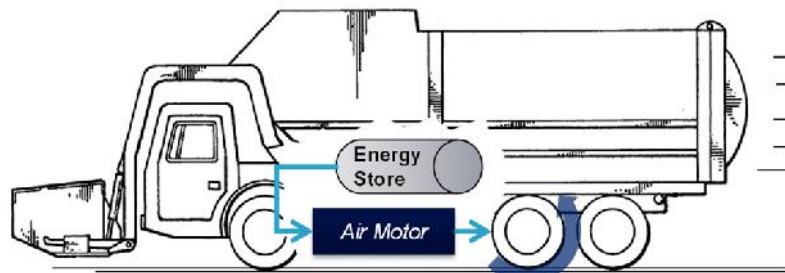
Braking Event



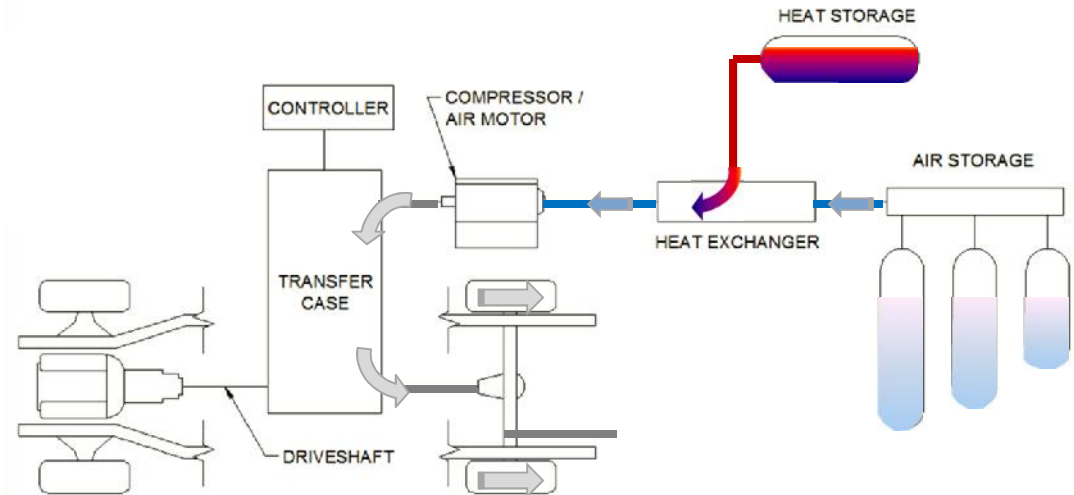
Energy Stored In Gas Pressure & Heat



Acceleration Event



Stored Gas Energy Released to Air Motor



System Advantages



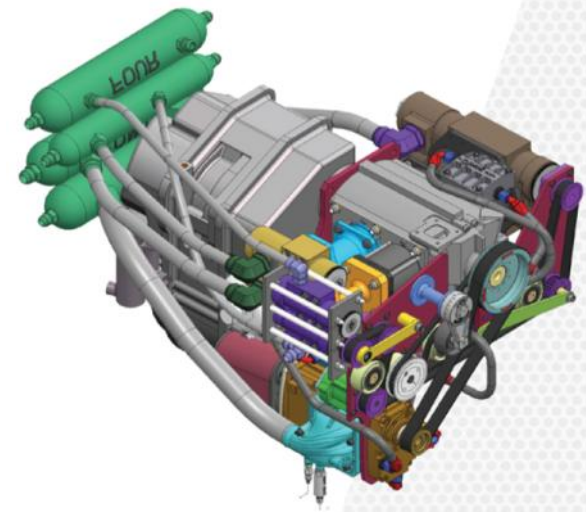
Pneumatic Hybrid Competitive Advantages

- Affordable
 - Low Entry Price With Low Ownership Costs
 - Increase Brake Life by ~300%
- Cleaner & Lighter
 - No Hydraulic Fluid To Leak or Heavy Limited Life Batteries
 - 67% Lighter Than Lightest Competing Hybrids
 - Environmentally Friendly (Green Technology)
- Flexible Performance
 - Operates Over A Broader Power Range Than The Competition
 - Less Duty Cycle Sensitive
- Operational Advantages
 - Compact & Configurable
 - Faster Vehicle Launch & Actuator Equipment Cycles
 - ~800 lbs. Weight Savings Over Diesel and CNG Vehicles
 - Reclaim Braking Energy
 - Fleet Fuel Savings (30-35%+)
 - ~3 Year End User Payback Period
 - 10+ Years Operational Life



Discriminating Technology:

- Rotary Drive Compressor
 - Compact Package
 - Increased Speed
 - Increased Horsepower
 - Integrated Thermal Recovery



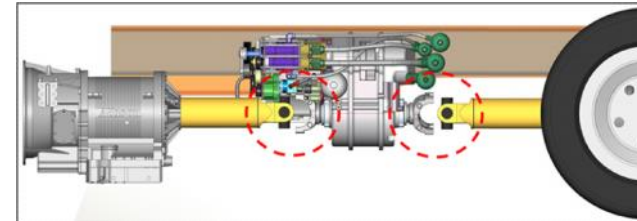
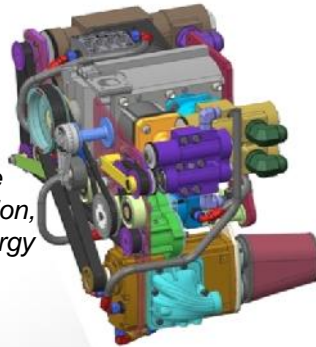
Modules



Air Motor / Air Compressor

During Vehicle Braking, The Compressor Drives Air From The Atmosphere Into The Energy Storage System. Upon Acceleration, The Air Motor Harnesses The Stored Energy To Drive The Vehicle Forward.

- COTS Based / Low Cost
- Unique Rotary Valve IP
- Highest Power / Lowest Weight Hybrid



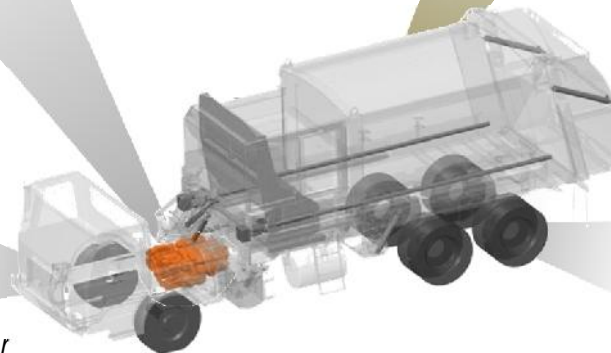
Modular 2 Point Vehicle Integration

- Light Weight Enhances Payload & Productivity
- High Speed Decreases Load Cycle Times
- Small Package Enables CNG Vehicle Integration
- Low Recurring And Non-recurring Costs Meets ROI Objectives

Transmission

Connects To Vehicle Drivetrain, Directs Braking Power From The Wheels To The Compressor. When Vehicle Accelerates, The Transmission Directs Air Motor Power Back To The Wheels To Boost Vehicle Performance.

- COTS Based / Low Cost
- Adaptable, Compact And Efficient
- Programmable For A Wide Range Of Applications And Vehicles



Energy Storage

Air And Water Vessels To Collect And Store Energetic Air And Heat Produced By The Air Compressor. This Energy Can Then Be Directed To The Air Motor And Functions To Boost Vehicle Performance

- COTS Based / Low Cost
- Proven Technology
- Patented System
- Adaptable For Wide Range Of Conditions

