

Advances in Electric Motor Technology for HEV/EV Applications

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Remy Electric Motors

POWER DENSITY

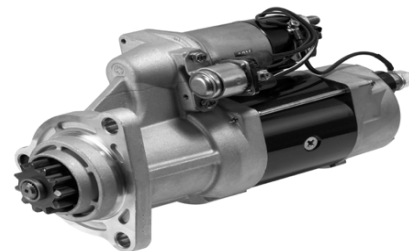
EFFICIENCY

DURABILITY

READY TO POWER YOUR FUTURE™

Remy International, Inc.

- Manufactures Starters, Alternators, Propulsion Motors
- 5,500 Employees, 23 Facilities in 10 Countries
- Over 100 years experience in rotating electrics
- Over 17 Million Units Produced Annually



Business Description

- High output traction motors & generators for Hybrid and Electric Vehicles



High Performance Products

- 30-300 kW Output
- 200 -2000 Nm Torque
- High Efficiency
- Zero Defect Philosophy

Customer Value

- Unique Technology - Highest Power Density
- Durable Motors:
 - 90,000+ motors produced
 - 3 Billion kilometers of proven reliability
 - 2 warranty returns since April 2008
- Broad Experience - Application support

Key Milestones

- 1959 First HVH alternator produced
- 2002 Produced 1st eMotor for electric bus
- 2003 Developed & patented HVH technology
- 2006 Launched Dual-mode Hybrid with GM
- 2008 Contract for Daimler ML 450 & BMW X6
- 2009 Won \$60M US Dept of Energy Grant
- 2010 Launched Remy Electric Motors, LLC

\$120 Million Investment in Motors for Hybrid/ Electric Vehicles

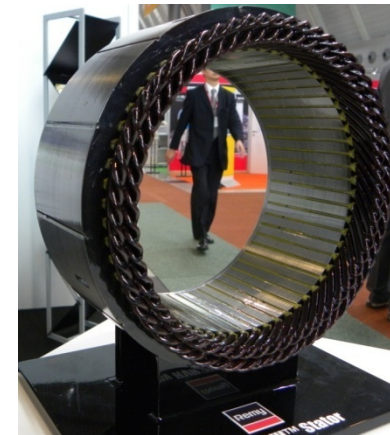
We Make Electric Traction Motors & Generators ...



HVH 410



HVH 250

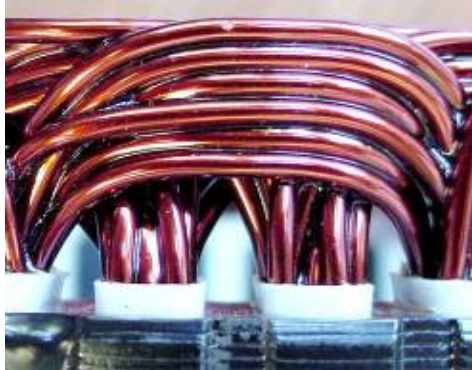


HVH 250 Stator

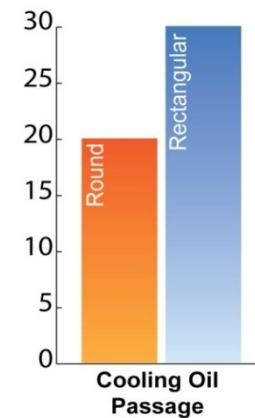
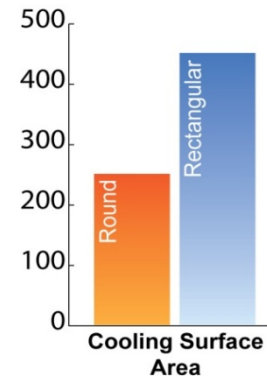
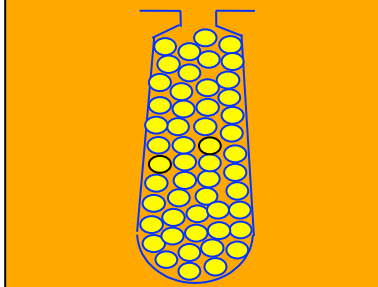
Feature Patented HVH Technology for Superior Power Density / Torque

Remy HVH (High Voltage Hairpin) Motor Design

Round Wire



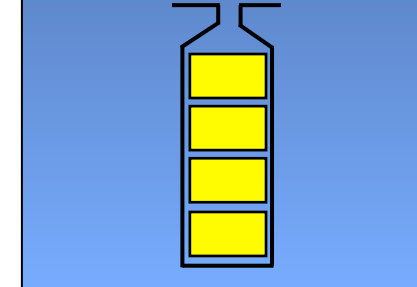
Conventional Winding
45% - 50% Slot Fill



Rectangular Wire



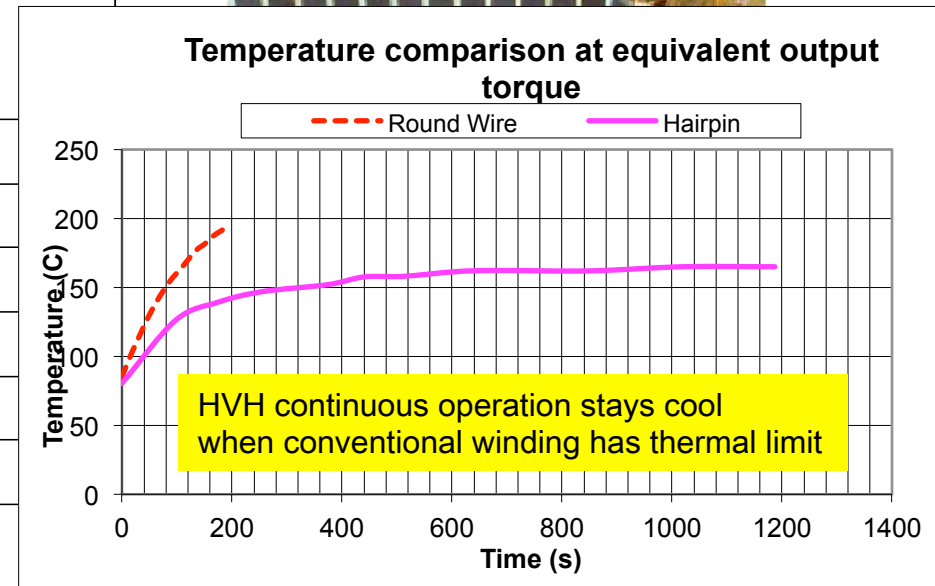
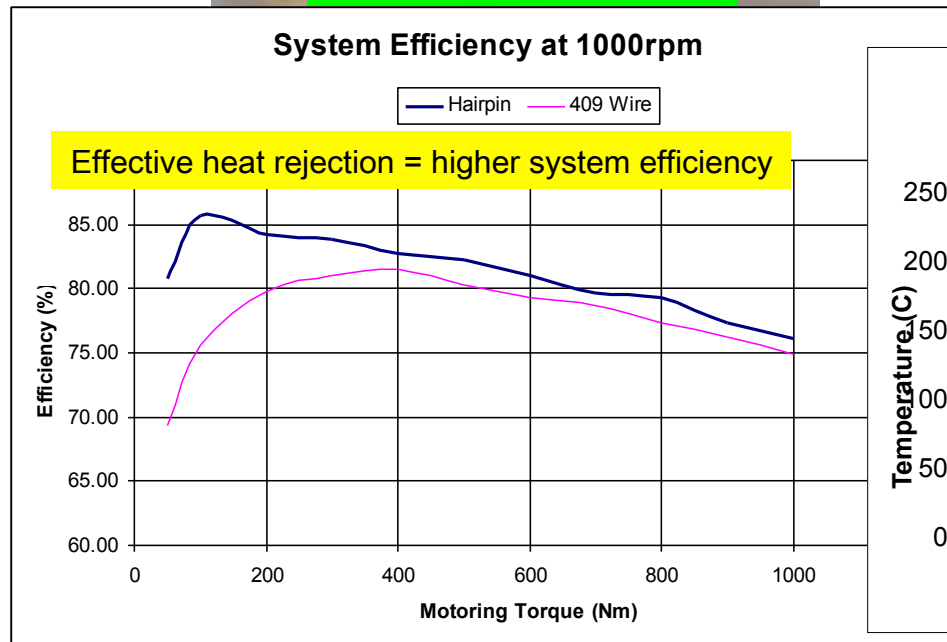
HVH Design
68% - 73% Slot Fill



Improved heat
conduction to slot wall

High Performance and Efficiency as Standard

HVH Stator Construction Advantages



Hairpin Allows Operation at Higher Power Levels via Cooling / Efficiency Benefit

Rare Earth Materials Cost Rising Rapidly

Dysprosium

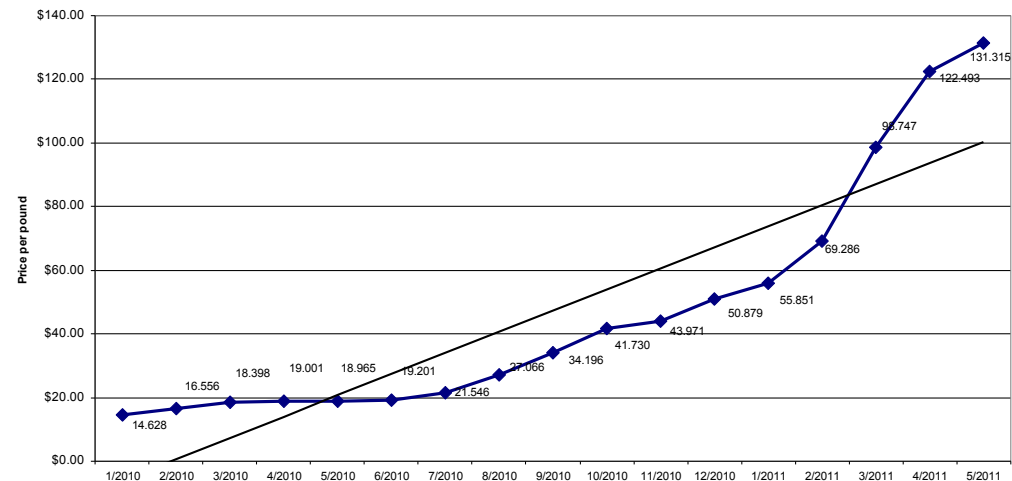
January 2011

\$65 / kg

August 2011

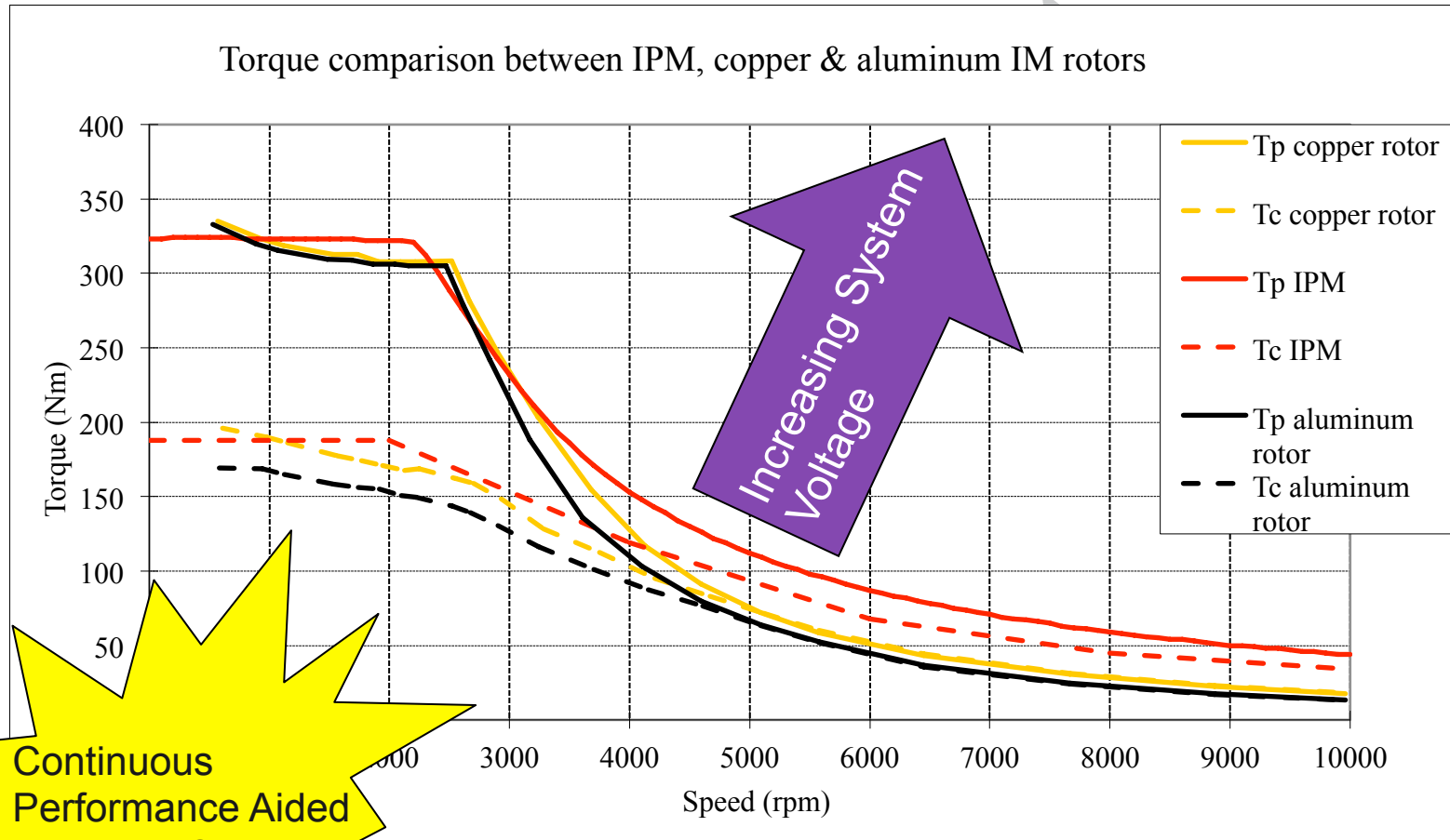
\$3,400 / kg

Neodymium Price Trends
Source: Metal-Pages: Rare Earth Metals Nd



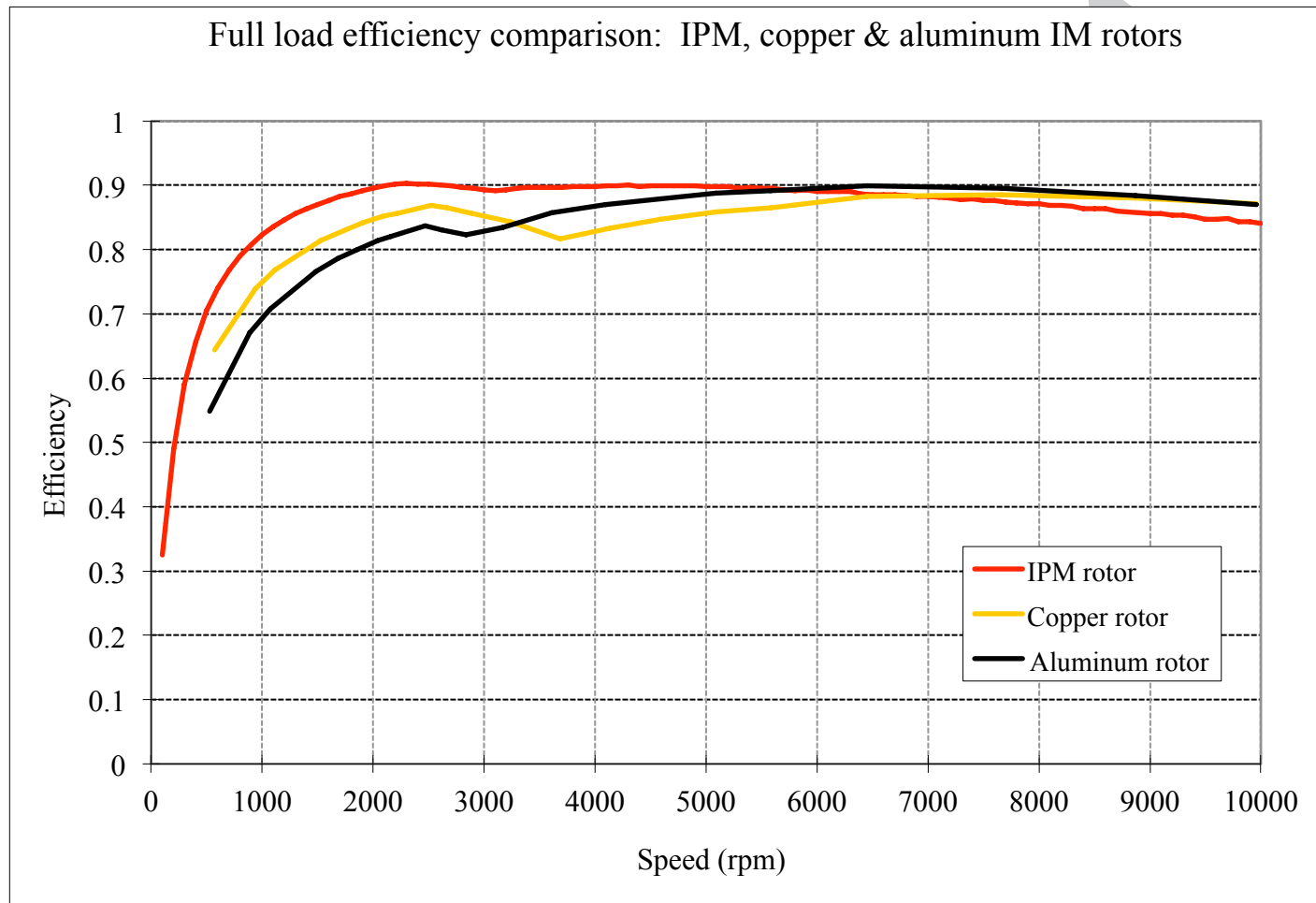
Future Motor Designs Will Require New Technology

Induction Motor Rotor - Torque



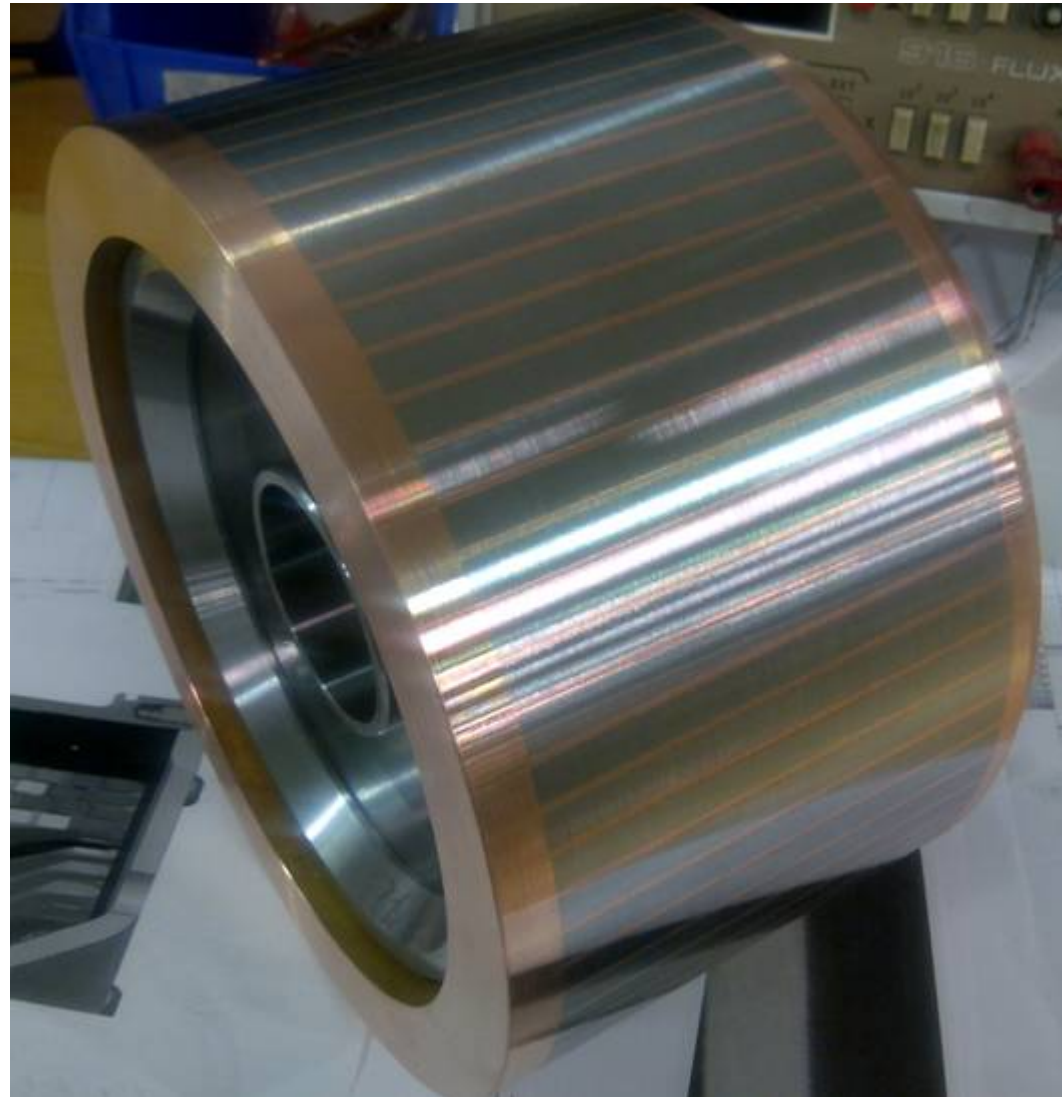
IM can produce similar torque to IPM at low speeds

Induction Motor Rotor - Efficiency



IM can produce similar efficiency to IPM at high speeds

Remy HVH250 Induction Motor Rotor



Conclusions:

1. Direct Oil Cooling of the Winding Maximizes Motor Performance
2. This in Turn Opens Up the Opportunity for High Performance Induction Motors
3. Reducing Dependency On Rare Earth Permanent Magnets Is Possible And Is Essential For Longterm Supply Chain Stability

Advancing Technology To Meet Your Needs



Thank You

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