

Energy Star Lighting Partners Meeting Lighting Technology Updates

Metal Halide: The “Other” White Light

Jay Busch - LC, LEED-AP, Commercial Engineer



On behalf of the NEMA Lamp Section

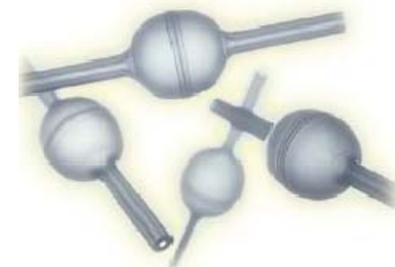
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Metal Halide Lamps

- Invented over 50 years ago (first U.S. patent, 1961)
- Since then, MH lamps have evolved into the most energy efficient white light sources available in the market today, due to advances in
 - Physics
 - Chemistry
 - Materials Science
 - Electronics
 - Engineering

What Is It?

- MH lamps have either a quartz or ceramic (polycrystalline alumina) arc tube
 - Ceramic arc tubes allow higher operating temperatures and still achieve high efficacy, lumen maintenance and color stability
 - Quartz arc tubes used widely based on cost



Main Advantages: Summary

- High efficacy
- Long lifetimes
- High maintained light levels
- Color temperatures and CRI
- Broad operating temperature range
- High luminance, optical efficiency
- Ballast compatibility
- Dimmable

High Efficacy

- MH lamps are the most efficient way to make white light commercially available today
- Recent technology advances with medium wattage ceramic MH enable
 - > 20,000 hrs rated life
 - CRI \geq 90
 - Luminous efficacies of 120 LPW

Long Lifetimes

- Proven lifetimes in excess of 20,000 hours
- Latest generation of electrodeless HID systems claim lifetimes in excess of 30,000 hours

High Maintained Light Levels

- Lumen maintenance was once a weak point of MH systems, but no longer
- Lumen maintenance now approaches 90% with pulse start lamps and electronic ballasts

Color Temperatures and Color Rendering

- MH systems available in wide range of
 - CCTs (1800 to 10,000 K)
 - Lumen packages (1200 to 200,000 lm)
 - Color rendering indices (up to 98)
 - Red rendering index (R9) available with values >50 in latest ceramic lamps

Operating Temperature Range

Operating characteristics of MH lamps

- Independent of ambient temperature
- Robust to extreme temperatures (contrast with fluorescent and LED)
- Allow for numerous applications
 - Outdoor and street
 - Studio and stage
 - Architectural
 - Office, hospitality and retail
 - High-bay
 - Sports



Luminance & Optical Efficiency

Source	Approx. luminance (cd/m ²)
Sun	10 ⁹
HID (e.g. MH)	10 ⁶ to 10 ⁹
High brightness LED	10 ⁷
60W incandescent	10 ⁵
T8 fluorescent	10 ⁴
OLED	10 ²

Luminance & Optical Efficiency

- Where high lumens required, MH lamps are smaller and lighter than current SSL systems
- Ceramic MH arc lengths up to 5x shorter than HPS and 2-3X shorter than quartz MH
 - Can drive more efficient fixture designs with better beam control, cut-off, dark sky capability and less glare
- MH lamps suitable for luminaires that collect and direct visible light for illumination at a distance, more of a point source than an array
 - From one meter to hundreds of meters

Ballast Compatibility & Dimmability

- MH lamps operate on wide range of commercially available magnetic and electronic ballast systems
 - Electronic ballasts up to 95% efficiency
 - Magnetic ballasts range from 75% to 92% efficiency



- Magnetic and electronic ballasts dim most MH lamps by as much as 50% of rated lamp power in all operating positions

Summary Characteristics

	Quartz Metal Halide	Ceramic Metal Halide
Typical Wattage Range	20-2,000	15-400
Efficacy (LPW)	68-120	80-120
CCT (degrees K)	2,700-10,000	2,700-5,500
Lifetime (hours)	6,000-20,000	12,000-30,000
Lumens	1,600-200,000	1,200- 48,000
CRI	60-95	60-98

Focus Areas of MH R&D

- 💡 Efficiency
- 💡 Life
- 💡 Maintenance
- 💡 Controls
- 💡 Drivers
- 💡 Integrated lamp-ballast systems
- 💡 Miniaturization
- 💡 Environmental sustainability
- 💡 Electrodeless

Greatest advances will be achieved when a systems approach is used – lamps, ballasts, controls, and luminaires developed and optimized together

Conclusions

- 💡 Good now and better soon (over next 5 years)
 - ≥ 150 LPW (with 90% lumen maintenance and 30,000+ hr rated lifetimes) commercially available in wide wattage range, from < 20 W to > 1000 W
- 💡 Most HID lamps are researched, developed and manufactured in the U.S.
- 💡 Government support for lighting R&D should be technology neutral.
 - MH and LEDs both have great potential
 - Both MH and LEDs will reduce US energy consumption and minimize lighting environmental impacts
- 💡 Energy Star eligibility