Energy Star Lighting Partners Meeting
Lighting Technology Updates

Metal Halide: The “Other” White Light

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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 ≥ 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

<table>
<thead>
<tr>
<th>Source</th>
<th>Approx. luminance (cd/m²)</th>
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<tbody>
<tr>
<td>Sun</td>
<td>$10^9$</td>
</tr>
<tr>
<td>HID (e.g. MH)</td>
<td>$10^6$ to $10^9$</td>
</tr>
<tr>
<td>High brightness LED</td>
<td>$10^7$</td>
</tr>
<tr>
<td>60W incandescent</td>
<td>$10^5$</td>
</tr>
<tr>
<td>T8 fluorescent</td>
<td>$10^4$</td>
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<tr>
<td>OLED</td>
<td>$10^2$</td>
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</tbody>
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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

<table>
<thead>
<tr>
<th></th>
<th>Quartz Metal Halide</th>
<th>Ceramic Metal Halide</th>
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<tbody>
<tr>
<td><strong>Typical Wattage Range</strong></td>
<td>20-2,000</td>
<td>15-400</td>
</tr>
<tr>
<td><strong>Efficacy (LPW)</strong></td>
<td>68-120</td>
<td>80-120</td>
</tr>
<tr>
<td><strong>CCT (degrees K)</strong></td>
<td>2,700-10,000</td>
<td>2,700-5,500</td>
</tr>
<tr>
<td><strong>Lifetime (hours)</strong></td>
<td>6,000-20,000</td>
<td>12,000-30,000</td>
</tr>
<tr>
<td><strong>Lumens</strong></td>
<td>1,600-200,000</td>
<td>1,200-48,000</td>
</tr>
<tr>
<td><strong>CRI</strong></td>
<td>60-95</td>
<td>60-98</td>
</tr>
</tbody>
</table>
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)
  - $\geq 150$ 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