Induction vs H.I.D. (High Intensity Discharge) lamps & Fluorescent Tubes

Comparison	Induction	Metal Halide	High Pressure Sodium	Fluorescent Tubes	Compact Fluorescent
Warranty	Compact: 5 Years Separate: 10 Years	None	None	None	None
Life Hours	Compact: 60,000 Separate: 100,000	6,000~20,000	24,000	8,000~20,000	8,000~10,000
Energy Saving Efficiency	Excellent	Lower	Lower	Lower	Good
Lumen Efficacy	Photopic Efficacy: 150 Plm/W (Plm = Pupil Lumen) Traditional Efficacy: 80 Lm/W	Photopic Efficacy: 110 Plm/W (Plm = Pupil Lumen) Traditional Efficacy: 75 Lm/W	Photopic Efficacy: 90 Plm/W (Plm = Pupil Lumen) Traditional Efficacy: 120 Lm/W	Photopic Efficacy: 69 Plm/W (Plm = Pupil Lumen) Traditional Efficacy: 70 Lm/W	Photopic Efficacy: 85 Plm/W (Plm = Pupil Lumen) Traditional Efficacy: 50 Lm/W
Lumen Depreciation Rate %	5% @ 2,000 Hours	40% @ 2,000 Hours	30% @ 2,000 Hours	25% @ 2,000 Hours	30% @ 2,000 Hours
Lamp Operating Temperature	Lower, <80°F Recuces A/C cost	Higher, >300°F Increased A/C cost	Higher, >350°F Increased A/C cost	Higher, >150°F Increased A/C cost	Higher, >100°F Increased A/C cost
CRI	>80 (Ra)	65~80 (Ra)	60 (Ra)	60 (Ra)	65~80 (Ra)
Restrike	Instant	Needs up to 10~15 minutes	Needs up to 10~15 minutes	Instant, with initial 3 minute warm up time.	Instant, with initial 3 minute warm up time.
Flicker	None	Much	Much	Much	Much
Glare	None	Much	Much	Much	Much
Environmental Safety	No Mercury No Lamp waste in 10 years	Contains Mercury Concern with much lamp waste over 10 years	Contains Mercury Concern with much lamp waste over 10 years	Contains Mercury Concern with much lamp waste over 10 years	Contains Mercury Concern with much lamp waste over 10 years

Induction Lighting: Features Advantages - Benefits

Features	Advantages	Benefits
• No electrodes, no filament to be damaged • Electrolytic capacitors used are high temperature (105 C) resistant and high voltage (450V) resistant capacitors • Mica-film capacitors, resistors and crystal diodes used are selected in terms of the highest quality standards.	• Long performance life up to 100,000 hours, lasting up to 100 times as long compared to incandescent lamps. • High luminous maintenance rate (at >95% after 2,000 hours and >85% after 6,000 hours) • High reliability factor	• Reduced re-lamping costs • Zero maintenance costs • Less problems caused by interruption of industrial production or traffic flow • Reduces recycling costs
• Power Factor>0.99 • IC controlled electronic ballast • Pupil Luminous Flux: Up to 150 Plm/W • High lumen efficiency • Superior energy saving	• Very high system efficiency (increase by 50% and 20% more than magnetic ballasts and conventional electronic ballasts respectively) • Better visibility • Lower energy bills	• Reduce electricity costs by up to 90%, 75% and 50% as compared to incandescent lamps, HID lamps, and fluorescent lamps respectively. • Reduced eye strain and stress • Increase bottom line profits
• Electromagnetic induction lighting	• Low heat output	• Reduced air-conditioning costs
• Wide voltage range • Instant start and instant re strike • Reliable ignition even to-40°C	• Greater range of applications vs HID and fluorescents	• Easy installation • Ease of use • Great for very low temperature regions and applications.
• CRI > 80 (Ra) • Wide color temperature range • Full spectrum available • Precise wavelengths • Working frequency: 210KHz	• Allows colors to be perceived correctly • Like natural sunlight • Range of color temperatures and wavelengths • Excellent lighting quality with no flicker	• Ideal for indoor retail, museums, shopping malls and more. • Increase safety and security • Increase worker productivity • U.V. Applications @ 253.7Nm
• Amalgam Content < 0.25mg	• No liquid mercury to harm human beings or the environment	• Health & safety • Environmental Protection
• Low Harmonic distortion-International "L" class standard. • Electromagnetic Compatibility (EMC) meets all international standards including FCC	• Less harm to electric safety • No Electronic interference or potential radiation damage	• Electric grid security • Safe for use near other electronic devices
• Listed and certified by CE, FCC, UL, CCC, ISO and other standards.	• No more restrictions for applications in the United States and around the world.	• Ease of use as a retrofit or in new construction applications

Measuring Lumens —What Are "Pupil Lumens"?

How people see and are psychologically impacted by lighting has been a subject of much study and discussion for years. Describing light as "lumen output" and measuring it as "foot candles" on a work plane have been the traditional ways of describing and defining how much light is required to perform a variety of tasks. However, that is being re-examined based on results of studies on visual performance and the psychological impacts of lighting. Additionally, the "color rendering index" (CRI) and correlated color temperature (CCT) describe the quality of the light (relating to how true colors appear compared to under a noon north sky on a clear day). As lighting technology evolves into various types and colors, simply measuring the lumens proves not to be fully adequate in predicting how well people can see. An excellent example is the low-sodium lamp which produces many lumens, but only two colors (yellow and gray); the ability to make out details—beyond shapes of objects—is lost under this light source. Different light sources produce light in different spectral ranges and there is a wide variety of spectral output available in fluorescent lamps.

Vision itself is affected by many factors, from light intensity, distribution, color, and contrast, as well as reflections, glare, air quality, motion of subjects and viewers, and more. Our eyes use different parts to see in bright light and low light conditions. The eye contains cones and rods which were thought to work in opposite conditions. Cones provide color vision and fine detail (photopic) in bright light and rods take over in dim light (scotopic). In bright light our pupils contract allowing more detail to be perceived, while depth of field and perceived brightness also increase. In low light our eyes dilate to allow more light in.

Light meters and recommended light levels for tasks have traditionally been calibrated for daytime viewing, and general interior lighting, based on the photopic response. However, studies are indicating that the scotopic vision is more involved in interior lighting than thought, and affects pupil size. At recent international conferences, some presenters encouraged designers to specify the photopic/scotopic (P/S) ratio of lamps when selecting them in order to get better design, efficiency, and better vision for occupants.

Sam Berman—formerly with the Lighting Systems Research Group at Lawrence Berkeley Laboratory and a major supporter of the importance of the P/S ratio in lighting selection— developed a conversion factor that applies the P/S ratio to lumen output of various light sources, and then expresses the effective lumens the eye will perceive for vision based on the size of the pupil and the effect on vision (Table 1). Some lamps, like low-pressure sodium, lose most of their output using this method, while others like high-quality fluorescent lamps gain substantially.
Induction lamps are basically equivalent to high-quality fluorescent lamps with a CRI of 80 and a color temperature of 4100K. Berman’s table suggests that, while the T-8 4100K lamp has rated lumens of 90 per watt, the pupil (effective) lumens are actually 145 per watt. If contrast and distribution are controlled, this suggests that fewer watts are needed to provide good vision than rated lumen output would suggest, meaning energy savings will result.

Conversion factors for lumens to "pupil lumens"
Correction factors applied to conventional values of lumens per watt yield a value for pupil lumens per watt, which is a measure of how effectively the eye sees the light that is emitted.

Light Source	Conventional Lumens per Watt	Correction Factor (P/S Ratio)	Pupil Lumens per Watt
5,000K T5 fluorescent	104	1.83	190
5000K Induction Lamp	80	1.62	150
4,100K T8 fluorescent	90	1.62	145
Clear metal halide	85	1.49	126
5,000K pure triphosphor fluorescent	70	1.58	111
Daylight fluorescent	55	1.72	95
5,000K pure triphosphor fluorescent	69	1.24	85
Vitalite fluorescent	46	1.71	79
5,000K 90 CRI fluorescent	46	1.7	78
2,900K warm white fluorescent	65	0.98	64
Low-pressure sodium	165	.38	63
5,000K pure triphosphor fluorescent	65	0.76	49
Deluxe mercury vapor	40	0.86	34
35-watt high-pressure sodium	55	0.57	31
Tungsten halogen	22	1.32	29
Standard incandescent	15	1.26	19

Summary
Recent studies favor white light (as from induction lamps) for viewing moving objects in low-light conditions, such as spotting a pedestrian, animal, or other moving object off to the side of the roadway at night. Some cities opt to use white light rather than the yellowish light of high pressure sodium in hopes of reducing accidents. In addition, superior color rendering of white light in retail areas, super-markets, manufacturing plants, warehouses highly favor induction lamps. Current codes and standards are based on measurements that do not address the impact of pupil lumens, and pupil lumens are quite different from traditionally measured lumen output of lamps. Studies on the relevance of light spectrum and the mechanics of vision are ongoing, and codes and standards will reflect that in the near future.

Induction lamps offer an amazing 100,000 hours of life, making it virtually maintenance free. It offers crisp white light with 80+ CRI and a choice of 3K, 4K, 5K and 6K color temperatures. The high CRI light makes colors look brighter, more vibrant and more attractive. It produces up to 80 lumens of light for each watt of energy. This 80 LPW efficacy makes it as energy efficient as high CRI metal

halide systems. Induction lamps offer high reliability and instant on - off. With less heat output.

The induction lamp system is vibration resistant. The fact that induction lamps have no electrodes make them more reliable in high vibration and gusty applications. The induction lamp system has proven its durability in bridges, tunnels and signage applications.

Induction lighting systems offer five to ten times the life of HID systems for only two to three times the cost of the HID lamp and ballast. In almost all cases, the payback in maintenance savings alone will more than offset the additional cost of the initial system.

Lighting Comparison for New Factory

Comparison Item	H.I.D. Lighting	Induction Lighting
Light Source	Metal Halide High Bay	Induction High Bay
Wattage	400W (per lamp)	200W (per lamp)
Actual Power Consumption	460W (lamp & ballast)	210W (lamp & ballast)
Brightness	373 Lux	510 Lux
Luminous Efficacy	Low Efficacy, Severe Luminous Decline, Poor CRI	High Efficacy, Low Luminous Decline, Excellent CRI
Life Hours	8000 hrs (1 yr @ 24 hrs/day) Change bulbs every year	100,000 hrs (10 yrs @ 24 hrs/day) Change Zero bulbs for 10 years
Number of Fixtures	51	51

Energy and Related cost savings for H.I.D. lighting with Induction:

460W - 210W x 51 fixtures = 12,750 Watts
12,750 Watts x 15 hours per day / 1000 = 191.25 kW hours per day savings
191.25 kW hours per day x 312 days (6 days per week) = 59,670 kW hours per year
59,670 kW hours per year x $0.097 rate = **$5788** per year energy cost savings
Plus: 51 lamps @ $21ea = **$1071** per year in replacement bulb costs
Plus: Labor to change bulbs - **$500** per year
Total savings per year: **$7359**
10 years Total cost savings: **$73,590** (assuming that energy, labor & lamp costs do not rise)

Energy and Related cost savings for Fluorescent lighting with LED:

141W (tubes & ballast) - 48W (no ballast) x 2 fixtures = 186 Watts
186 Watts x 15 hours per day / 1000 = 2.79 kW hours per day savings
2.79 kW hours per day x 312 days (6 days per week) = 870.48 kW hours per year
870.48 kW hours per year x $0.097 rate = **$84.44** per year energy cost savings
Plus: 8 lamps @ $4ea = **$32** per year in replacement bulb costs
Plus: Labor to change bulbs - **$25** per year
Total savings per year: **$141.44** for just two fluorescent fixtures
17 years Total cost savings: **$2404** (assuming that energy, labor & lamp costs do not rise)

Questions and Answers That Enlighten

Q: What is the induction lamp system and how does induction lighting work?

A: The induction lamp system uses a revolutionary technology of light generation that combines the basic principles of induction and gas discharge. Void of electrodes this new technology delivers an unprecedented 100,000 hours of high quality white light.

Q: What are the components of the system?

A: The system is comprised of three components; the generator, the power coupler and lamp. The power coupler transfers energy from the HF generator to the discharge inside the glass bulb using an antenna that contains the primary induction coil and its ferrite core. The power coupler also has a heat conducting rod with mounting flange. The mounting flange allows the Induction lamp system to be mechanically attached to the luminaire.

Q: Why Induction Lighting?

A: Induction lamps offer an amazing 100,000 hours life making it virtually maintenance free. It offers crisp white light with 80+ CRI and a choice of 3K, 4K, 5K and 6K color temperatures. The high CRI light makes colors look brighter, more vibrant and more attractive. It produces up to 80 lumens of light for each watt of energy. Induction lamps offer high reliability and instant on and off, and with less heat output.

Q: Is the induction lamp dimmable?

A: Yes. The integrated circuit board ballast allows for full dimming of induction lamps, which can increase energy savings and provide smooth light transition from ignition to full burn.

Q: Do induction lamps need a dedicated fixture?

A: Yes. Due to operating and thermal requirements the system needs to be properly installed in a suitable fixture, although the existing fixture may be able to be retrofitted with the new induction lamp & ballast.

Q: Can running a lamp interfere with computers or any other electronic device?

A: No. It runs at a low 210KHz and complies with FCC rules with no interference under normal circumstances.

Q: Will the induction lighting system interfere with telecommunication equipment?

A: No. The FCC standards are in place to protect navigation and radio communications. The system will not interfere with portable or cellular/mobile phones.

Q: Is the light output of an induction lamp affected by low temperatures? High temperatures?

A: The lamp's amalgam fill technology and the heat conduction rod in the center create stable light output over a wide range of ambient temperatures, maintaining at least 85% of nominal lumens from -30° F to 130° F (for an enclosed fixture with heatsink). Induction lamps can start at temperatures as low as -40° F.

Q: Does operating position affect output?

A: No. The universal operating position does not affect the performance of the induction lamp system.

Q: Is the induction lamp system vibration-resistant?

A: Yes. The fact that induction lamps have no electrodes make them more reliable in high-vibration and gusty applications. The induction lamp system has proven its durability in bridges, tunnels, and signage applications.

Q: What, if any, is the effect of voltage supply fluctuations on the performance of the induction system?

A: Due to the built-in pre-conditioner in the HF generator, which provides a well stabilized internal supply voltage a wide operating voltage range of +/- 20V) to the HF generator, the light output, consumed power and system efficacy (efficiency) of lamp system vary by less than 2% as a result of mains voltage fluctuations. There is no noticeable effect (visual or measurable) on the color performance (color temperature, color rendering, etc.) due to supply voltage fluctuation.

Q: Will induction lighting fade or damage materials?

A: The amount of ultraviolet light generated by an 80W lamp is roughly equivalent to that of a regular fluorescent lamp per 1000 lux. The permissible exposure time (PET) is +40 hours per 1000 lux, generously above the norm (24 hours per 1000 lux). The damage factor for materials is rated at a low 0.3 so induction lamps can be used in open luminaries without any front glass.

Q: How far can the HF generator be remotely mounted from the power coupler/discharge vessel assembly?

A: The length of the coaxial cable connecting them (15”). Because the cable forms part of the oscillating circuit of the HF generator, the length of the cable cannot be modified.

Q: At the end of life, must all components be replaced?

A: All three components are separately replaceable, however, induction lights are almost always supplied as a three-component system, even for relamping. End of life usually means the generator must be replaced, and at the time, it is usually recommended to replace the bulb, as phosphor degeneration at 100,000 hours lowers lumen output up to 37%.

Q: Why is induction lighting technology worth more?

A: Induction lighting systems offer five to ten times the life of HID systems for only two to three times the cost of the HID lamp and ballast. In almost all cases the payback in maintenance savings will more than offset the additional cost of the initial system.