GreenTech Fixtures Inc.
56 Stanley Street, Goderich, Ontario, Canada N7A 3K5
Tel: 519.440.2054 Fax: 519-524-8416

How GreenTech Induction Lamps Work

Prepared By: L. Michael Roberts for GreenTech Fixtures Inc. - © 2010 - All Rights Reserved

Electrodeless Lamps

Almost all of the light sources currently in use have one thing in common, metal electrodes sealed into the walls of the lamp (bulb envelope) to bring the electrical current inside the lamp chamber/envelope.

Unsurprisingly, the main failure mechanisms in these typical lamps [other than breakage] is:

- Failure of the filament due to depletion of the filament material over time as atoms are stripped off by the electrical current;
- Vibration which breaks the filament, especially when it is hot;
- Failure of the seal integrity of the lamp; typically caused by thermal stresses in the area where the electrodes go through the glass walls. The failure of the seal can either be sudden and complete, or a "slow leak" over time allowing the entry of atmospheric gasses which contaminates the interior.

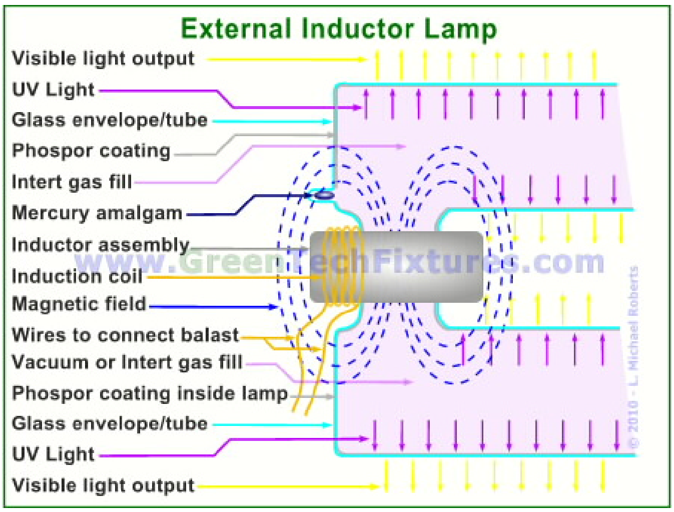
The dream of lighting inventors has been to produce a lamp with no internal electrodes so as to eliminate these common failure modes. In an electrodeless lamp the envelope [bulb] is completely sealed and thus there is no chance of atmospheric contamination due to seal failure and no electrodes to wear out. On 23 June 1891, Nicholas Tesla was granted US patent 454,622 to cover an early form of Induction lamp.

In an electrodeless lamp, the main failure mechanisms [other than breakage] are:

- Depletion of the mercury amalgam inside the envelope [bulb]. When the mercury ions are excited and bombard the phosphors, a small percentage of them are absorbed by the phosphor coating over time.
- Failure of the electronics [ballast] used to drive the lamp. This is not a catastrophic failure mode as typically the electronics [ballast] are external to the lamp and can easily be replaced.

So how do you get an electrical current inside the lamp envelope to excite the mercury ions?

Magnetic Induction Lamps



Magnetic induction lamps are basically fluorescent lamps with electromagnets wrapped around the outside of a part of the tube, or inserted inside the lamp. In external inductor lamps, high frequency energy, from the electronic ballast, is sent through wires, which are wrapped in a coil around the ferrite inductor on the outside of the glass tube, creating a powerful magnet.

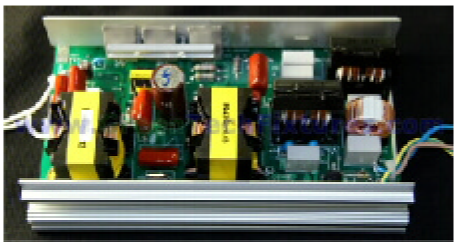
The induction coil produces a very strong magnetic field which travels through the glass and excites the mercury atoms in the interior. The mercury atoms are provided by the amalgam (a solid form of mercury). The excited mercury atoms emit UV light and, just as in a fluorescent tube, the UV light is up-converted to visible light by the phosphor coating on the inside of the tube. The glass walls of the lamp prevent the emission of the UV light as ordinary glass blocks UV radiation in the 253.7 nm and 185 nm range.

GreenTech Fixtures Inc.
56 Stanley Street, Goderich, Ontario, Canada N7A 3K5
Tel: 519.440.2054 Fax: 519-524-8416

The induction lamp system can be considered as a type of transformer where the inductor outside the glass envelope is the primary coil, while the mercury atoms, in an inert gas-fill within the envelope/tube, form a single-turn secondary coil.

The high frequency magnetic field from the inductor is coupled to the metallic mercury ions causing their electrons to reach an excited state. When the electrons revert to the ground state, photons of UV light are emitted which excites the phosphor coating to emit visible light.

The external inductor lamps have the advantage that heat generated by the induction coil assemblies is external to the tube and can be easily dissipated by convention or conduction. The external inductor design lends itself to higher power output lamp designs which can be rectangular or round. As with conventional fluorescent lamps, varying the composition of the phosphors coated onto the inside of the induction lamps, allows for models with different colour temperatures. The most common colour temperatures of induction lamps are 3500K, 4100K, 5000K and 6500K but other colour temperatures, and even coloured versions are available.



INDUCTION LAMP BALLAST

Induction lamps require a correctly matched electronic ballast for proper operation. The ballast takes the incoming mains AC voltage [or DC voltage in the case of 12 and 24V ballasts] and rectifies it to DC. Solid state circuitry then converts this DC current to a very high frequency which is between 2.65 and 13.6 MHz depending on the lamp design.

The high frequency signal produced by the ballast is fed to the coil wrapped around the ferrite core of the inductor. The ballasts contain control circuitry which regulates the frequency and current to the induction coil to insure stable operation of the induction lamp. In addition, the ballasts have a circuit which produces a large “start pulse” at power-up to initially ionize the mercury atoms and thereby start the lamp.

The induction lamps do not start at 100% light output - they start at between 75% and 80% output thus they are considered to be “instant on” lamps. It takes between 60 and 120 seconds for the mercury bearing amalgam in the lamp to heat up and release enough mercury atoms to reach 100% light output.

The close regulation of the lamp’s inductor by the ballast, and the use of microprocessor controlled circuits, allows the ballasts to operate at around 98% efficiency. Only around 2% of the energy is wasted in the induction lamp ballast compared to the 10-15% wasted in traditional “core and coil” type designs used with most high output commercial and industrial lighting.

The advantages of Induction lamps:

- Long lifespan due to the lack of electrodes - between 65,000 and 100,000 hours depending on the lamp type and model;
- Very high energy conversion efficiency of between 62 and 85 Lumens/watt [higher wattage lamps are more energy efficient];
- High power factor due to the high frequency electronic ballasts which are 98% efficient - less wasted energy in the ballast;
- Minimal Lumen depreciation (declining light output with age) compared to other lamp types;
- Instant-on and hot re-strike, unlike most conventional lamps used in commercial/industrial lighting;
- Environmentally friendly as the mercury is in a sold form and can be easily recovered if the lamp is broken, or for recycling at end-of-life;
- These benefits offer a considerable cost savings of between 35% and 60% in energy and maintenance costs, compared to other types of lamps which they replace.