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The Management of Lighting System in Warehouse Application and The Conservation of Energy.

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Abstract:
Lighting systems using induction lamp have been found to be the most suitable option for warehousing applications as it helps in conservation of energy, and ensures safety and long-term use.

Electrode less Induction Lamp (New Technology)

What is Induction lamp?

Induction lamp is not a new addition as a light source but its features and efficiency have been considerably improved. It is sometimes referred to as electrode-fewer lamps because there is no electrode or wire connection inside the lamp.

It consists of a glass bulb with a hollow centre and there is induction coil in it. The coil is connected to a high frequency supply generated by a control gear mounted on the lamp. The lamp has a sealed glass bulb which contains Krypton gas, a small amount of mercury and internal phosphor coating. When an electrical current passes through low pressure of mercury, vapour produces UV radiation. This radiation is absorbed by the phosphor coating and emitted as light.

The induction lamp has a long life and practically no instances of failure. On the flip side, as the electrode absorbs high level of energy it reduces the efficacy of the lamp. Sometimes there are signs of local blackening which affects the light output.

There are two basic elements used in an induction lamp.

A glass envelope, with inside coating of phosphor, evacuated and sealed after filling with a trace of inert gas (like argon/krypton) and a small amount of mercury, generally as an amalgam.

There are two basic designs of induction lamp.

In high wattage lamps, the glass envelope is tubular in circular or torridly shape with HF ferrite driver around the envelope (Fig-1).

In low wattage lamps, the glass envelope is of bulb shape with HF ferrite driver projecting inside the envelope as shown in Fig-2.

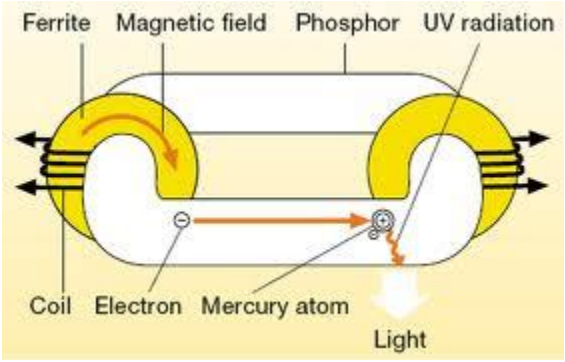


Figure -1

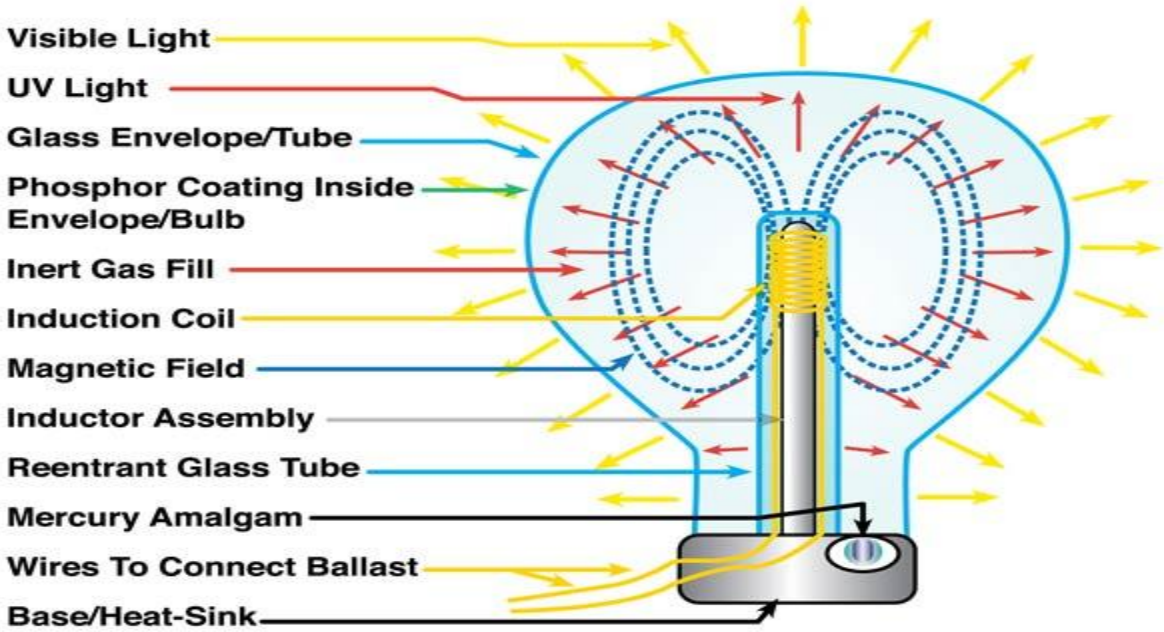
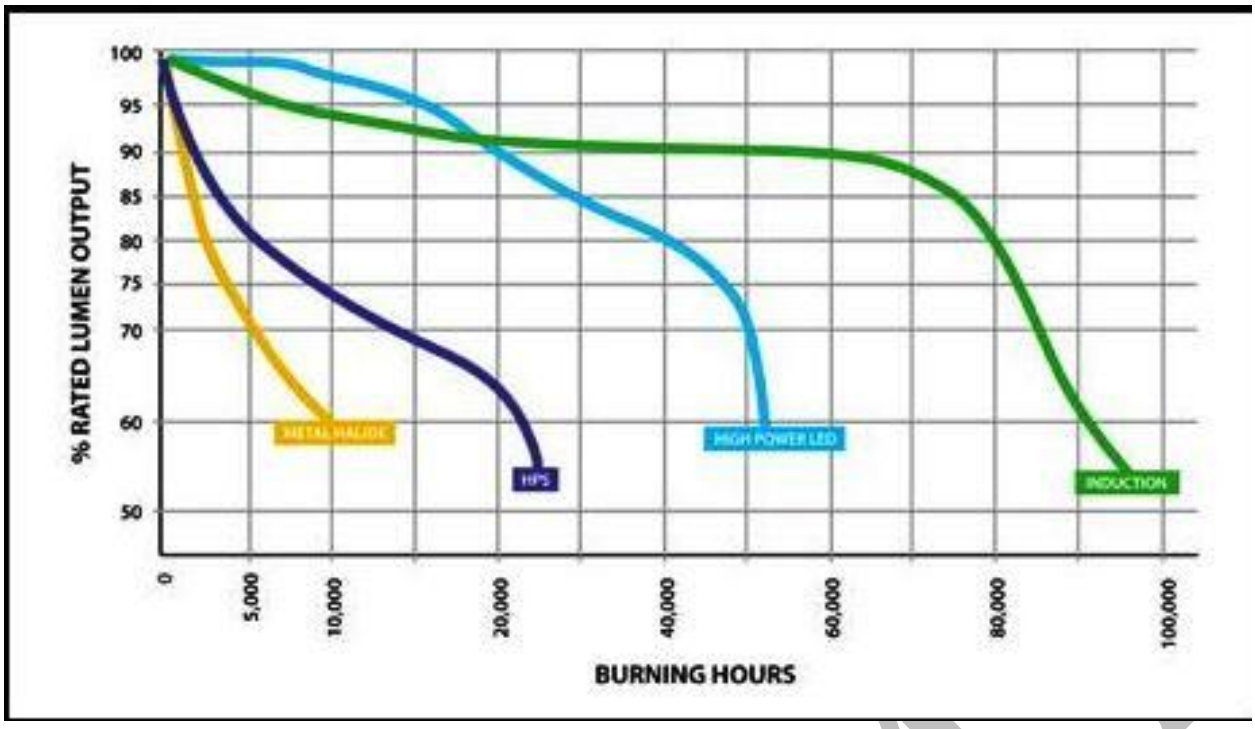
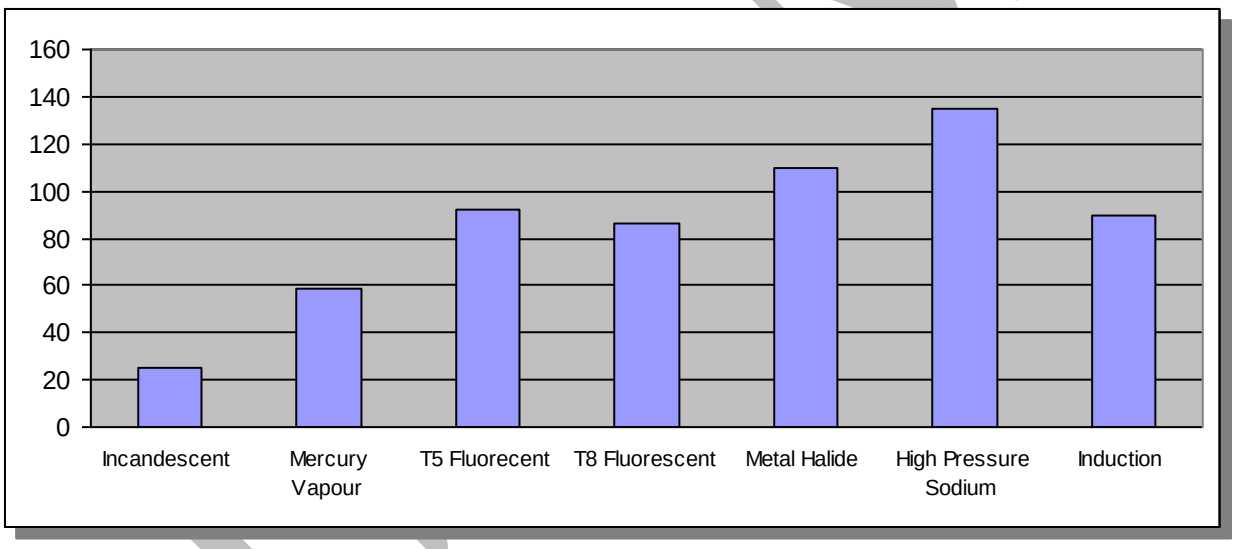


Figure2

Rated Lumen Outputs of Induction Lighting against burning hours



Electrical conversion Efficiency- Different lamps (in lumen per watt)



The Conversion Efficiency of Sodium Lamp is higher but it is not converted the Visual

Methods and Results:

Visual Effective Lumens:

Mainly there are two types of vision.

a. **Photopic Vision:** It applies only at 'high' light levels (daylight, lit interiors etc.), where the rods in the human retina are less active and cones dominate our vision, and colour discrimination and the ability to resolve detail in the visual field are both good.
b. **Scotopic Vision:** At 'low' light levels (e.g. moonlight), only the rods are active, visual acuity is poor, and it is not possible to distinguish colours in this condition.

In warehouse lighting, Photopic vision is considered.

Visual Effective Lumen	**Initial Lumen**		**VEL**
250W Sodium	**27000**		**16740**
120W Induction	**9000**		**17640**

Visual effective lumens is more for 120W Induction lamp

Requirement of light in different areas of a Warehouse:

For efficient functioning of a warehouse, right illumination is essential for different areas as each area caters to specific activities. The following list gives an idea of the illumination required in different areas:

a. **Very active areas: Where loading and stacking takes place and forklift movement is intense. The illumination required is 10-20 foot candles.**

b. **Active area: Where small items are packed and containers are labelled. The illumination required is 20-50 foot candles.**

c. **Inactive areas: This area requires 5-10 foot candles.**

d. **Horizontal and vertical illuminations: The best way to calculate the illumination level essentially required is to consider the 'average to minimum' ratio. The horizontal average-to-minimum ratio for a rack area should not exceed 3:1. For example, if light level in the aisle is 20 foot candles, the minimum horizontal level of illumination should not be more than 6.7 FC. The vertical average-to-minimum ratio for the same area should not be more than 10:1.**

e. **Reflectance of the surrounding areas: It is important to remember that illumination is also impacted by the surrounding walls, ceiling, floor, racks, pallets and containers.**

(foot candle - one lumen per square foot)

Discussion:

The logistics sector in India is witnessing a phenomenal growth. According to a recent study released by Amarthi Consulting and CII Institute of Logistics, around 110 logistics parks, spread over approximately 3,500 acres, are expected to come up across India at an estimated cost of US$ 1 billion. The logistics sector has been growing at a rate of 8 to 10 per cent per annum since 2002 and is expected to grow over $100 billion in 2014.

Warehousing activities account for around 20 per cent of the total Indian logistics industry. This market segment is estimated to grow from US$ 20 billion in 2007-08 to about US$ 55 billion by 2014.

The government has been giving impetus to the logistics sector by allowing 100 per cent FDI, eliminating CST, introducing VAT and improving multi-modal transportation through projects such as dedicated freight corridors.

However, challenges still remain.

Modern warehousing and logistics parks are still in their nascent stage. Indian companies wrongly perceive a logistics park as an extended version of warehousing.

Hence, these companies have a long way to go before they fulfill the basic requirements for a world class logistics park. They will have to come up with quality products so that customers are encouraged to outsource logistics services from third party logistics (3PL) companies.

Add to this, the snail's pace at which the government acts. The government has to take immediate steps to facilitate the industry keep up with the growth demand. Fast implementation of GST, rationalization of tax regime, adoption of a liberal land acquisition policy, enhancement of multimodal connectivity would be the prerequisites for logistics park projects to succeed.

With the advent of foreign manufacturing, retail and 3PL companies, more and more warehousing companies are providing modern amenities. The ensuing GST regime has also necessitated organized and consolidated warehousing system.

Though the SEZ programmes in the country ran aground as it failed to generate significant employment and boost national exports in real terms, state governments in all likelihood will continue establishing SEZs. Hence, development of logistics parks will become imperative to cater to this sector.

KPMG in one of its recent report states that the Logistics sector appears to be the most prominent sector in terms of growth and development. A look at their report will give an insight into the growth potential and the demand.

Driven by growth in production and consumption, organised retail, logistics outsourcing, modern assets and the likely rollout of Goods and Service Tax (GST), the demand for warehousing space is estimated to grow from ~ 391 mn sq. ft. in 2010 to 476 mn sq. ft. in 2013, growing at ~ 6.8 percent CAGR during this period.

Further, it is important to mention that warehouse spaces would be mainly occupied by the Food, Engineering, Electronics and the import industries.

Note: Warehousing demand excludes CFS warehousing space, warehousing space within factories and public agriculture warehouses
Source: Industry discussions, KPMG in India Analysis

Location preferences of warehouses:

Major supply chain glitches are a constant worry for companies as it can impact their goodwill, bottom lines and shareholder value. So the pressure to reduce inventories and increase inventory turns has made location, size and design of warehouses major considerations. An analysis in the light of various growth prospects and challenges reveals that most attractive locations lie in major western and southern cities. Mumbai, National Capital Region (NCR), Hyderabad and Nagpur top the list of attractive locations.

Lighting system requirements and the conservation of energy:

Given that the Indian warehousing landscape is gradually getting redefined from the conventional concept of a 'godown' - a mere four-wall-and-shed structure – to modern set ups with high levels of automation, multi-rack and palletization infrastructure, the need for the wider industry to re-visit their warehousing approach is pressing. Perhaps, the onset of GST, with its potential to revamp the national warehousing network, could be considered as the single largest industry-wide opportunity to consider smart warehousing as a cost-saving opportunity across the supply chain instead of a standalone necessary evil due to its capital-intensive nature, noted a KPMG report.

It does not merit reiteration that warehousing sector will need huge amount of energy for illumination, operation and maintenance of such establishments. However, since this segment is yet to emerge as a new area of consumption, it has not been considered in the present energy consumption data. Therefore, there is an urgent need to look into this sector in terms of conservation of energy and suggest the right kind of light source.

Induction Lamp and LED lighting are the two alternatives to conventional lamps and these offer almost equal benefits in terms of energy saving. That said, induction lamp and lighting system are most suitable for all the parameters of warehousing. It also scores on the life expectancy and the ease-to-manage factors.

Most important, the lighting domain needs to be carefully looked into from the perspective of climate, manpower, skilled R&D, retrofit, replacements and manufacturers of a particular country.

The India Perspective:

Area	Induction	LED
Technology	Mature	Initial
Climate	Under testing	Under Testing
Skilled Manpower	Available	Not Available
Skilled R&D	Available	Not Available
Retrofit	Yes	Not all
Manufacturers	Yes	No
Replacement	Yes	No
Specifications	Yes	Yes
Standards	RDSO(Indian Railways)	Partly by BIS

Now, let us compare the different aspects of Induction and LED lighting:

COMPARISON	INDUCTION LAMPS	LED
Life Hours	100,000	50,000
Energy Saving Efficiency	Excellent	Excellent
Lumen Efficacy	upto 85 Lm/W	upto 95 Lm/W
Lumen Depreciation Rate %	10% @ 50,000 Hours	30% @ 50,000 Hours
CRI	80 - 90	70 – 90
Start & Re-strike	Instant	Instant
Flicker	None	None
Glare	None	Yes
Environmental Safety	Very little solid mercury, easy to recycle the lamp after 100,000 Hours.	Currently, disposing of LED products is not a big issue yet. However, LED recycling issues will have to be addressed in the near future.
Damnability	dim to 50%	dim to 1%
Replacement	the Lamp & Generator can be replaced separately	the LED modules are integrated in the fixture & are hard to replace.
Temperature	from -40C to 60C	Over-heating will cause reduction in light & shorten the service life
Warranty	5 years	3 years

Advantages of Induction lamps:

- Consumption of Power: With the installation of new efficient Induction Lamp technologies, the energy consumption can be reduced to 50% +/- of the conventional lighting systems. Therefore, all existing lamps and fixtures should be considered for replacement, retrofit or upgrading to maximum energy consumption.
- Life: The life span of Induction lamp is 100,000 burning hours. Translated, it means 12 hours of ignition per day for 22 years. This holds the key to cost reduction and lowering of maintenance cost. Due to its long durability, expenses incurred on logistic, administration, warehousing, disposal et al can be reduced.
- Maintenance: The maintenance cost is low in comparison to all other lighting sources.
- Wear and tear of parts: Induction lamp is an electrode less device. Since it does not contain any filament and electrode, which causes conventional lamps to fuse, the replacement cost is minimal. This device can sustain in extreme conditions like accidental collision, storms, intense vibration and long hours of ignition.

- Generation of Heat: Less heat is generated in Induction lamp because of the technology. Hence, the cost of lighting fixture maintenance and the HVAC or air-conditioning energy consumption is less than other lighting sources.

- Color Rendering Index (CRI): This parameter is very important in any lamp as it ensures visibility, safety and visual comfort. The Induction lamp has natural colour of light. So it is suitable for all areas of lighting.

- Cold Ignition: Induction lamp remains operational even in minus 40 degree temperature. It can be comfortably used in cold locales like hill stations and mountainous regions of the country.

- Flicker and Glare: These do not occur in Induction lamps.

- Noise: Induction lamp with good design does not make any humming noise.

- Safety: Induction lamp is safe for the environment as it does not contain mercury. It uses a small quantity of amalgam which can be recycled.

- EMC: The ROI of Induction lamp is around 3-4 years which can be drastically reduced with more and more use.

- Areas of application: Induction lamp can be installed in the following areas:

High Bay light, Low Bay Light, Flood Lights, Indoor Lights, Wall Lights, Security Lights and other warehouse areas.

In an article in Lux magazine, Lighting economist Dave Tilley shared an interesting experimental data about a warehouse in Belgium. The warehouse has an aisle which is 164m long, 9m wide and 8m high. The 22 existing luminaires are 400W switch-start HIDs that operate for 3,000 hours a year.

The decision about which technology to choose is, in fact, an investment issue. Based on figures, one can determine the most efficient solution. For number mongers, here is an example.

	INDUCTION	LED	Fluorecent
No of Luminaires	22	22	22
Power(W)	250	150	320
Luminous Flux(lm)	366.302	310.552	567.600
Luminous efficacy(lm/w)	65.51	94.11	80.63
Average Lux	171	145	204
Luminaire cost	INR 41614	INR 45781	INR12486

Comparison between Induction, LED and Fluorescent Technologies

Luminaire	Annual energy use	Energy savings	Cost savings In Pound sterling	Luminaire cost	ROI
400Wt HID	31680KWh				
250Wt INDUCTION	16500kwh	15180kwh	1.518	1100	7 years 3momth
150Wt LED	9900kwh	21780kwh	2.178	12100	5 years 7months
320Wt T5	21120kwh	10560kwh	1.056	3300	3 years 2months

Well, it seems to be a relatively easy decision both cost wise and efficiency wise. But what about the cost of maintenance and replacement?

If we assume that the T5 will be maintained every three years at a cost of £1,500 then over 10 years the T5 cost increases to £7,800 with an ROI of seven years and five months.

Given the 3,000 annual operating hours, each of the technologies has a reasonable life. But if we look at life claims, both theT5 and LED sources will have to be replaced at least once during the lifetime of the induction luminaires.

This would result in incurring both luminaire and installation costs, apart from the fact that work can be interrupted. Therefore, the decision should be based on the investment and the length of time the business will be occupying the space in its existing layout.So as the number of annual operating hours increases the argument in favour of induction lighting gets stronger.

The above example would not provide similar results in India but following these measurements and analyzing the applicable data, proper selection of lighting can be ascertained.

Management of Lighting in warehouse:

To ensure the management of Induction lighting in warehouse following steps are to be taken:

- Power Supply: Considering the poor quality of power and the fluctuation, the design and production of suitable Power Suppy to be used in order to sustain the long life of Induction lamp.

- Remote Control System: Thanks to improved technology and state-of-the-art innovation, Induction lamp can be operated with the Remote Control System. It ensures automatic switch on and off at the touch of a button on a computer monitor. The whole process can be monitored via real-time video internet based camera. This process will further reduce cost and with the constant rise of energy tariff this needs to be followed and implemented.

- Qualified Installation professional: Installation of Induction lamps must be done with the help of qualified professionals because it requires working in high voltage electrical circuits.

- Dimmer: In warehouses, the need of dimming is important so clear understanding of the type of the dimmer must be ensured.

- Uniform Light Distribution: The light distribution plays an important role in efficiency of the warehouse performance.

1. Lighting uniformity in the warehouse space is paramount because visibility should be clear. Forklift operators must be able to easily look up and down the stack of merchandise without adjusting their vision frequently.

2. Placement of Luminaries is important to ensure lighting uniformity. The designer should make an effort to minimize shadow by placing the luminaries in strategic locations like the aisle, top of the rack, below the ceiling, on the wall, in the loading bay and security areas.

3. Controls: There are areas where the light is required 24 hours. But in peripheral areas, the light is required only during operation. A bi-level switching system should be used in the warehouse area so that not just illumination costs but operation costs are controlled as well.

Conclusion:

Energy conservation has become the need of the hour for a country like India which has a huge population, an ever-growing middle class, cities bursting to the seams and limited energy resources. The country spends top dollars to import oil, thus contributing to its growing current account deficit. So it is imperative that an energy-intensive sector like warehouse illumination uses an efficient lighting system.
Further, due to vast improvement in the features and efficiency of the induction lighting system, it is a prudent choice in terms of cost control, especially for a cost-intensive segment like warehousing. Though initial investments will be more, it will accrue long-term benefit because of durability and minimal replacement cost. The light fixtures can be used in all the bay areas, on poles above 8 meters and can be mounted on the ceiling as per design requirements. The designers should consider minimum application, maximum coverage, ease of operations and management.
The induction lamps are now being manufactured in India. A US lighting major is importing the lamp from their China factory and are manufacturing the ballast and the efficient fixtures in their factory based in Pune. Therefore the quality control is ensured.

What is required is evolving specifications and standards suiting the Indian condition. The Bureau of Indian standard is taking steps in that direction. Meanwhile, in the absence of any Indian standard, the research wing of the Indian Railways, RDSO, has developed its own specifications. After testing Induction lamps as per those specifications, they have decided to procure a large consignment for one of their workshop facilities in northern India.
This initiative is directed not only to conserve energy but to meet the growing demand too meet the growth thrust in the present and future of this nation.

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