

**TITLE: Energy efficiency through sustained lamp performance**

**Author: Dhananjoy Biswas**

**Inventor Dragon Kink Effect –HID lamp**

Scientist E ; Electronics Regional Test Laboratory (East)

Sector –V: Block-DN: Salt Lake City: Kolkata-700091

India

Email: [dnbiswas@yahoo.co.uk](mailto:dnbiswas@yahoo.co.uk)/[dnb@ertleast.org](mailto:dnb@ertleast.org)

**Abstract:**

High Intensity Discharge (HID) Lamp such as Sodium Vapour and Metal Halide has an average life of about 20000 hours in Europe and USA compared to 8000 hours in many parts of Africa, Asia including India. Lamp failures are observed either due to burning hours of lamp or due to no of switching cycle. In Europe and USA Lamp failures are mainly due to ageing / burning hours of lamp. Whereas in many parts of Africa, Asia including India lamp failures are due to number of switching cycle (ON/OFF) as a result of frequent power supply interruption (Average 3 switching per 12 hours of operation). Starting a HID lamp require a high amplitude high energy pulse to ionize mercury vapour with other halides. The high amplitude high energy pulse are provided by an ignitor for a duration of 3 to 5 minutes till lamp current is almost 90 percent of nominal value /110 percent of nominal lamp voltage. This high amplitude high energy pulses causes sputtering /erosion of lamp electrode, thus reducing lamp efficacy as well as switching life of a lamp. Luminous efficacy depreciates to below 40 percent of 100 hour value in 8000 hours in India and in 20000 hours in Europe and U.S.A .It is a well known fact that in sports and security lighting where high voltage ignitor pulses in the order of 20 KV are used for instant switching on HID lamps , lamp life decreases to few cycles. It is observed through experimentation that when HID lamp such as High Pressure Sodium Vapor and Metal Halide lamps are ignited with Pulse ignitors inbuilt into luminaire having energy content 2.25 mJ for 100 cycles , luminous efficacy depreciation is 8 to 10 percent of 100 hour value for sample size of 10. Maximum luminous efficacy depreciation observed 2 percent, when same rating lamps are subjected to ignition for 100 cycles with ignitors having energy content below critical limit under same condition. This arrest of depreciation of luminous efficacy is due to arrest of erosion of tungsten electrode. Depending upon arc tube length, critical energy of discharge tube will vary. Sustained illumination with ageing of lamp is possible with correct determination of critical energy and starting lamp with ignitor pulses below critical energy. Sustained illumination of lamp will enable to consider higher maintenance factor for illumination design, thereby lower power HID lamp can be used in place of higher power lamp. It is estimated to save 33 percent energy. Sustained illumination of lamp also contributes to arrest of global warming by arrest of heat radiation from millions of aged light sources.

**TITLE: Energy efficiency through sustained lamp performance**

**Author: Dhananjoy Biswas**

**Inventor Dragon Kink Effect –HID lamp**

Scientist E

Electronics Regional Test Laboratory (East)

Sector –V: Block-DN: Salt Lake City: Kolkata-700091

India

Email: [dnbiswas@yahoo.co.uk](mailto:dnbiswas@yahoo.co.uk)/[dnb@ertleast.org](mailto:dnb@ertleast.org)

**Text:**

High Pressure Sodium Lamp (H.P.S) and Metal Halide Lamp (M.H) are also known as High Intensity Discharge Lamp. Both lamps are widely used in street lighting and flood lighting. Among white light sources luminous efficacy of Metal Halide lamps are much higher than any other sources. High Pressure Sodium Lamp that produces strong yellow light (589 nm) has luminous efficacy between 100 to 135 lumens per watt with poor color rendering index (CRI). A High Pressure Sodium Lamp (H.P.S) has a discharge tube enclosure of quartz/quartz glass or a ceramic discharge tube of densely sintered polycrystalline metal oxide ( $Al_2O_3$ ) material with filling comprising mercury in excess, sodium /sodium iodide/cerium iodide in excess and an inert gas (Xenon/Krypton/Argon) as buffer. Inert gas such as xenon act as an aid in starting of lamp. Discharge tube has two electrode made of tungsten. Spacing of the electrode depends on the power rating of the lamp.

To start a sodium vapor lamp we need a high amplitude pulse with sufficient energy for starting ionization in the discharge tube. We are mostly conversant with two types of ignitors that are used for starting discharge in discharge tube of High Pressure Sodium Lamp and Metal Halide Lamp. They are Pulse Ignitor and Superimposed Ignitor. Often ignitor designs are universal for power rating from 70 watt to 400 watt HID lamp. Pulse ignitors use ballast as a transformer for generation of high amplitude high-energy pulse that can start a lamp even at 30-meter distance from control gear.

Superimposed ignitors are also known as series ignitor. Lamp current passes in series with ignitor and has comparatively low energy high amplitude pulse output. It can ignite discharge tube for short distance only. Superimposed ignitors are normally used inbuilt into the luminaire.

An ignitor provides high-energy high amplitude pulses for duration of 3 to 5 minutes till lamp voltage is 110 percent of typical lamp voltage of lamp or lamp current is 90 percent of typical lamp current value.

Universal ignitor provides same pulse amplitude and energy across the lamp irrespective of lamp power rating. No consideration has been accounted for discharge tube length and ratings. Erosion of lamp electrode in 150 watt HID lamp discharge tube by universal ignitor due to pulse energy greater than critical limit will be higher than 400-watt discharge tube. The ionizing potential required for 150 watt (1.8 KV peak) HID SON lamp is much lower than 400 watt (3.2 KV peak) HID SON lamp.

Accordingly depreciation of luminous efficacy is also higher in 150 Watt HID lamp because of the use of Universal ignitor.

Frequent power supply interruption and restarting of lamp with ignitor pulse energy greater than critical limit causes lamp failure much earlier than declared lamp life. The failures are due to “Dragon Kink Effect”. It is a well-known fact that in sport and security lighting where very high voltage high-energy ignitor pulse greater than 20 KV is used for instant switching on HID lamps, lamp life decreases to few switching cycles only.

Failures of lamps are mainly due to gradual erosion tungsten electrode, which is associated with depreciation of lumen out put. In photometry measurement when pulse ignitors are used inbuilt into the luminaire, depreciation of illumination after successive five switch on /off cycle is clearly evident through measurement. When such pulse ignitor are used externally, nearly 15 meters away and luminaire is subjected to five switch on /off cycle, hardly such depreciation of illumination is observed.

High Intensity Discharge (HID) Lamp such as High Pressure Sodium and Metal Halide has an average life of about 20000 hours in Europe and USA compared to 8000 hours in many parts of Africa, Asia including India. Lamp failures are observed either due to burning hours of lamp or due to no of switching cycle. In Europe and USA Lamp failures are mainly due to ageing / burning hours of lamp. Whereas in many parts of Africa, Asia including India lamp failures are mainly due to number of switching cycle (ON/OFF). Repeated switch on/off cycle is due to frequent power supply interruption (average 3 switching per 12 hours of operation).

In Europe and USA during 20000 hours of operation, HID lamps will be subjected to **1667 switching on/off cycles** (considering 12 hours of operation per day without any power supply interruption). Luminous efficacy depreciates to 40 percent of 100 hours value in average life of 20000 hours.

Most of countries in Africa, Asia including India Luminous efficacy depreciates to below 40 percent of 100 hour value in 8000 hours. , HID lamps will be subjected to **2400 switching on/off cycles** (considering 12 hours of operation per day and average three power supply interruption).

Depreciation of Luminous efficacy means lower conversion rate of electrical power into light output. Heat radiation from lamp increases. Millions of lamp across the globe acts as a source of heat generation and a major contributor to the global warming.

In Europe and USA depreciation of luminous efficacy is slow as no of switching cycle is less. Other than burning hours, every starting of HID lamps in developed countries after 24 hours is also a major cause of gradual depreciation of luminous efficacy.

Depreciation of luminous efficacy could be minimized by determining correct critical energy of the discharge tube in HID lamps used **in both developed and developing** countries and by using ignitor that provide critical energy across the lamp during starting and arrest erosion of tungsten electrodes. Ignitors that are designed to provide critical energy across the lamp as per rating will be known as D-Kink Ignitor.

## Experimentation results shows

- a) Metal Halide Lamp rating 250 Watt subjected to switching 100 cycles (on/off) ignited through pulse ignitor having energy content greater than 2.25 mJ inbuilt into the luminaire has luminous efficacy depreciation 8 to 10 percent. for a sample size of ten(10).

Metal Halide Lamp rating 250 Watt subjected to switching 100 cycles (on/off) ignited using D-Kink ignitor that provide critical energy across lamp inbuilt into the luminaire has luminous efficacy depreciation maximum 2 percent.

- b) High Pressure Sodium lamp rating 250 Watt subjected to switching 100 cycles (on/off) ignited through pulse ignitor having energy content greater than 2.25 mJ inbuilt into the luminaire has luminous efficacy depreciation 3 to 5 percent. for a sample size of ten(10).

High Pressure Sodium lamp rating 250 Watt subjected to switching 100 cycles (on/off), ignited using D-Kink ignitor that provide critical energy across lamp inbuilt into the luminaire has luminous efficacy depreciation maximum 1 percent.

From the result it is concluded that Metal Halide lamps are more susceptible to starting and will have less life than High Pressure Sodium lamp.

Sustained illumination nearly 80 percent luminous efficacy of 100-hour value with ageing of lamp (20000 hrs) is possible through correct determination of critical ignition energy of discharge tube and use of **D-Kink ignitor**.

It has also been observed, 150 watt lamp has higher depreciation of luminous efficacy than 250 watt lamp with universal pulse ignitor having energy content greater than 2.25 mJ inbuilt into the luminaire subjected to switching 100 cycles (on/off) ignited through pulse ignitor

Sustained illumination of lamp will enable to consider higher maintenance factor for illumination design, thereby lower power HID lamp can be used in place of higher power lamp. It is estimated to save 33 percent energy (electricity cost) and save billions of Dollar/ Euro across the globe.

Sustained illumination means arrest of heat radiation from millions of light sources across the globe, which has been a source of great concern so far. This will effectively contribute to arrest of global warming.

**References:**

1. IEC Specification: IEC60927/60926 FOR IGNITORS : IEC 61167 for M.H lamp and IEC 60662 for SON lamp
2. Data from Philips Lighting
3. Data from Venture Lighting
4. Data from GE lighting
5. Data from Crompton Greaves Lighting
6. Data from Sigma Search Light, Kolkata
7. Wikipedia- Sodium Vapor Lamp

**Acknowledgements for support and encouragement:**

1. Mr. R.R.Ray General Manager; Crompton Greaves Lighting
2. Mr. Manoj Verma Vice President Crompton Greaves Lighting
3. Mr. Kunal Chaudhuri General Manager; Philips Electronics India Ltd.
4. Mr. S. K. Das Deputy. Manager; Philips Electronics India Ltd
5. Mr. R.K. Bhandari Managing Director - Sigma Search Light
6. Mr. Saibal Chatterjee Senior Director –ERTL (East)
7. Dr. S.L.Sarnot Director General (STQC)