A STUDY OF ILLUMINATION PATTERN OF AN LED LUMINARIES

B. Balaji Bhanu
Department of Electronics, Andhra Loyola College, Vijayawada, AP, India
Email: balajibattu@gmail.com
L. Ekambaram
Department of Electronics, Andhra Loyola College, Vijayawada, AP, India
N. Lakshmi Kanth
Department of Electronics, Andhra Loyola College, Vijayawada, AP, India

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Abstract: Light emitting diodes (LEDs) are commonly used as light sources in diverse applications. LEDs are more energy efficient than traditional light sources. They provide much higher energy conversion efficiency than incandescent lamps, and fluorescent lamps. LEDs are an excellent choice for various lighting applications ranging from indoor to outdoor lighting. As the luminarie is a complete lighting unit, comprises an LED light source together with the parts which distribute the light, position and protect the lamps, and connect the lamps to the power supply function is to direct light to appropriate locations, without causing glare or discomfort. Luminous distribution based on Point source of radiation (e.g. Incandescent Lamp), Line source of radiation (e.g. Tube Lights), Plane Source of Radiation (Ideal situation). In this paper the performance of a few basic illumination patterns are compared. Finally, three basic regular grid shapes for an LED array are compared. Since the light output is not the same intensity at all angles; there is more light in some directions than others. There are three common light emission distributions for LEDs: Lambertian, batwing, and side - emitting. Finally based on the illumination patterns the luminaries are used for different applications in hospitals, industries, educational institutes, shops, restaurants & other commercial places.

Keywords: Illumination Pattern, Luminaries, LED, Luminous Flux, Viewing Angle.

Introduction: A luminaire is a complete lighting unit, comprised of a light source (lamp or lamps), together with the parts that distribute the light, position and protect the lamps, and connect the lamps to the power supply. The luminaire's function is to direct light to appropriate locations, without causing glare or discomfort. A luminaire or a light fixture, main function is to direct light using reflective and shielding materials. The combination of a module or a light engine with control gear to form a lighting system is described by the term LED luminaire. The luminaire also defines the optical system in conjunction with the light source and functions simultaneously as a heat sink, if required.

Light Intensity and Light Intensity Distribution Characteristics: Illuminance light intensity in each direction of the space has uniform distribution. The test results received from the detectors of different receiving apertures in different distance are the same. However, because the different light distribution of LED, the test result changes with the measuring distance and the detector aperture.

One of the main characteristics of a light is the luminous pattern, to better understand the distribution of intensity of light emitted on a work area in every direction. For example the light beam of an automobile headlight[1]. The fixture directs majority of the light in a forward direction in a narrow beam. So choose the technologies that distribute the light where it is most needed. If the light is distributed to an area where it is not needed then the design is not efficient and the purpose will not serve at all.

Luminaires Are Characterized By The Manner In Which The Light Is Distributed: The light distribution produced by luminaires is characterized by the Illuminating Engineering Society as follows[4]:
Direct luminaires emit light downward. These include most types of recessed lighting, including down lights and troffers.

Fig. 1: Direct (90 to 100 percent of the Light is Directed Downward for Maximum Use.

Indirect luminaires emit light upward, bouncing light from the ceiling into a space. These include many styles of suspended luminaires, sconces, and some portable lamps.

Fig. 2: Indirect (90 to 100 percent of the Light is Directed to the Ceilings and Upper Walls and is Reflected to All Parts of a Room.)

Diffuse luminaires emit light in all directions uniformly. These include most types of bare lamps, globes, chandeliers, and some table and floor lamps.

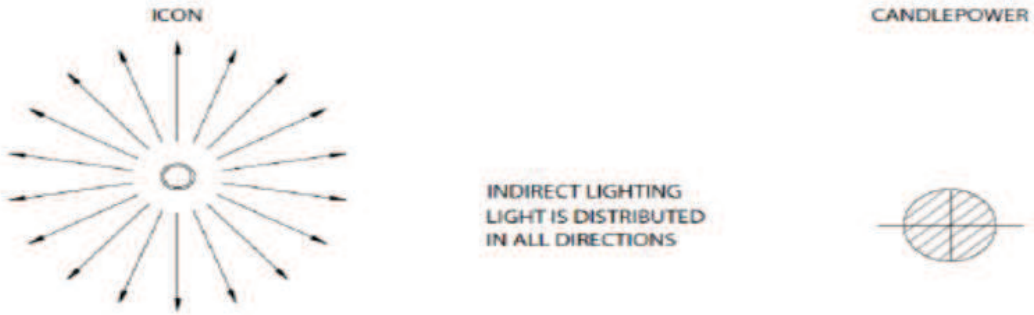

Fig. 3: General Diffuse or Direct-Indirect
(Equal Portions of the Light are Directed Upward and Downward.)

Direct/indirect luminaires emit light upward and downward but not to the side. These include many types of suspended luminaires as well as some table and floor lamps. Note that direct/indirect luminaires can be *semi-direct* or *semi-indirect* according to the proportions of up and down light.

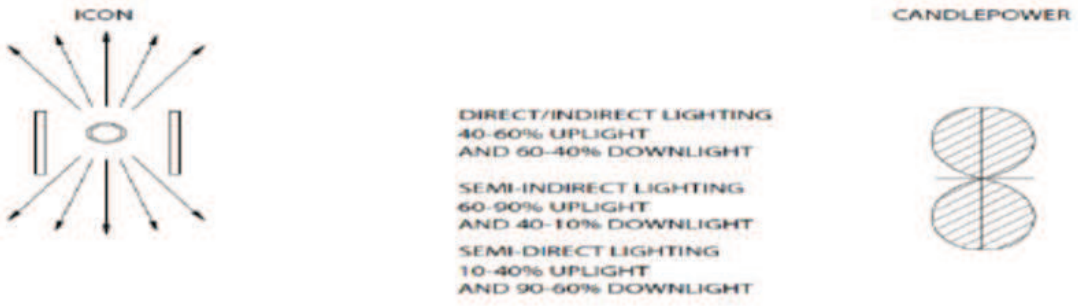

Fig. 4: Distribution Not to Sides

Asymmetric luminaires are usually designed for special applications. Asymmetric up lights, for instance, are indirect luminaires with a stronger distribution in one direction, such as away from a wall. Wall washers are a form of direct luminaire with stronger distribution to one side so as to illuminate a wall [2].

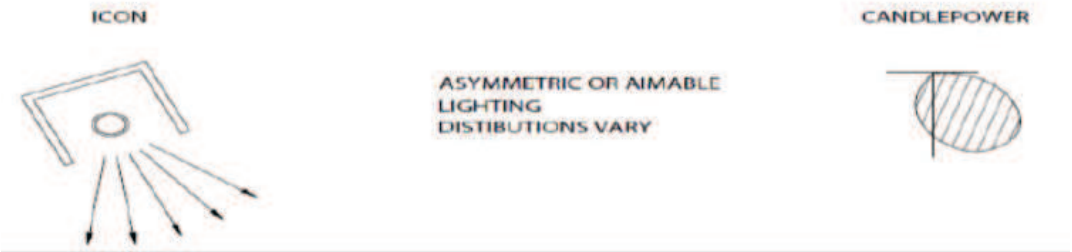

Fig. 5: Distribution for Special Applications

Types of Liminaires based on Applications:

Downlights: are often called *cans* or *top hats*. A type of direct luminaire, they are usually round and recessed in the ceiling. Their principal use is general illumination in a wide range of residential and commercial applications, especially in lobbies, halls, corridors, stores, and other finished spaces. Downlights can be equipped with incandescent, halogen, low-voltage incandescent, compact fluorescent, or HID lamps. Downlights typically consist of two parts: the can above the ceiling, and the trim installed from below the ceiling. The can must be suitable for the application.

Troffers: are widely used in offices, stores, schools, and other commercial and institutional facilities for general lighting in work and sales areas. Troffers are the most common type of fluorescent luminaire. Most troffers are designed to lay in to acoustic tile ceilings. Troffers can be equipped with most fluorescent technologies, including dimming, magnetic or electronic ballasts lamps. They can be equipped with emergency battery packs to power some or all of the lamps during a power outage or emergency condition.

Commercial Fluorescent Fixtures: *Commercial fluorescent* fixtures comprise several types of fluorescent direct luminaires. The most common type is the wraparound, wherein a lens or diffuser top surrounds the lamps, hiding them from direct view while radiating light downward and to the sides. Commercial luminaires are among the lowest- cost lighting fixtures. They are typically used for general and utility lighting in modest projects.

Industrial Luminaires: *Industrial luminaires* generally have a utilitarian or functional appearance. Fluorescent industrials are strip lights and open fixtures with simple reflectors designed to be surface-mounted or hung by chains or rods. Industrial fixtures are generally used in factories, warehouses, and, increasingly, in schools and retail stores where a less finished appearance is desired. Although most industrials are direct lighting, many are semi-direct—that is, having a small percentage of uplight to improve visual comfort.

Linear Lighting Systems: *Linear lighting systems* are fluorescent luminaires having indirect, semi-indirect, and direct-indirect lighting distribution; they are designed to illuminate offices and other more finished spaces. Because the luminaires can be obtained in varying lengths and assembled into patterns, they are called linear systems [3].

Architectural Lighting Fixtures: Architectural lighting fixtures are fixtures that are not decorative but rather functional and inconspicuous. They are used to illuminate architectural shapes and forms.

Wall washers: *Wall washers* are available in several types:

- *Eyelid* wall washers are, essentially, down lights with an eyelid-shaped shield on the room side.
- *Recessed lens* wall washers resemble down lights but use an angled lens to throw light to one side.

- *Surface and semi recessed lens* and *open* wall washers throw light onto an adjacent wall and generally work best; they can also be mounted to track.
- D*own light* wall washers are down lights designed to illuminate rather than scallop an adjacent wall, but not well enough for display purposes.

Wall Grazing Fixtures: *Wall grazing fixtures*, sometimes called *wall slots*, are used to illuminate walls in lobbies, corridors, and core areas. They are especially well suited to textured and polished surfaces.

Accent Fixtures: *Accent fixtures* allow light to focus on art and building surfaces.

Cove Lights: *Cove lights* permit uplighting from coves or other architectural elements more efficiently than do strip lights, and without socket shadows.

Task Lights: *Task lights* are specially designed to illuminate a desk area while minimizing veiling reflections.

Luminous Intensity Distribution: In case luminous intensity distribution values are provided by the manufacturer or responsible vendor, the luminous intensity distribution values of each individual LED luminaire in the measured sample shall not deviate by more than 5 percent of the rated value for all luminous intensity distribution. One of the primary functions of a luminaire is to direct the light to where it is needed.

The lighting distribution that is characteristic of a given luminaire is described using the candela distribution provided by the luminaire manufacturer. The candela distribution is represented by a curve on a polar graph showing the relative luminous intensity 360 around the fixture (looking at a cross section of the fixture. This information is useful because it shows how much light is emitted in each direction and the relative proportions of down lighting and up lighting. The cut off angle is the angle, measured from straight down, where the fixture begins to shield the light source and no direct light from the source is visible. The shielding angle is the angle, measured from horizontal, through which the fixture provides shielding to prevent direct viewing of the light source. The shielding and cut off angles add up to 90 degrees[3].

Experiment: G*enerally*, a light from any light sourc*e is in* a spherical shape aroun*d its* surr*ounding*. So in order to measure a light output at a specific said angle we need to divide the entire spherica*l* su*rface in*to solid angels and need to measure of distri*bu*tion of light an each one of conical surface, In general to measure total light output emitted by light source we should use lux meter. This is high*ly* précised instrument which is highly able to measure the light on conical surface even which is able to measure the even with solid angle of half degree because of practical constraint we adopted light source which is known as lumen method[5]. In this method we are going to measure Lux of a light source at *one meter distance* from source point with solid angle of 5 degree variation and measure in lux with different conical surface of different solid and finally estimating the total lumen output with the average of all measures[5].

Procedure:

1. Arrange the lamp whose pattern to be studied with a suitable lamp stand.
2. Fix the lux meter to the Zig at the height which is equal to centre of the light source from horizontal plane
3. Take care of distance between the lux meter and the centre of the light source must be equal to one meter.
4. Adjust lamp position such that lux meter has to show some lux both at at 0 degree and 180 degrees positions
5. Measure lux at different conical surface of different solid angle with 5 degree validation
6. Enter the measured values in a given excel format as shown below.

Precautions:

1. While performing the practical take care that no light fall inside the dark room.
2. Maintain the distance between the source point and lux meter is always one meter distance.
3. The source of the lux meter point is at the centre of the light source since the commencement of the experiment.
4. Take lux values of different conical surface with different solid angle as small as possible.

The experimental set up of each lamp arrangement in a dark room are shown in the following figures

Fig. 6: LED Street Light of 28 Watts [6]

Fig. 7: Troffer Light of 16 Watts

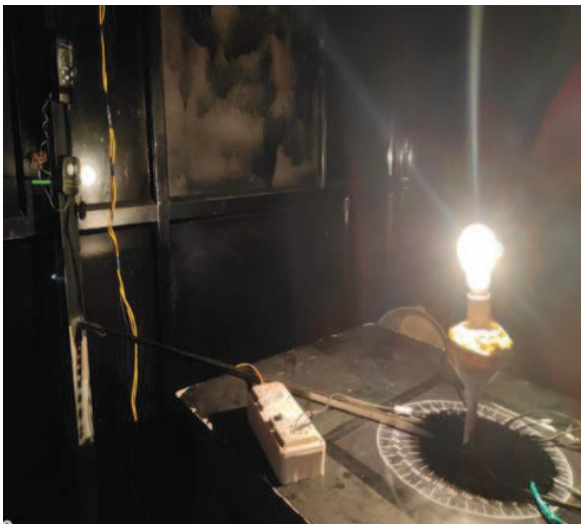

Fig. 8: Incandescent Bulb of 60 Watts

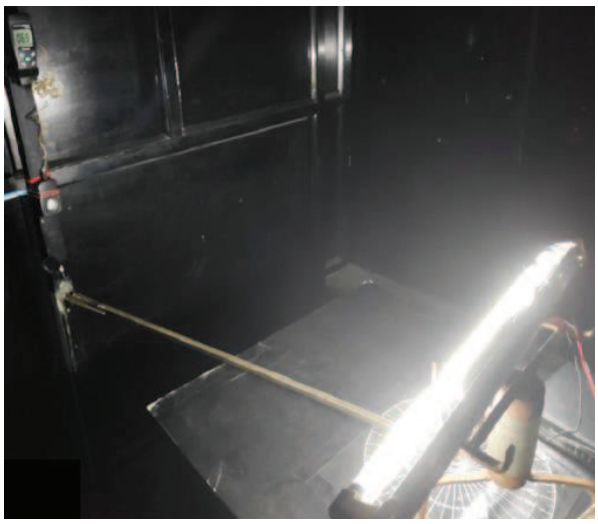

Fig. 9: Fluorescent Bulb of 18 Watts

Table 1: Tabular Form of Intensity of Light at Different Positions of Street Light, Troffer and Fluorescent Lamps

Angle in Degrees	Street Light of 28 Watts	Angle in Degrees	LED TROFFER Lamp of 16W	Angle in Degrees	Fluorescent lamp of 18W
0	6	0	4	0	17
10	280	10	10	10	72.4
20	944	20	49	20	123.6
30	948	30	92	30	157.2
40	681	40	137	40	169.6
50	513	50	178	50	170.8
60	438	60	212	60	171.1
70	397	70	237	70	171.2
80	369	80	253	80	171.1
90	367	90	255	90	171.3
100	370	100	253	100	170.7
110	400	110	249	110	170.3
120	459	120	229	120	169.3
130	561	130	201	130	162.6
140	738	140	165	140	147.2
150	967	150	128	150	122.5
160	691	160	85	160	90.1
170	96	170	39	170	42.7
180	2	180	5	180	8.4

Table 2: Tabular form of Intensity of Light at Different Positions of an Incandescent lamp

Angle in Degrees	Incandescent Lamp of 60W
0	77
10	76
20	84
30	88
40	90
50	80
60	83
70	85
80	95
90	92
100	83
110	76
120	77
130	74
140	76
150	87
160	89
170	73
180	70
190	68
200	69
210	75
220	82
230	92
240	95
250	80
260	85
270	90
280	93
290	88
300	82
310	79
320	81
330	75
340	78
350	84
360	83

Illumination Patterns of Four Different Lamps

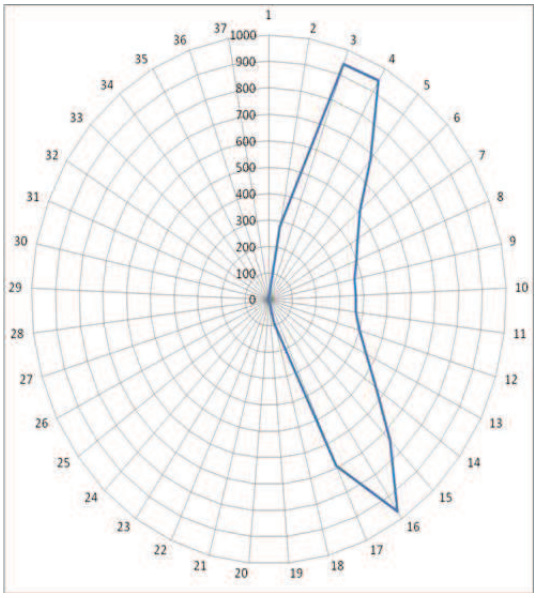

Fig. 10: Illumination Pattern of LED Street Light of 28 Watts

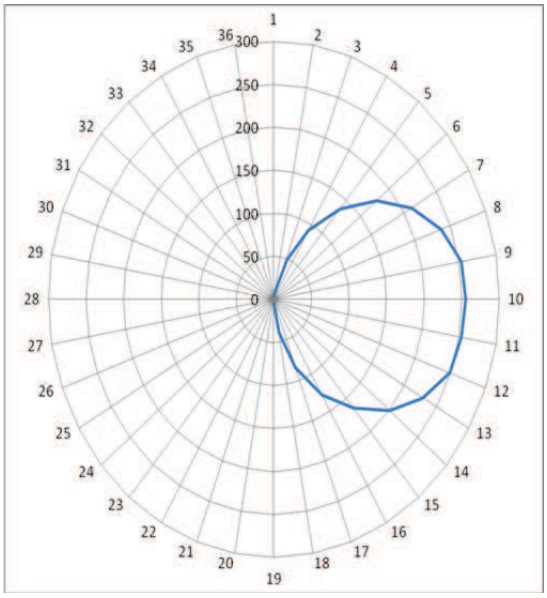

Fig. 11: Illumination Pattern of Troffer Light of 16 Watts

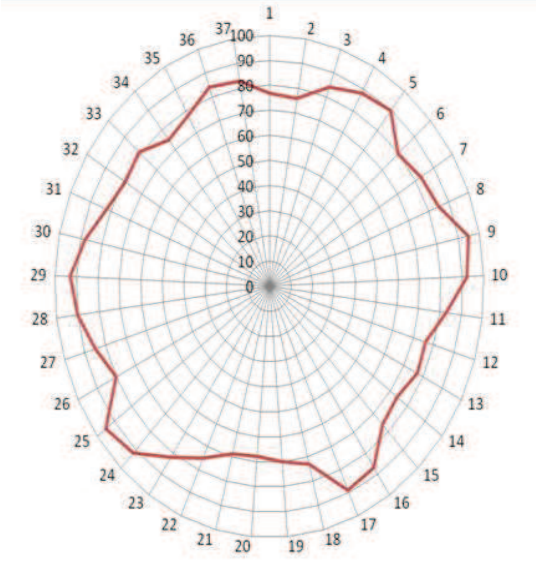

Fig. 12: Illumination Pattern of an Incandescent Bulb of 60 Watts

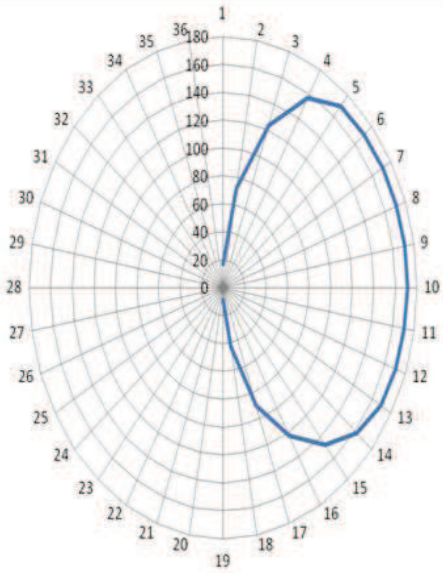

Fig. 13: Illumination Pattern of Fluorescent Bulb of 18Watts

Results and Discussion: Various lamps of illumination patterns are drawn with the experimental values of luminous intensity versus a solid angle. Various patterns shown provides a **visual guide to the type of distribution expected from the luminaire** e.g. narrow or wide beam etc, in addition to intensity [3].

Multidirectional diffuse distribution is produced by Incandescent lamp that delivers both upward and downward components of light. This lamp emits light in several directions at the

same time—toward the ceiling and walls as well as toward the floor. The reflected light from the ceiling and the interior reflection of light in the space diffuse the downward distribution, reducing shadow and contrast and creating a uniform, high-brightness interior. Luminaires that deliver both direct and indirect light, but no side lighting, provide efficient use of light on work surfaces while relieving contrast by reflecting light from the ceiling plane. Multidirectional distribution created with concentrated beam-spreads is called multidirectional concentrated.

Conclusion: Luminous intensity distribution patterns are useful when a light intensity changes rapidly within a small angular area. Then the lighting designer can assess the suitability of the luminaries for the planned purpose.

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