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Study different parameters for Energy conservation in Lighting at Technical textile production units

H. N. Amin[1], D.V.Bihola[2]

[1]Textile Technology Department, Sarvajanik College of Engineering & Technology, Surat-395001,Gujarat.
[2]Textile Manufacturing Technology, R.C. Technical Institute, Ahmedabad-380060, Gujarat.

Abstract: *Lighting is an essential service in all the industries. The power consumption by the textile industrial lighting varies around 2 - 12% of the total power depending on the type of industry. The quality and quantity of lighting affects the ambiance, security and function of facility as well as the performance of employees. Innovation and continuous improvement in the field of lighting, has given rise to tremendous energy saving opportunities in this area. This study gives overview of lighting characteristics, different lighting systems and effective ways to conserve energy in lighting at Technical textile production units.*

Key words *- Lighting, Technical Textile, Energy Conservation, Quality, Renewable Energy*

I. INTRODUCTION

Lighting in textile industry covers a wide range of different working interiors and tasks: from small workshops to huge factory halls, and from fine precision work to heavy industrial tasks. The lighting quality should always be high enough to guarantee sufficient visual performance for the tasks concerned.

1.1 Effects of Poor lighting quality

Working in poor or low quality lighting, people can suffer eye strain and fatigue, resulting in poorer performance [1]. In a number of cases, it can lead to headaches. Headaches may sometimes be caused by lamp flicker. In some cases, flicker can also cause stress in people.

1.2 Good quality Lighting Criteria

- sufficient light at the visual task
- good uniformity of the lighting over the whole task area
- balanced luminous distribution throughout the room
- lighting without flicker
- good colour rendering and appropriate light colour

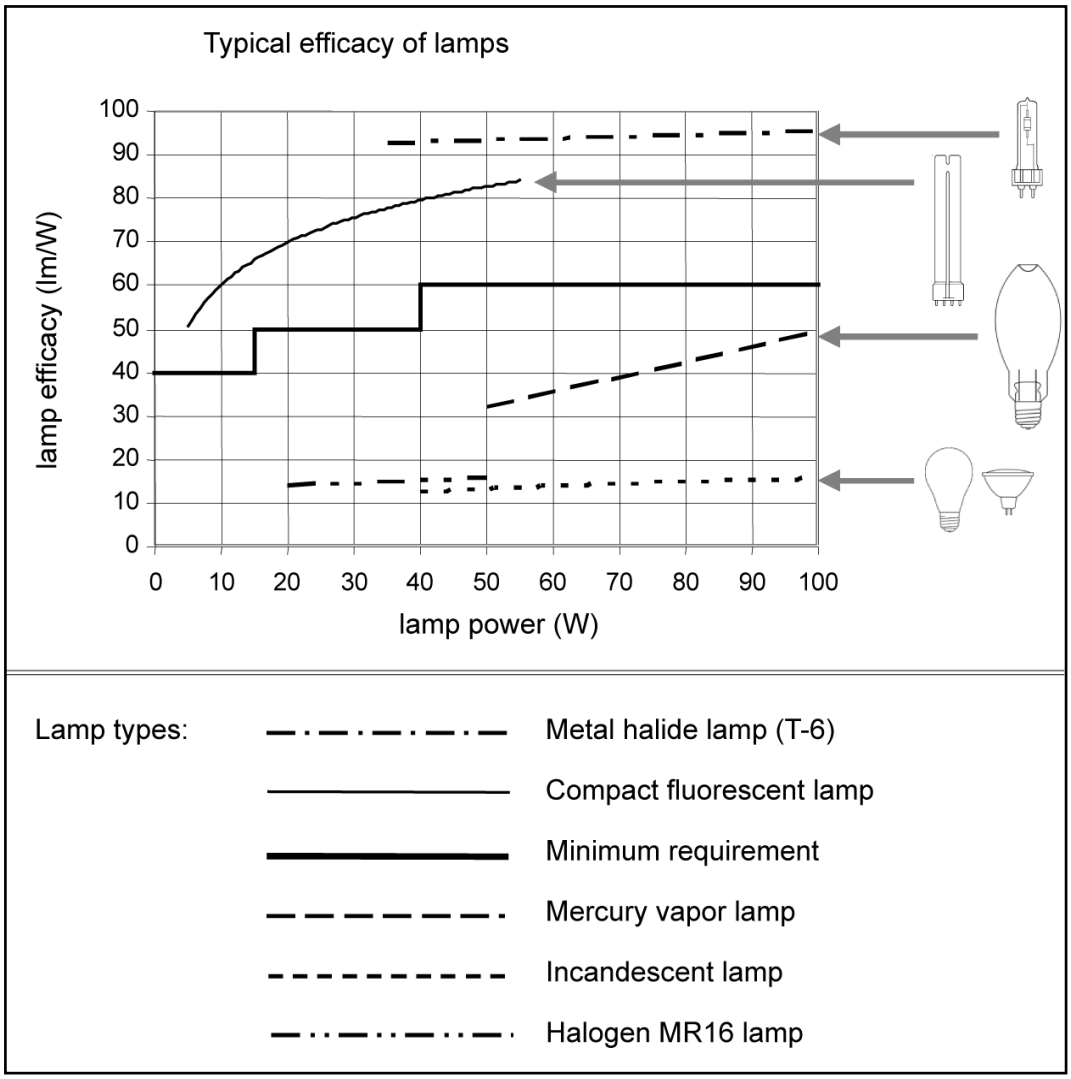
1.3 Effects of increased overall quality of lighting

- increase in task performance
- reduction in number of rejects/failures
- accident reduction

II. DIFFERENT LIGHTING SYSTEMS USED IN TECHNICAL TEXTILE PRODUCTION UNITS

- **Incandescent [2]**
- **Fluorescent [3,4]**
- **High Intensity Discharge (HID)[5]**
  - Mercury Vapor (MV)
  - Metal Halide (MH)
  - High Pressure Sodium (HPS)
  - Low Pressure Sodium (LPS)
- **Solid-State Lighting**

III. TYPICAL LAMP EFFICACIES [6]



IV. THE MEASURE OF LIGHT

Color temperature is a measure of the light bulb's color when illuminated, and is measured in degrees Kelvin (Table 4). The higher the number, the whiter and then bluer, the color.

"Table 4: Bulb Color Temperature Chart"

Color Temperature (Kelvin)	2700K	3000K	3500K	4100K	5500K 6500K
Atmosphere	Warm		Neutral	Cool	Daylight
Mood Created	Inviting, Comfortable, Relaxing		Efficient, Balanced	Bright, Clean, Lively	Crisp, Refreshing, Energetic

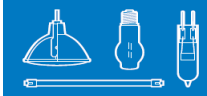
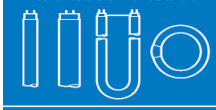
V. ENERGY CONSERVATION IN TECHNICAL TEXTILE PRODUCTION UNITS

Lighting can account for up to 12% of textile industry's total electricity bill. By reduction in this through conservation means can also contribute to lower carbon emissions, a major cause of climate change. Different ways to conserve energy in lighting are as follows :

5.1 Efficient light source

The standard 60 watt incandescent light bulb provides 13 to 14 lumens per watt. An equivalent CFL provides between 55 and 70 lumens per watt. An equivalent LED can range between 60 and 100 lumens per watt[8]. (Efficiency is measured by the number of lumens per watt a bulb provides. Lumens tell us how bright a light bulb is. Watts tell us how much energy the light bulb uses.) Two types of fluorescent lamps are available, namely the cool light (colour 54) with a colour temperature of 650CTK and the white (colour 33) with a colour temperature of 420CTK. For the same illumination level, 10 % saving of energy is possible with white fluorescent than with cool day light fluorescent lamp[7]. Different Energy-efficient alternatives are shown in Table 5.1 [9].

"Table 5.1: Different Energy-efficient alternatives"

Lamp Type	Average Life (hrs)	Energy saving opportunity	Savings
Tungsten filament lamps 	1000	Replace with equivalent light output 'energy saving lamps' (called Compact Fluorescent Lamps or CFLs) which last 8 times longer.	Up to 75%
Tungsten halogen display & security 	2000-4000	Replace with metal halide lamps in some instances Replace floodlights with high-pressure sodium or metal halide lamps according to colour rendering requirements	Up to 60% Up to 75%
Fluorescent tubes 	5000-15000	Replace 38mm diameter tubes with slimmer 26mm tri-phosphor versions. Specify tri-phosphor coating (clearly labelled on the packaging) for all new tubes	Up to 10% Up to 30%
High intensity dishcharge lamps 	Varies	Select lights on applications – all are better than tungsten halogen. Consider colour rendering – and time controls to prevent their operation out of hours. Replace any high pressure mercury lighting with metal halide lights.	Varies

Energy efficiency cannot be obtained by mere selection of more efficient lamps alone. Efficient luminaires along with the lamp of high efficacy achieve the optimum efficiency. The most efficient light source (ENERGY STAR qualified) must be selected while planning new lighting systems or modifying the existing ones. In many cases, replacement of the existing low efficiency lamp types with lower wattage, more efficient types will result in reduced total costs and improved lighting.

5.2 Efficient light distribution

Mirror-optic luminaires with a high output ratio and bat-wing light distribution can save energy. For achieving better efficiency, luminaires that are having light distribution characteristics appropriate for the task interior should be selected. The luminaires fitted with a lamp should ensure that discomfort glare and veiling reflections are minimised. Installation of suitable luminaires, depends upon the height - Low, Medium & High Bay [10].

- Low bay, for heights less than 5 metres.
- Medium bay, for heights between 5 - 7 metres.
- High bay, for heights greater than 7 metres.

System layout and fixing of the luminaires play a major role in achieving energy efficiency. This also varies from application to application. Hence, fixing the luminaires at optimum height and usage of mirror optic luminaries leads to energy efficiency.

5.3 Efficient Light Control

5.3.1 Installation of microprocessor based controllers
Another modern method is usage of microprocessor / infrared controlled dimming or switching circuits [10]. The lighting control can be obtained by using logic units located in the ceiling, which can take pre-programme commands and activate specified lighting circuits. Advanced lighting control system uses movement detectors or lighting sensors, to feed signals to the controllers.

5.3.2 Installation of "exclusive" transformer for lighting
In most of the industries, lighting load varies between 2 to 10%. Most of the problems faced by the lighting equipment and the "gears" is due to the "voltage" fluctuations. Hence, the lighting equipment has to be isolated from the power feeders. This provides a better voltage regulation for the lighting. This will reduce the voltage related problems, which in turn increases the efficiency of the lighting system.

5.3.3 Installation of servo stabilizer for lighting feeder
Wherever, installation of exclusive transformer for lighting is not economically attractive, servo stabilizer can be installed for the lighting feeders. This will provide stabilized voltage for the lighting equipment. The performance of "gears" such as chokes, ballasts, will also improved due to the stabilized voltage.

5.3.4 Installation of high frequency (HF) electronic ballasts in place of conventional ballasts
New high frequency electronic ballasts have the following advantages over the traditional magnetic ballasts: Energy savings up to 35%; Less heat dissipation, which reduces the air conditioning load; Lights instantly; Improved power factor; Operates in low voltage load; Less in weight; Increases the life of lamp.

5.4 Replace old one
Most discharge lamps display a gradual reduction in light output with years of service[7]. While light output may fall, energy consumption remains the same. It follows therefore that lamps should be replaced at the end of their economic life rather than waiting for them to fail.

5.5 Lamp Arrangements
More supplementary lights, e.g., twin tubes luminaries should be provided in the region further from the windows and less supplementary lights, e.g., single tube luminaries near the windows. It should further be noted that the illumination output for 2 x 40 W - 4 feet long tube light fixture is same as for that of 1 x 65 W - 4 feet long tube light fixture.

5.6 Lower the ceiling heights
The number of light fixtures that are required can be reduced by lowering the height of the light fixture or false ceiling. If lowered by 1 m, about 20 - 30 % electrical energy can be saved.

5.7 Switch off lights
The least expensive way to reduce lighting cost is to remove unnecessary lamps and switch off unnecessary lights - lights in storage and toilet areas should be switched off, preferably by a timer switch[7].

5.8 Maximise the use of natural lighting
Daylighting often provides a highly directional source of light, and excellent three dimensional modeling. Natural light can be effectively used by : (1) Installing large fibre glass sky lights in the roof. (2) Providing high opening in the entire length of the walls. (3) Providing facilities to switch off electric lighting when natural light levels are adequate or dimming the lighting according to changing needs.

5.9 Periodic Cleaning
Periodic cleaning of the lamps and window panes at 3-4 months interval will be useful to ensure full utilisation of day light and artificial lights.

5.10 White washing
Paint walls and ceiling with light colour to reduce artificial light requirements. Amount of light reflected from different colors & materials are given in Table 5.7 [11].

"Table 5.7 Reflectance Table"

Reflectance Table			
Colors	**%**	**Materials**	**%**
White	70-80	Plaster - white	80
Light cream	70-80	White porcelain	65-75
Light yellow	55-65	Glazed white tile	60-75
		Limestone	35-70
Light green	45-50	Marble	30-70
Pink	45-50	Sandstone	20-40
Sky - blue	40-45	Concrete - gray	15-40
Light gray	40-45	Granite	20-25
		Brick - red	10-20
Beige	25-35	Carbon - black	2-10
Yellow ocher	25-35		
Light brown	25-35	Mirror	95
Olive green	25-35	Clear glass	6-8
Orange	20-25		
Vermillion red	20-25	Maple (Natural)	60
Medium gray	20-25	Birch (Natural)	35-50
		Oak - light	25-35
Dark green	10-15	Cherry (Natural)	15-30
Dark blue	10-15	Oak - dark	10-15
Dark red	10-15	Mahogany	6-12
Dark gray	10-15	Walnut - dark	5-10
Ideal Ceilings	**60-90**	Tin	67-72
Ideal Walls	**35-60**	Stainless steel	50-60
Ideal Countertops	**30-50**	Aluminum	55-58

5.11 Building Lighting Design & Landscaping

"Design" is the science and art of making things useful to humankind, and lighting design is the application of lighting – including daylight when it is specifically used as source of lighting-to human spaces [12]. With the ability to modulate light levels, appropriate electric light energy should be used at all times, maintaining a minimum necessary light level and therefore, minimum necessary lighting energy consumption. A well-designed landscape can not only add beauty to business area but it can also reduce heating and cooling costs. On average, landscaping for energy efficiency provides enough energy savings to return an initial investment in short time span.

5.12 Renewable Energy

At the time of designing or remodeling a new business building, consideration of constructing what's called a high-performance building is also a matter of energy conservation. For building's electricity needs, one can buy clean electricity or make own electricity from a renewable energy source. Solar energy is a clean alternative to fossil fuels and nuclear power. Solar energy is free. It's silent. Solar power can be captured anywhere without creating noise pollution. One of the greatest advantages of solar energy, of course, is that there are no carbon dioxide, methane or other emissions that warm the atmosphere.

5.13 Implementation of Advanced Industrial Lighting Guideline

- Design lighting systems that are based on a dynamic, rather than a static, model of vision and natural light. Design ambient lighting to illuminate the majority of the space to about one-third the task illumination level.
- Scotopic/Photopic ratios can be used to determine the relative sense of brightness from different sources.
- Provide task lighting that is under the control of each worker.
- Avoid distinct patterns, especially patterns that are irregular or harsh.
- Use night lighting only when and where necessary. Use the minimum amount of light needed rather than the maximum. Use sources with cutoff optics that restrict light to the intended area of illumination.
- Consider use of : Easily re-configured controls, Portable luminaires, Modular wiring, Lighting tracks and Lightweight suspended luminaires.
- Find lighting systems that embody the project's style or aesthetic…while using high-efficacy sources and efficient principles.
- Work with higher color temperature and higher CRI sources (CRI 80, or better) to produce beneficial vision effects.
- Use light colored room surfaces and minimize the use of dark surfaces.
- Ensure that the average room surface luminance is at least 10% of the task background.
- Be the most concerned about sources of glare in relation to stationary tasks.
- Blend direct and indirect lighting to provide a combination of comfort and modeling.
- Use lighting techniques that reveal texture to enhance visual perception.

VI. CONCLUSION

Technical Textile industrial lighting is where the necessity of light meets the challenges of environment, dirt and practicality. It is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy efficient lamps, luminaires and gears, apart from good operational practices. Advances in state-of-the-art lighting technology and effective steps for energy conservation in lighting can significantly reduce energy use and costs while providing light levels and quality as per requirement. Mounting and ceiling heights vary from close-in task lighting to out-of-the-way locations 20 to 30 feet or more, above the floor. Moreover, lighting costs are critical, and there is an expectation of efficiency in every way.

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