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Heat Emission from All Time Headlights On: A Comparative Analysis of 45W Halogen and LED Bulbs in the Context of Road Safety and Environmental Impact

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Abstract:- Synopsis: This study examines the amount of heat generated by 45W halogen and LED motorcycle headlight bulbs under normal riding circumstances. The study is being carried out in accordance with Notification No. G.S.R. 188(E), dated February 22, 2016, which outlines India's All Time Headlight-On (AHO) mandate. This study compares the thermal energy produced by 12V halogen and LED headlights with daily travel of 1 hour. It also covers the effects of AHO on traffic safety, how LED technology lowers heat dissipation, and the environmental effects of AHO, especially in relation to carbon emissions.

I. INTRODUCTION

The Government of India's regulation, enforced by Notification No. G.S.R. 188(E) in February 2016, mandates the All Time Headlight-On/ Automatic Headlight On system (AHO) system for motorcycles manufactured after April 1, 2017 (Ministry of Road Transport and Highways, 2016). When the engine starts, this system automatically turns on the headlights to increase road safety, especially in low-visibility conditions like rain, fog, and dust storms. This is done with the intention of reducing accidents by increasing motorcycle visibility to other drivers, particularly during the day.

II. OBJECTIVES

- To assess the amount of heat generated by 45W halogen and LED motorcycle headlights when they are used regularly.
- To compare the energy consumption and heat dissipation efficiency of LED and halogen light bulbs.
- To examine how using LED lightbulbs instead of halogen ones reduces CO2 emissions.
- To suggest a transition plan for automakers to use LED lights at the OEM level in order to enhance the sustainability and performance of their vehicles.

III. METHODOLOGY

The conventional formula for electrical power can be used to determine the power consumption of both LED and halogen bulbs:

$V \times I = P$

Where P stand for power (in watts), V stand for voltage (in volts),

I stand for current (in amperes).

The formula for calculating the total energy consumed over time that goes toward producing heat is $Q = P \times t$.

Where t is the amount of time (in seconds) that the lightbulb is on, and Q is the total heat energy (in joules).

IV. DATA AND CALCULATIONS

A. 45W Halogen Bulb

- Specifications: 12V operating voltage, 45W power rating.
- Current: $I = P/V = 45W/12V = 3.75A$.
- 30°C is the ambient temperature.
- Duration Assumed: One Hour (3600 Seconds).

A 45W halogen bulb uses 162,000J of energy in total in an hour. This is calculated as $Q = 45W \times 3600s$.

$Q = 0.90 \times 162,000J$

Q= 145,800J is the total heat produced by the halogen bulb, assuming that 90% of the energy is converted to heat.

B. LED Bulb

LED bulbs, being more efficient, convert about 40-50% of their energy into light. Regarding an LED lightbulb with a 45W power rating:

- 45W, 12V specifications.
- Current: $I = P/V = 45W/12V = 3.75A$.
- Duration Assumed: One Hour (3600 Seconds). Over the course of an hour, the LED bulb uses $Q = 45W \times 3600s$ = 162,000J of energy.

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Assuming 50% of this energy is dissipated as heat, then Q = 0.50 × 162,000J
Q = 81,000J.

V. IMPACT OF AHO ON ACCIDENT PREVENTION

The purpose of the All-Time Headlight-On/Automatic Headlight On system (AHO) is to increase motorcycle visibility in traffic, especially in low-visibility situations like fog, rain, and dust. An important way that the AHO system lowers the danger of an accident is by maintaining headlights on whenever the engine is operating. European countries, which have long used similar daytime running lights (DRLs), have experienced a marked decrease in road fatalities and accidents caused by low-visibility situations.

VI. CARBON EMISSIONS AND ENVIRONMENTAL IMPACT

Under the AHO system, headlight use—especially halogen bulbs—increases energy consumption, which raises fuel consumption and CO2 emissions.

An average motorcycle needs 0.06 liters of fuel per hour to run a 45-watt halogen lightbulb. The following formula can be used to determine the emissions related to halogen headlights, with each liter of fuel burned producing roughly 2.31 kg of CO2:
0.06 liters × 2.31 kg CO2/liter = 0.1386 kg CO2 emissions
Regarding LED light bulbs: Emissions of CO2 are equal to 0.03 liters × 2.31 kg CO2/liter, or 0.0693 kgCO2.

VII. RECOMMENDATION FOR AUTOMOTIVE COMPANIES

When it comes to lessening the environmental effect of their cars, automakers are essential. The OEM (Original Equipment Manufacturer) level's adoption of LED headlights is a significant step toward sustainability. Companies can significantly lower the heat dissipation in the headlight assembly and raise the overall energy efficiency of their motorcycles by adding LED technology to new models.

VIII. CONCLUSION

This study highlights the important distinctions between heat generation, energy efficiency, and environmental impact between halogen and LED bulbs. Halogen light bulbs use more energy and produce excessive heat, which increases fuel consumption and carbon emissions.

LED bulbs, on the other hand, provide a more environmentally friendly substitute because they use less energy and produce less heat, which lessens the thermal load on the headlight assembly and lowers CO2 emissions.

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