OPTIMAL PASSIVE COOLING OF UV-LED PANELS FOR AGRICULTURAL AND SPACE APPLICATIONS

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Introduction

We sought to address heat management in high power LEDs. Poor heat management lead to decreased efficiency and shortened LED life span. Our study consists of passive cooling techniques. We utilize heat sinks and heat pipes simultaneously to monitor their effects on heat transfer.

Experiments were performed in controlled environments using Hastest's industrial chambers model HPCH-252XSUH. An LEDLinx LED panel (AB0051 ~ 14 LEDs - 28W) was selected in our study. K-type thermocouples along with Keysight's data acquisition system (Model 34970A) were used to monitor temperatures.

Baseline temperature distribution was obtained by way of omitting the cooling system. The impact of environmental conditions were also studied. Test chamber temperature and humidity levels were varied between 40% and 60% to see their impact on the heat transfer process.

Results show that the achievable minimum temperature was limited by the surrounding environmental temperature, whereas the effects of the surrounding humidity was found marginal. This poster provides detailed experimental results. A new design to optimize the heat management system for high-power LED systems will be discussed.

OBJECTIVES

- Investigate simultaneous passive cooling techniques using heat sinks and heat pipes to improve heat dissipation in high lumen LED lights.
- Using K-type thermocouples measure temperature at each LED of LEDLinx LED Panel (AB0051)
  - Panel Only
  - Panel with Aluminum Base Plate
  - Panel with Aluminum Base Plate & Heat Sink & Heat Pipe
- Observe LED Panel and heat sink performance at various environmental conditions
  - 25º C & 40 % humidity
  - 25º C & 60 % humidity
  - 60º C & 80 % humidity

METHODS

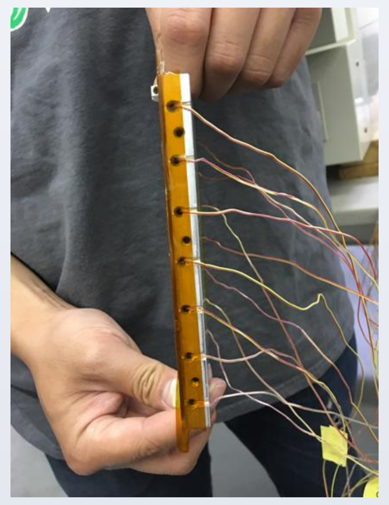

Figure 1: Thermocouples secured to Aluminum Base Plate

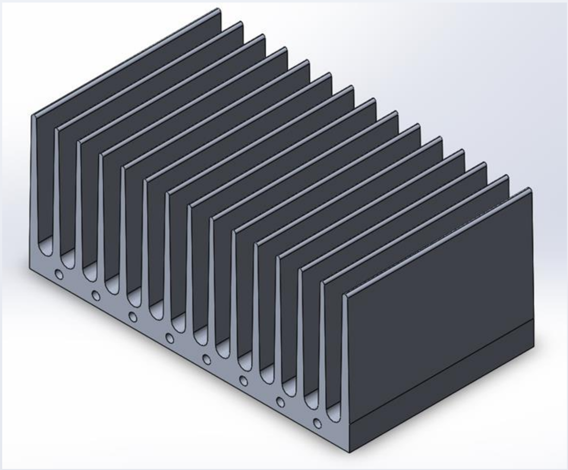

Figure 2: Heat Sink of Study

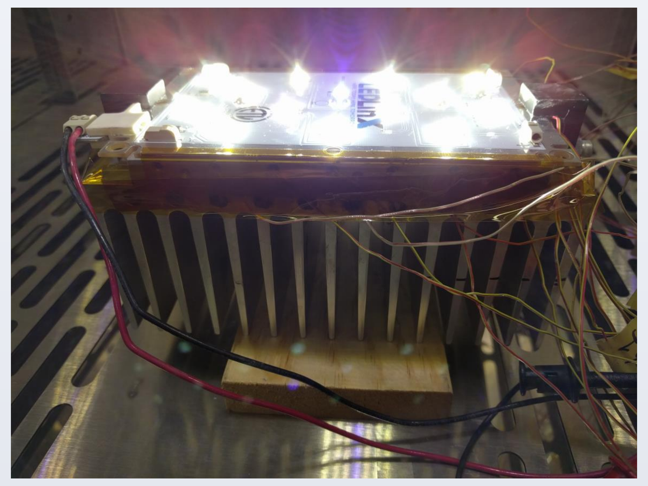

Figure 3: Acquiring temperature values in controlled environment chamber.

Equipment:

- LEDLinx LED Panel (Part #: AB0051)
- 6061 Aluminum Heat Sink
- KeySight (Agilgent) 34970A Data Acquisiton/Switch Unit
- K-type Thermocouples (14)
- Hastest Industrial Chambers (Model HPCH-252XSUH)
- Power Supply

Procedure:

- In controlled environment at room temperature measure temperature at each LED for one hour period using k-type thermocouples.
- Perform measurement for LED Panel by itself for a base line temperature reference.
- Repeat Procedure for Aluminum Base Plate and lastly Aluminum heat sink & heat pipe attached to Aluminum Base Plate.
- Repeat Procedure varying environment temperature and humidity.

RESULTS

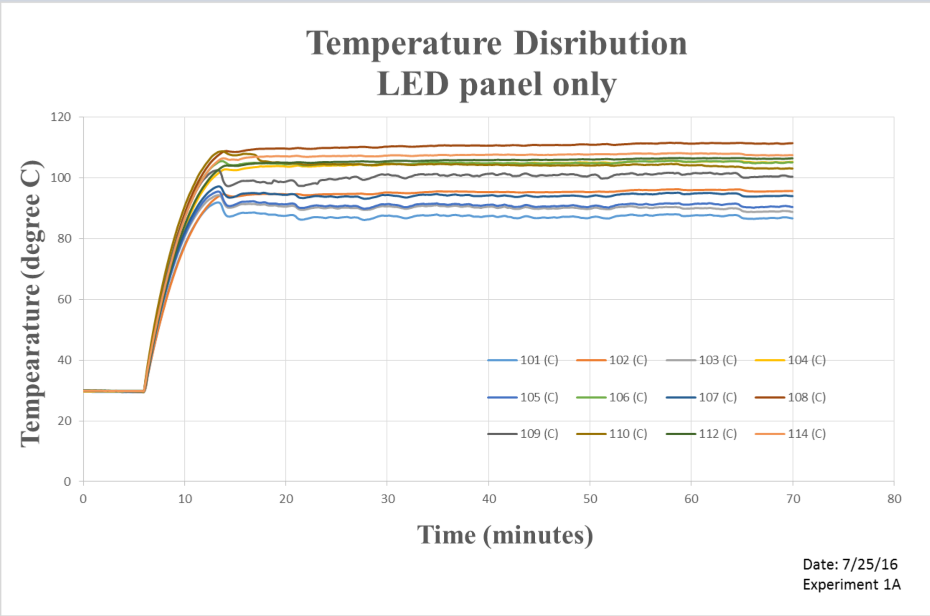

Figure A: Temperature distribution ranges between 80° C and 120° C

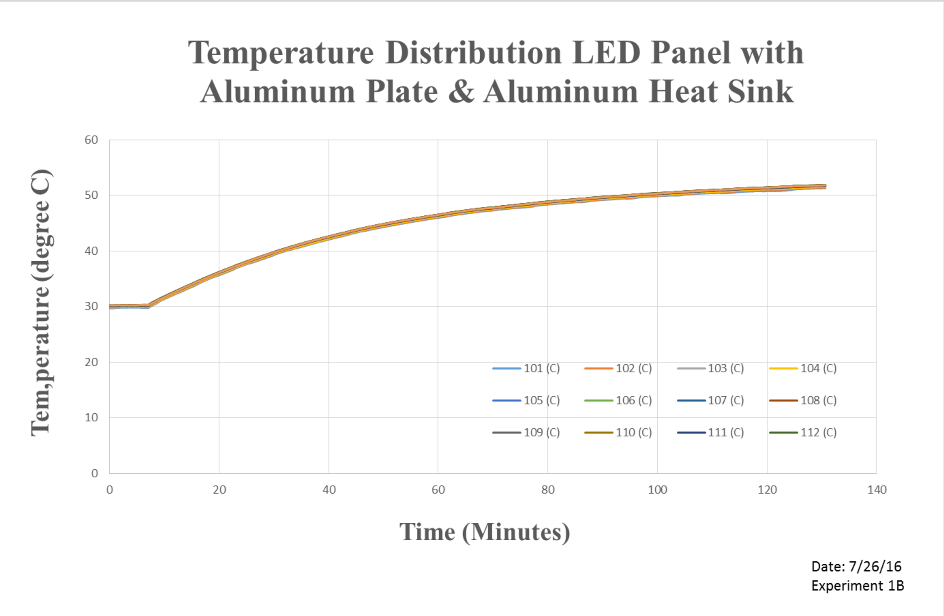

Figure B: All temperatures stabilize slightly above 50° C

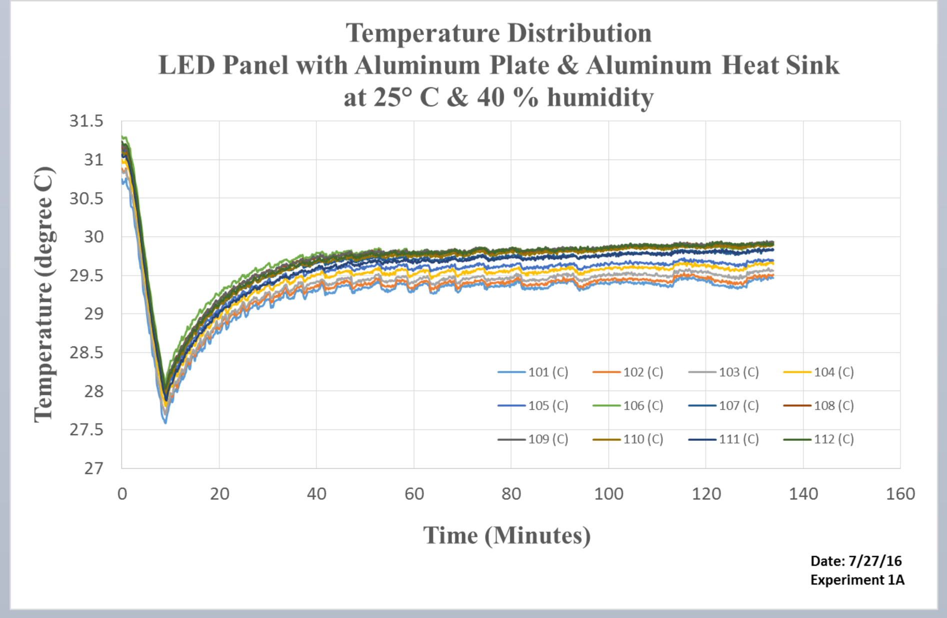

Figure C: Temperatures reach equilibrium below 30° C

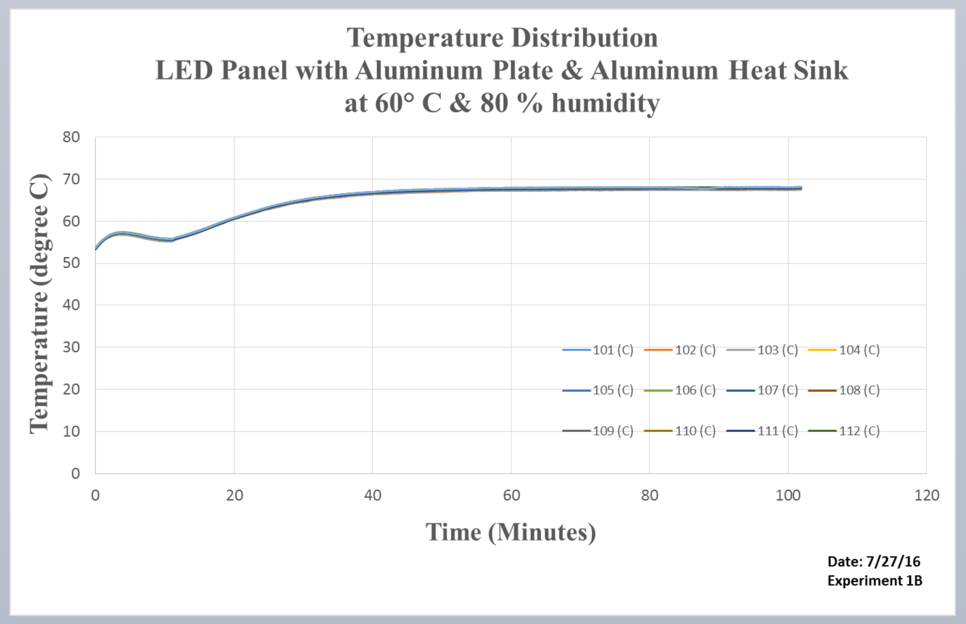

Figure D: All temperatures collectively reach equilibrium below 70° C

CONCLUSION

The combined passive cooling techniques of heat sinks and heat pipes proved to be very effective. Experimental results show a 58% reduction in temperature. This reduction may be improved using different geometries or manufacturing techniques. Controlling temperature in such a manner will increase efficiency and prolong the life of the LED.

Such controlled operation of LED lights could be comfortably implemented in various environmental conditions such as agriculture applications without anomaly.

REFERENCES

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2. Lienhard IV, J. and Lienhard V, J. (2017). A Heat Transfer Textbook: 4th Edition. Phlogiston Press.
3. Duggan T, Ersepke J, Labat F, Olivas A, Tsai R, Datye A, Zaidi S. (2016) Heat Management of UV-LED Panels for Agricultural Applications.

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