TEMPERATURE CHARACTERISTICS OF CCFL'S

The rated light output of CCFL lamps for design purposes is usually specified at 25°C. The actual output of a given CCFL lamp is, however, significantly affected by the ambient temperature in which it operates. An understanding of the temperature characteristics of CCFL lamps is therefore essential to the correct design of a lamp for a particular application.

Temperature Characteristics of CCFL Lamps

Figure 1 indicates the typical temperature profile for a CCFL lamp operating in ambient temperatures ranging from -20 to 80°C. The brightness is indicated as a percentage of the lamp brightness at 25°C. From this profile, it is evident that a typical lamp may lose up to 80% of its brightness when operating 10 degrees below freezing. At temperatutes below -15°C the reduction in light output levels off and does not fall below 90%. Conversely, at temperatures above 25°C, a lamp may be up to 40% brighter than the stated design capacity. The light output measured after 3 minutes of operation is significantly higher (up to 80%) than immediately after firing. This is because the heat produced by the lamp results in an increase in the lamp body temperature with a corresponding increase in lamp brightness.

Heated CCFL Lamps

CCFL lamps can be operated in lower ambient temperatures, without a significant reduction in light output, by making use of a heating element. Heating elements commonly consist of nichrome wire laid longitudinally or wrapped spirally along the lamp body. This increases the lamp body temperature resulting in a corresponding increase in light output. The heating capacity of such an element is a function of the resistance of the wire, the applied voltage and the configuration. A spirally wrapped wire offers the most efficient transfer of heat from the heating element to the lamp body.

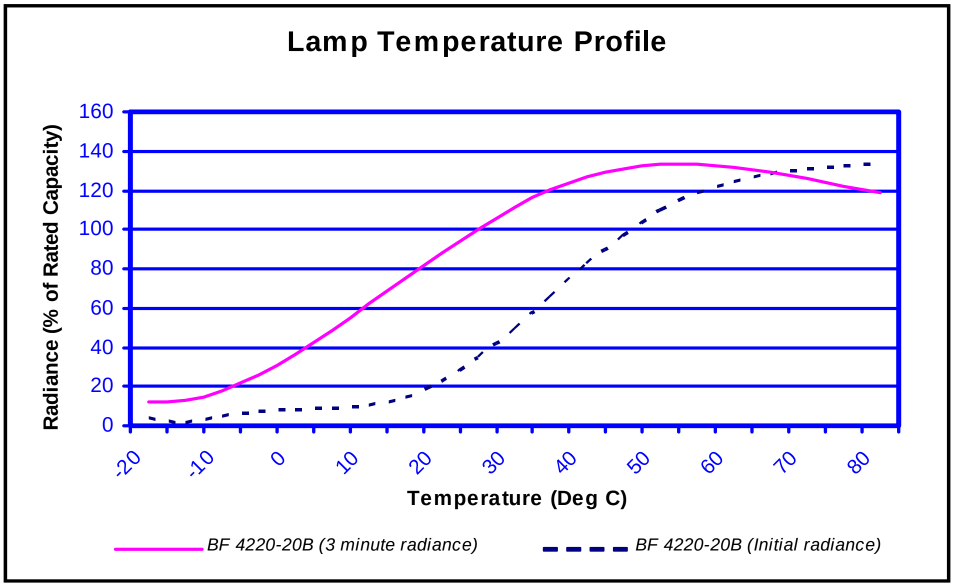

FIGURE 1

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Figure 2 shows the temperature profile for the same CCFL lamp containing 2, 4 and 8 watt heating elements. The slope of the graph is an indication of the degree to which the light output of the lamp will change with a change in temperature. The heating element therefore not only increases the light output of the lamp at lower temperatures, but it also renders the lamp less sensitive to fluctuations in ambient temperature. A given heating element does not produce an increase in light output in proportion to its own power consumption i.e. a four watt heating element does not double the light output of a two watt heating element. The correct sizing of a heating element is therefore required in order to achieve optimum operation. An oversized heating element will result in a loss of efficiency and even a loss in light output at higher temperatures. An undersized heating element may not sufficiently increase the light output at a given temperature.

Design Considerations

Time Constraints

In applications which cannot accommodate the "heat-up" time required for CCFL's to reach optimum operating conditions, a lamp should be selected with a design light output 50%-80% greater than what is required after 3 minutes of operation.

Efficiency

Lamps operating above 25°C will have a light output above their stated design specifications, but will be operating at reduced efficiencies at temperatures above 60°C. Lamps operating in small enclosed spaces will produce a local heating of the environment with a corresponding increase in their light output. An ambient temperature of 50-60°C results in optimum lamp output.

Low Temperature Applications

Reduction in light output at lower temperatures can be compensated for by selecting a lamp with a higher light output than required. As a general rule of thumb, allow for a 2.5% reduction in light output for every degree below 25°C ambient temperature.

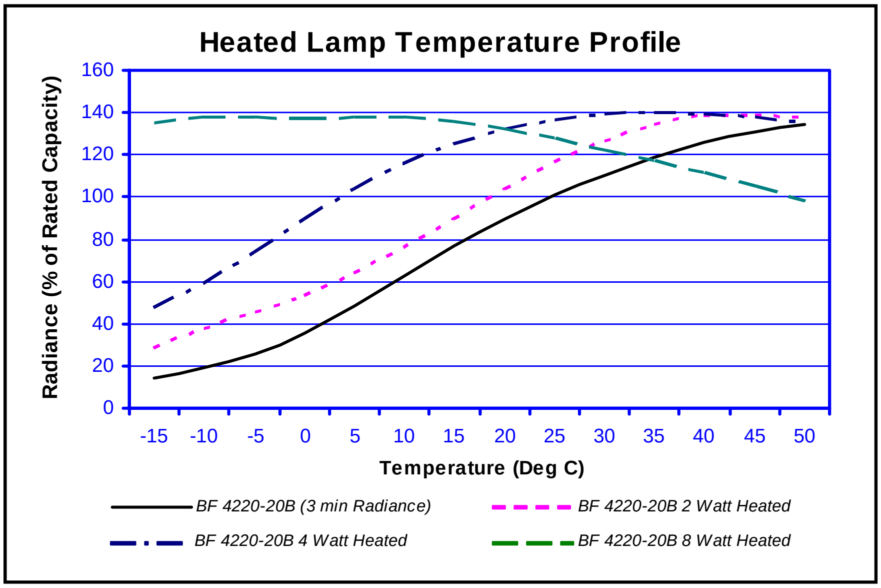

FIGURE 2

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Heating coils must be sized for optimum operation. As stated above, the most efficient configuration for a heating element is to coil it around the body of the lamp. A 6 watt heating coil provides sufficient heat input to permit 2, 3 and 4 mm lamps to operate at their rated capacity at temperatures down to -15°C without regard to lamp length. In order to reduce power consumption and increase lamp life, such heating coils should be designed to switch off at temperatures above 20-40°C.

A 6 watt heating element does not provide the most efficient operation for all configurations of lamps and operating conditions. Heating coils can be more accurately sized to suite specific design conditions of lamp size, ambient temperature and required light output.

The following equation can be used as a general guideline for sizing heating elements for lamps 2-4 mm diameter; 100-400 mm length.

$$W = \sqrt{[L/2 + (5/g)^2]} - 5/g$$

Where:
L = The required increase in light output (%, up to a maximum of 120%)
W = The required heater size (watts)
g = The weight of lamp (grams)

Sample Calculation:
A 3 x 220 mm lamp operating at a temperature of -10°C is required to give 80% brightness 3 minutes after start up.

Lamp mass = 2.2 grams
According to the rule of thumb stated above, allow a 2.5% reduction in output for every degree below 25°C. Therefore unheated lamp output at -10°C is approximately 100-35x2.5 = 12.5% of design capacity.

L = 80%-12.5% = 67.5%

$$W = \sqrt{[67.5/2+(5/(2.2))^2]} - 5/(2.2)$$

W = 3.96 watts. Therefore use a 4 watt heating element for this design.

Conclusion
Small diameter CCFL's are highly influenced by environmental temperature. A given lamp may produce as little as 10% of its rated luminance at environmental temperatures below -15°C. This loss of light output can be compensated by heating the lamp at low temperatures using coiled nichrome wire. For most low temperature applications, a heater of 4-6 watts will provide sufficient heating for the lamp.

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