Tungsten Filament Lamps

Gilway Technical Lamp supplies a wide variety of incandescent vacuum, gas-filled and halogen lamps for a broad range of technical and commercial applications. The general characteristics of each lamp type are discussed below as an aid to selecting the most appropriate technology for any application.

Vacuum Lamps

The tungsten filament of a vacuum incandescent lamp is heated to temperatures where visible light is emitted by resistance heating. The filament acts as an electrical resistor, which dissipates power proportional to the voltage applied, times the current through the filament. When that power level is sufficient to raise the temperature to above 1000 degrees Kelvin, visible light is produced. As the power dissipated is increased, the amount of light increases and the peak wavelength of the light shifts to the blue. Typical vacuum lamps may have filament temperatures ranging from 1800 to 2700 degrees Kelvin. The light from the low temperature lamps appears reddish yellow while the high temperature lamps have a ‘whiter’ appearance.

The tungsten filament evaporates more rapidly as the temperature of the filament goes up. The evaporated tungsten particles tend to deposit on the glass envelope, causing over time, an increase in light absorption. Depending on the application, the light output obstruction could be high enough to end the useful life of the lamp. Eventually, the filament material will evaporate enough to cause the filament to break, completely ending the life of the lamp. Both of these effects are strongly dependent on the temperature of the filament, which is why long life vacuum lamps tend to be operated at the low end of the temperature range and the light has a yellowish appearance.

The electrical resistance of the tungsten filament at room temperature is initially quite low. When electrical power is first applied to the lamp, a large in-rush current causes rapid heating of the filament. The resistance of the filament rises to a value five to ten times the cold resistance, which causes the amount of current drawn by the lamp to stabilize and the lamp to emit a stable light output. Depending on the size of the filament, the in-rush period can be from tens of milliseconds to hundreds of milliseconds. This in-rush current requirement should be taken into account in the selection of the power source for a specific lamp application.

Gas-Filled Lamps

Gas filled lamps produce light from an incandescent filament operated in an inert gas atmosphere. The addition of the inert gas suppresses the evaporation of the tungsten filament, which increases the lifetime of the lamp or allows higher temperature operation for the same life. The normal gases used are Nitrogen, Argon, Krypton and Xenon. The cost rises dramatically as the rarer gases are used, particularly for Xenon, due to their very low natural abundance. The advantage of the higher atomic weight gases is they suppress the evaporation of the tungsten filament more effectively than the lower weight gases. This allows the filament of gas filled lamps to be run at temperatures up to 3,200 degrees Kelvin and achieve reasonable life times. The light from these lamps has a high blue content giving the light a pure white appearance.

Gas-filled lamps require more power to achieve the same filament temperature than vacuum lamps. The surrounding gas cools the filament while suppressing evaporation, and reducing the migration of evaporated tungsten to the wall of the lamp. The higher operating temperature of gas-filled lamps produce more light output per watt of input power, which justifies their use in critical applications.

Halogen Lamps

The halogen lamp is similar to an inert gas-filled lamp, except it contains a small quantity of an active halogen gas such as Bromine. The inert gas suppresses the evaporation of the tungsten filament, while the halogen gas acts to reduce the amount of tungsten that plates the interior wall of the lamp. The halogen gas reacts with the tungsten that has evaporated, migrated outward, and been deposited on the lamp wall. When the lamp wall temperature is sufficient, the halogen reacts with the tungsten to form tungsten bromide, which is freed from the wall of the lamp and migrates back to the filament. The tungsten bromide compound reacts the filament of the lamp and deposits the tungsten on the filament and is freed to repeat the cycle again. Unfortunately the tungsten is not deposited in the same zone as the evaporation took place so the filament still becomes thinner and eventually fails.

The light output of a halogen light is more stable than a non-halogen gas lamp due to the cleaning action of the halogen gas on the lamp envelope. This feature coupled with the high color temperature of the light and long-life make these lamps very desirable for many industrial and scientific applications. The restriction on duty cycle due to the requirement to maintain the envelope of the lamp at sufficient temperature to initiate the halogen cycle is a disadvantage. However, in continuous duty applications it is relatively easy to provide correct ventilation to ensure the proper operating temperature.

Life at Design & Operating Voltages

Lamp life expressed in hours is calculated at design voltage and under ideal laboratory conditions. Deviation from design voltage will result in decreased or increased values of lamp life. This deviation will also alter values of current consumption, brightness, and color temperature. These deviations should be used advantageously by the design engineer to enhance the technical lamp's specifications for the specific application.

Figure 1 is supplied to express percent variations in current, color temperature, and brightness when operating voltage differs from design voltage.

Figure 1

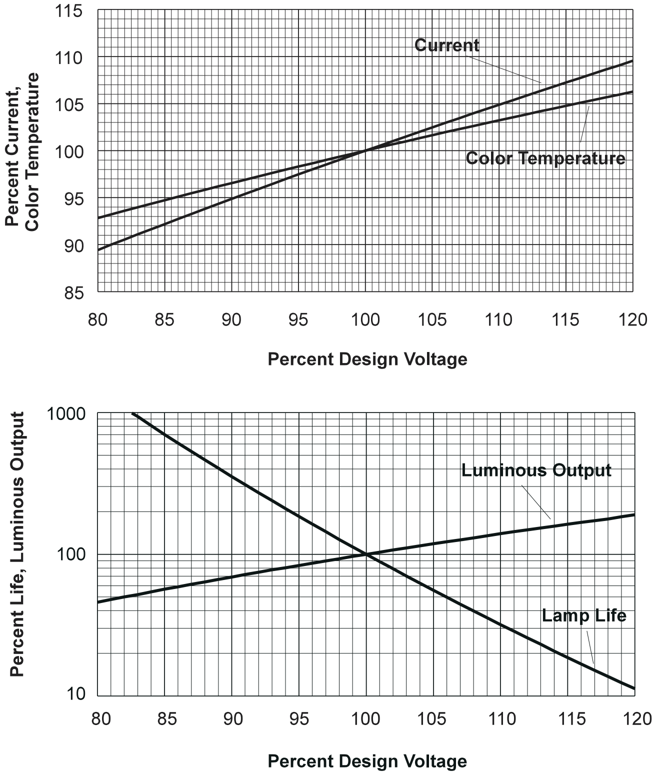

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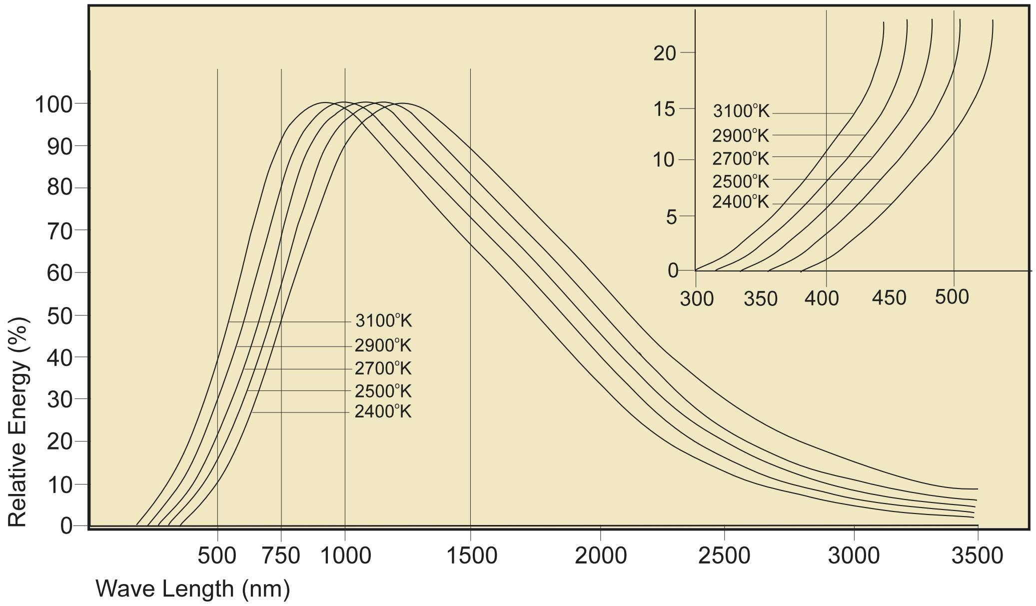
Figure 2: Spectral Radiation Output for Tungsten Filament Lamps (Including Halogen Lamps & Technical Lamps).



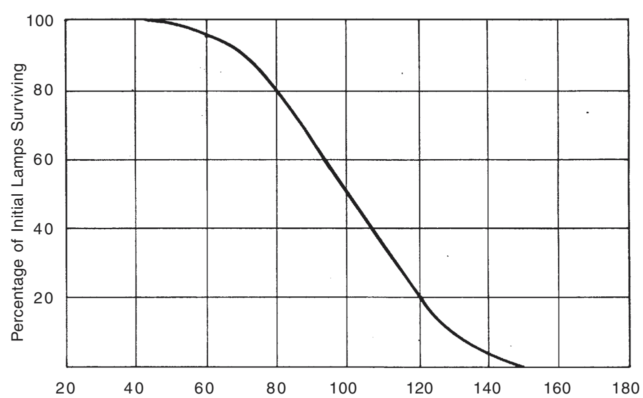
Spectral Radiation Output

The spectral radiation of a lamp is a function of the temperature of the filament. The curves in figure 2 give the output versus wavelength over a typical range temperatures for lamps ranging from vacuum to gas-filled with halogen.

Rated Life for Tungsten Filament Lamps

Rated life as specified in this catalog is expressed in terms of hours. Rated life is calculated at design voltage, with alternating current, and under ideal laboratory conditions. In actual use, lifetime may be shortened as a result of hostile environments such as shock, vibration, and extreme temperatures. Life may be substantially increased, by selecting an operating voltage less than the design voltage. This decrease from design voltage will also result in a cooler filament providing increased resistance to shock and vibration.

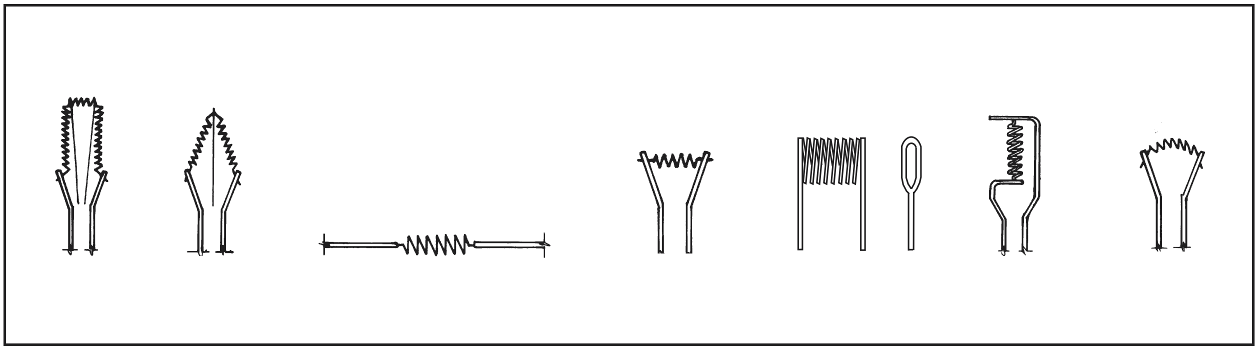
Figure 3: Mortality Curve for Tungsten Filament Lamps

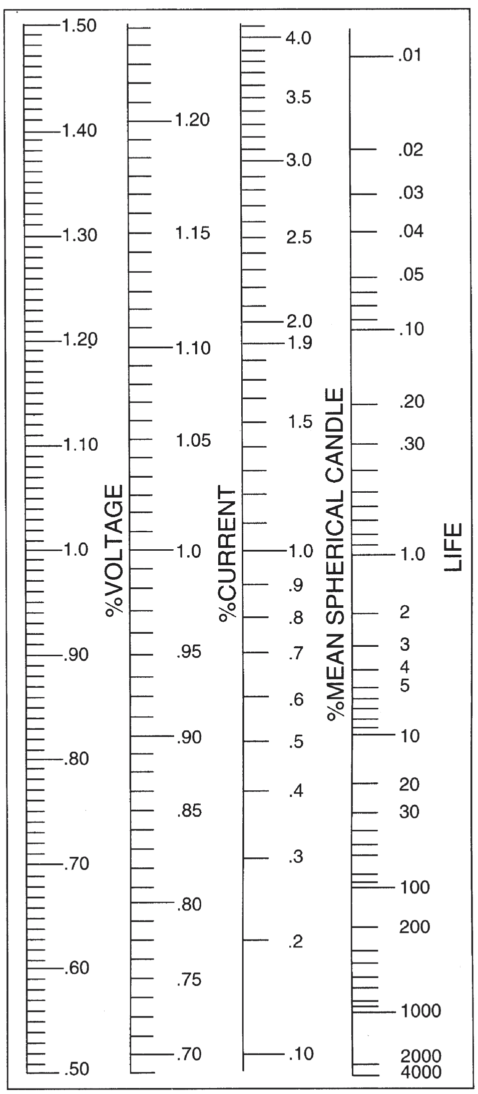


Because of slight variations in miniature lamp manufacturing and in the component parts, it is impossible to have each individual lamp operate for exactly the life for which it was designed. Lamp life is rated as the average life of a large group of lamps. At the end of rated life approximately 50% of the lamps in a large group will have failed and 50% will continue to operate as detailed in Figure 3. Please note that this data pertains to all tungsten filament lamps: gas filled, halogen and vacuum.

Filament Shapes

Filament shapes used for lamps are classified into several different forms according to the filament sizes (filament diameter and length) and shock resistance. See figure 4.





Rapid Lamp Calculator Diagram

This diagram allows the user to determine the dependence of Current, Mean Spherical Candela and Life on the value of voltage applied to the lamp as a percentage of the design voltage for that lamp. Draw a horizontal line through the percent of design voltage to be used and read the value of the calculated parameters on the right side of the diagram

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