About Lighting

Color Temperature of Metal Halide Sources

By Mike Wood

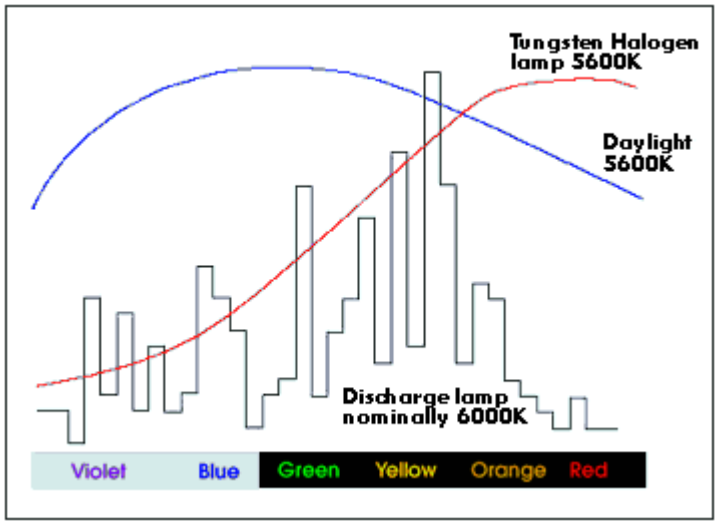
The 'Minolta' style of meter is used extensively to measure the color temperature of lamps in Television Studios without many people being aware of one big problem - you can't use this style of meter to accurately measure the color temperature of many Metal Halide Discharge lamps.
This article presents an explanation of this problem and some possible solutions.

It is often convenient to talk about a lamp's 'Color temperature' but very often, with the type of lamps commonly used in today's computer controlled automated luminaires, this can be a misleading name. Color temperature as a concept can only literally be used with incandescent light sources; these sources emit light solely because of their temperature. This type of source is found in a normal tungsten filament light bulb; the tungsten wire is heated by the flow of electric current to a high temperature - maybe 3000C (5400F) - and 'glows' brightly enough to emit visible light. The light that comes off an incandescent source is distributed in a nice, smooth, continuous way across the spectrum - you have light of all wavelengths from Red to Blue.

The precise definition of color temperature of a light source is the temperature of a black body radiator at which the color of the light source and the black body are identical. Without going deeply into the definition of a black body, we can say that in real life the color temperature of a tungsten filament lamp is pretty much the same as the actual filament temperature.

OK so that's incandescent lamps - what about the discharge lamps that many fixtures use? Why can't we use the same concept?

The problem is that a discharge lamp doesn't emit its radiation in a nice smooth curve with emission at all wavelengths. A discharge source has big 'spikes' in its output spectrum which come from the particular elements used in the fill mix forming the arc. For example, a discharge lamp might have a large spike in the Blue region, two or three spikes in the Green and a number of smaller spikes in the Red. What color is that? What your eye and brain do is smooth out these spikes and you see it as one color.



Spectral curves of incandescent and discharge sources

So how do you define a concept like Color Temperature for this 'spiky' source? The method normally used is to match the output of the arc source to an incandescent source and then take the color temperature of the

incandescent source. When it's matched like this the color temperature of the discharge source is referred to as its 'Correlated Color Temperature' which provides a helpful approximation.

It is in this matching where the problem occurs - in theory this matching is supposed to be done so that the human eye sees them as the same color. That isn't very convenient, so measuring instruments (such as the Minolta meter) have been developed to do this matching for you. These meters have a response which is designed to match the response of the eye - and it does this very well WITH AN INCANDESCENT SOURCE. Unfortunately they have problems with very spiky discharge sources; it's very difficult to predict how the human eye (or a TV camera) will perceive these spikes and how the brain will smooth them out into a single color. Some discharge sources are reasonably smooth so that they work well enough; but Metal Halide lamps (which include MSR, MSD, CSI and HMI) are not in this category.

The end result is that a color temperature meter of this type doesn't give consistent, reliable readings for a source such as Metal Halide lamps. You can't use it to judge and compare these lamps to studio incandescent sources with any certainty that what the meter tells you is the same as what your eye sees or what the camera will see. Unfortunately it is very tempting to believe what a meter is telling you but errors of over 1000K have been seen in these types of meters when used with Metal Halide sources - so don't use them! There are more expensive, full spectral analysis type meters that give a more accurate response. Manufacturers such as Thoma, Photo Research and Gamma Scientific make spectroradiometers and spectracolorimiters which will analyze the peaks and troughs in a way which more consistently matches the human eye response. In fact, Minolta also manufactures this type of meter - however at a much higher price than the small handheld type we are discussing.

But really the best way to judge these lamps reliably is to use the device that will be the 'end user' - the human eye in a Theatre or the camera in a Television Studio. It is also important not to try and measure the light source directly; but rather to illuminate a known (usually white) object with the light and then look at the reflected light from that object.

Measuring devices using these principles give a more accurate estimate of the correlated color temperature. For example, in a TV studio the camera looking at the normal Line-Up chart gives you exactly these conditions. In a Theatre, using the source to illuminate a piece of scenery - or more critically an actor's face - and then viewing the result is much better than relying on a meter's misleading figures.

The bottom line is - your eye is the best judge, trust it!