About Lighting

A Life Story - Metal Halide Lamps

By Mike Wood

Filament incandescent lamps where the light is produced by a 'white hot' tungsten filament are relatively easy to understand - you can see what's going on to produce the light. Both light output and color of the filament remain fairly constant over the life of these lamps - any changes in lamp output and color are probably due to some kind of contamination of the lamp's glass or quartz walls - again you can see what's going on and why. (This simple situation is complicated somewhat by the tungsten/halogen cycle but pretty much holds true)

Metal Halide lamps however, such as the MSR and MSD lamps used in High End System's products, are more complex devices. You have an arc between two electrodes in a sea of chemicals which give the arc its spectrum and specific color spectrum (see Fig 1).

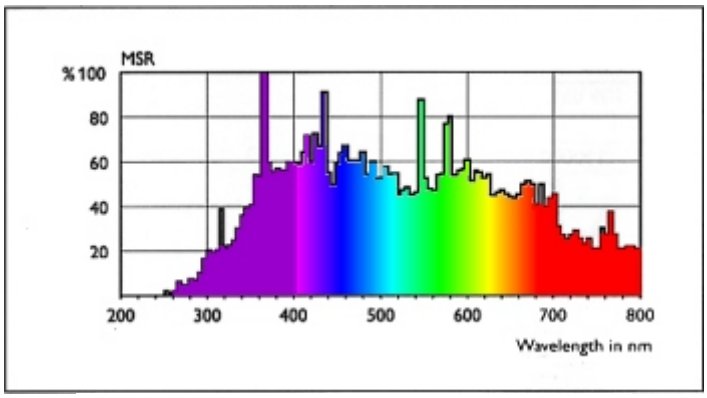

Figure 1 - Spectral Output of a Normal MSR Lamp

You can see that the spectrum is not smooth - it's a spiky output where each spike represents the emittance of a particular compound used in the lamp fill. This mix of compounds (comprising mostly salts of rare earths and halides as well as the Mercury which provides the conduction path) is carefully chosen to produce an output which approximates to 'white' light as perceived by the human eye. Any change to this delicate chemical balance will alter this spectrum and therefore the perceived color.

The arc and the chemical fill are contained in a small quartz envelope to provide as stable and controlled an environment as possible. It's a ferociously unfriendly environment however with temperatures approaching 1000C and pressures of 3 or 4 atmospheres. Under these conditions even quartz, an extremely stable and resistant substance, starts to suffer.

The quartz is attacked from all sides - high temperatures, high pressures, chemical attack, Infra Red and UV - it takes them all. This inevitably starts to result in slow damage - the quartz (which like all glasses has an amorphous, non crystalline structure with no regularity) can start to very slowly grow crystals and become a more regular crystalline quartz. Doesn't sound so bad until you realise that crystalline quartz is opaque to light! So the the small opaque area produced absorbs more of the light and Infra Red hitting it and gets even hotter - this leads to more crystallisation and so the process continues. This whole process takes many hundreds of hours and, very often, provides the normal failure mode of the lamp when the inner lamp has become so opaque that it either melts or just doesn't allow an acceptable amount of useful light to exit the lamp.

What you see as the user is a gradual reduction in light output over the life of the lamp. Surprisingly

perhaps you also see a change in the color temperature - as the lamp envelope absorbs more Infra Red and gets hotter so the pressure inside goes up. This results in the chemical equilibrium inside the envelope changing slightly (we no longer have an absolutely stable environment) and the Color Temperature of the output moves slightly lower. Other factors come into play here as well - the electrodes slowly burn back increasing the arc length and some of our chemical fill can undergo reactive change - all these effects tend to change the color temperature slowly towards the 'Red' end of the spectrum.

Typically with a single ended discharge lamp such as the MSR and MSD you can expect to see between 0.5 K and 1K drop in Color Temperature per hour of operation over the life of the lamp - so maybe up to 750K drop in the lifetime of a typical lamp. (This is better than with the double ended metal halide lamps by the way where you can see nearly twice this - 1 K to 1.5 K per hour)

Of course the lamp manufacturers are continually striving to improve this situation. Refinements in electrode design, envelope sealing techniques and fill material compositions have produced significant improvements over the past few years. Lifetimes have gone up from 500 hours to 1000, 2000 or even 3000 hours with some lamps and we expect to see continued gains here. Initial lamp consistency has also improved with much less spread in initial color than previously possible however there is still some tolerance (200K - 400K) in new lamps which it is important to be aware of.