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Plasma light as one of the New lighting techniques in the Cinema and Television

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Abstract:
Plasma light is a green light with a super high power efficiency, with a very long-life compared to any light source. Plasma light has no filament, nor does it has electrodes. One of the essential features of plasma light is that it does not emit carbon dioxide. In fact, it is identical to today's high-speed cinematography and as it is a flicker free, it is seen as better than HMIs lights. Plasma light comes with many varieties which gives the lighting designer the freedom of painting with light. It can be used in lighting green screens, especially if a person wants to mimic outdoor shooting, because it has super high power with less power consumption. It can also play a vital role in shooting for establishing shots which requires lighting sources with very high outputs so plasma light can solve this dilemma easily. It does not also create noise like HMIs lights. Plasma light gives a more natural look than any LED lights with a very high color rendering index of +94. Plasma light can be used as a cool moonlight, which fits with the modes of fantasy films. Plasma is the perfect lighting for a high-speed camera which will revolutionize the language of the visual grammar of cinema.

Keywords:
Plasma
Light Emitting Plasma (LEP)
high-efficiency plasma (HEP)
Spectral Energy Distribution
Color Rendering Index
The Extended CRI

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Introduction
Light Emitting Plasma (LEP) is a new technology that can change the methods and techniques in television production and cinematography which makes this light so unique in terms of its super lumen production as compared to any other lighting fixtures. For example, the intensity it gives is ten times higher than tungsten lights, and 2x compared to LEDs and 1.5 to HMI lights. In addition to their intense, Plasma is a flicker-free output, The LEP fixtures give a continuous spectrum that is almost similar to the daylight, with a long life compared to LEDs and HMIs lights. These characteristics of the LEPs make them an ideal source for motion picture lighting applications (Holt, 2009). Plasma technology is designed to last for 30,000 hours without a detection of any color shift. Plasma lights generate far less heat than HMIs and Tungsten's lights, which makes plasma more feasible. Plasma light needs only 30-90 second to strike which makes it better than HMIs lights. To restrike the plasma light again, it needs a duration of three minutes. Plasma is a flicker-free up to a theoretical maximum of 225,000,000 fps. Plasma is a perfect choice for high-speed cameras. Plasma lights have no noise, and it is dimmable mechanically by using modifiers like scrims, diffusion, gels, etc. Moreover, their low heat will make gels and scrims last much longer.

Statement of the problem
The advent of the economical easy to use complementary metal–oxide– semiconductor CMOS cameras which highlight the shortcoming of existing lighting technology, showing up the flicker problems, and color shift and color artifact problems.

Modern cameras require less light, and modern light sources emit less heat. However, the latest versions of digital cameras record images at very high frame rates that require large amount of light and where the inherent light flicker becomes visible. HMI high-frequency ballasts have partly alleviated this problem, but for frame rates above 500fps, it still creates problems. LED technology delivers almost flicker-free lighting, but it can produce color shift and low intensity. The introduction of plasma technology will open up a whole new frontier for film and television lighting with an excellent color accuracy without any flicker.

Methodology
The researcher will use the descriptive methodology by explaining the properties of the plasma light and its pros and cons. He will clarify the different types of Plasma fixtures according to their usage and will show the difference between Plasma, HMI, daylight, LEDs in light of color spectrum distribution.

Objectives
1- Describing the different types of Plasma according to the usage.
2- Defining the difference between Plasma Light, HMI, and LEDs.

3- Showing How Plasma light can change the methods and techniques of lighting in the cinema and T.V.

Literature Review

What is Hive Plasma

Plasma uses a single point source bulb, and it does not have a filament. Instead, of that, the quartz bulb is filled with noble gases (argon, neon, krypton, and xenon) or a mixture of them. Some bulbs include other materials, like metal halides, sodium, and mercury. These materials vaporize in the air during the process, so it becomes part of the gas mixture. During the process the gas is ionized, and becomes free of electrons that are quickened by an electric field in the tube, collide with gas atoms. Some of the electrons are excited by these collisions to a higher energy state (DotLighting, 2019). When the excited electron falls back to lower energy orbits, it emits a photon of light . see figure 1.

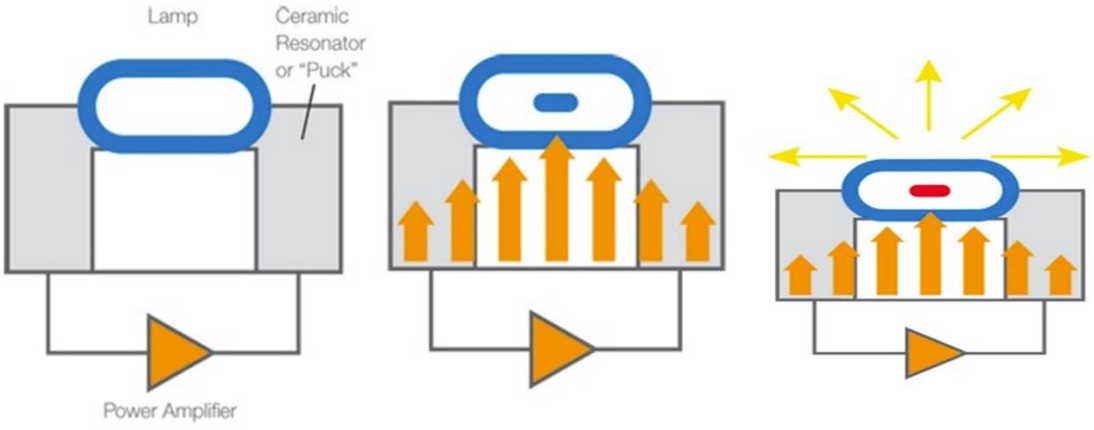

Figure 1

The generated color depends on the gas we used (Holt, 2009) . When the gas is excited, it converts its state of matter from gas to the plasma state, which results in an incredibly powerful light source, essentially a micro star plasma lamps give 5600k balanced to day light boast a CRI of 94. Nowadays there are three kinds of LEP lamp heads on the market: the Photon Beard Nova 270, the Helio 270, and Hive. All these fixtures use the same Luxim Plasma Emitter behind the Fresnel lens.

Plasma History

Plasma fixtures are a type of gas discharge lamp which generate light by sending an electrical discharge through an ionized gas energized by the radio frequency (RF) power.

They are distinct from the novelty plasma fixtures that were popular in the 1980s. Tesla introduced the internal-electrode less lamp after his experimentation with the high-frequency currents in evacuated glass tubes. The first feasible plasma lamps were the sulfur fixtures manufactured by Fusion Lighting. This fixture suffered many severe problems and did not succeed in the field. Luxim and Ceravision gradually overcame these problems .plasma (HEP) lamps have been introduced to the general lighting market. Modern plasma fixture generates the light by exciting a plasma inside a closed transparent bulb by using the radio frequency (RF) power. The newest plasma lamps, a waveguide is used to constrain and focus the electrical field into the plasma (Adermann, 2013). In 2000, a system was developed that concentrated radio frequency waves into a dielectric waveguide made of ceramic, which energized light· emitting plasma in a bulb positioned inside. This system, for the first time, permitted a large compact yet bright electrode-less lamp. It has taken decades of R&D to make this technology economical and useful for general lighting applications. Hive has taken this technology, initially developed for street lights, and makes plasma fixtures for image capture that cinematographers, photographers and visual professionals in all fields can use to maximize the benefits of this new technology.

Plasma Light as greener source

Plasma is super-power-efficient, “green” (meaning environmentally friendly) light fixtures. It is very saving energy without sacrificing light output and quality. It has no filaments, no electrodes, and is closer to the light Spectrum of the sun than current light models on the market. Plasma lights can plug right into a wall, helping the crew avoiding noisy, belching diesel generators and trucks outside (Peterson, 2014) . Using Plasma will prevent the emission of carbon dioxide, if every light in Hollywood replaced, plasma lights could reduce 35,000 to 60,000 metric tons of air pollution from the Los Angeles (Hollywood) the rough equivalent

of removing 15,000 to 25,000 cars from roads each year (Kozlowski, 2012) . Plasma does not contain any harmful material like LED in case if it is broken.

Color Rendering Index CRI

CRI is introduced to measure of the ability of the light source to show object colors "realistically" or "naturally" compared to a familiar reference source, either incandescent light or daylight (NLPIP, 2004). (Tungsten –sunlight). The CRI scale ranges from zero to one hundred. The biggest the number, the more reliable and color accurate the light source will be. The dilemma with CRI it does not measure all the spectrum colors. Instead, CRI is the total average of the eight colors as defined by the International Commission on Illumination (CIE). They chose these colors due to they are representative of the rest of the color spectrum since they are relatively low in the color saturation and reasonably evenly distributed see figure 2

Figure 2 CRI Colors

Unluckily the eight color samples only work for sources has a full spectrum light such as (Tungsten and Daylight), these sources emit light across the entire range of the visible light. Any light source that is not full spectrum has gaps and spikes resulting in some colors poorly rendered. While the classic CRI scale does not go far enough with its eight color samples, so they introduced the extended CRI range that goes to up to 15 colors. See figure 3

Figure 3 CRI Extended

The Extended CRI has three significant colors included in these additional seven colors samples, the first one is R9, which is the saturated red. This color is quite tricky to the LED light to produce it. the eye can distinguish this color easily, so it is essential to get right, especially since it is a critical component of skin tone. So if you want good skin tones, you need an excellent R9 reading. The two other vital colors are R13, which is a light skin tone, and R15, which is a medium skin tone (Tim, 2015).

3- Plasma Fixtures types:

There are different types of Plasma Varies according to usage such as:

BEE Plasma – wasp Plasma

1- **BEE Plasma**: There are three different types of BEE plasma (BEE 250 - is daylight balanced 1K light. Great for small rooms and one person interviews in an office with windows. By nature, the BEE is a flood light, add a soft box or fire through a 4×4 frame, and this will produce some great results. The plasma is expensive compared to HMI However, if you are always doing interviews with tons of windows and need more punch then Kinoflo, this could be the light for your production.

2- **Wasp Plasma**: There are three different types of Wasp plasma (wasp 250 – wasp 1000 – killer Maxis)

Wasp 250 is parabolic aluminized reflector light (par). Which means the ability to control the spread of beam by adding plastic lenses very lightweight compared to HMIs which uses glass lenses. Plastic lenses mean it very handy no gloves needed. Wasp 250 is equivalent to 575 w HMI. Wasp is Flicker free up 225 million frames per second very perfect for high-speed cinematography (Hurlbut, 2013). The wasp 250 is a full spectrum with CRI 94, and it works with ellipsoidal lens barrel which allows adding gobos to control light and give aesthetics patterns widely used in drama and documentary interviews, for example, it can mimics the effect of light coming from a window see figure 4

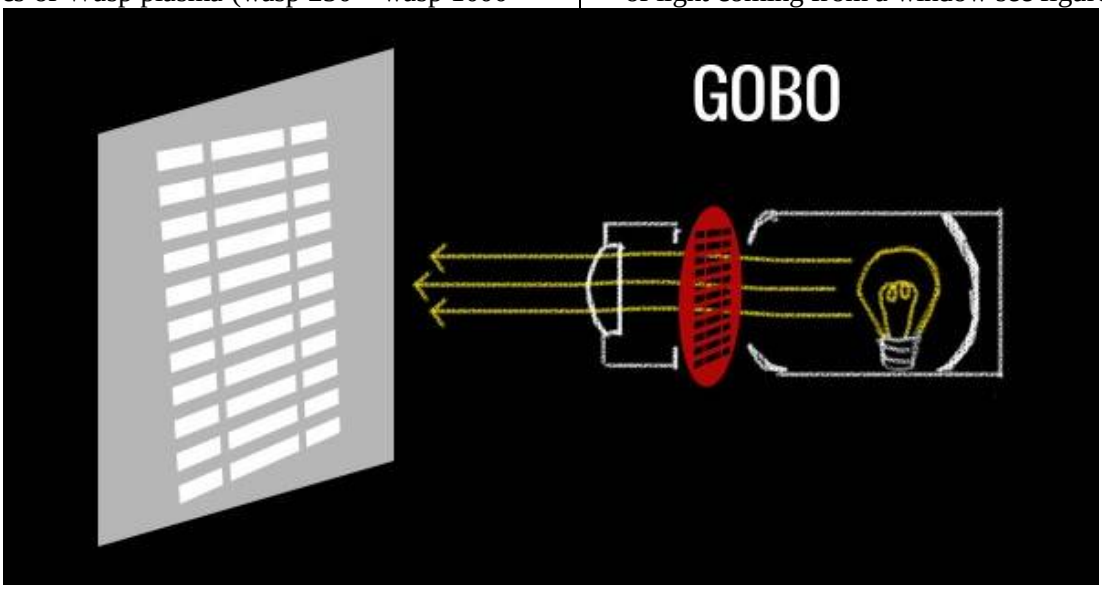

Figure 4 shows gobos drawing a window pattern.

The Wasp 1000 fixture has a full spectrum of 98 CRI with daylight color temperature of 5600K. See figure.

The Wasp 1000 offers electronic dimming control from full output down to 50%.

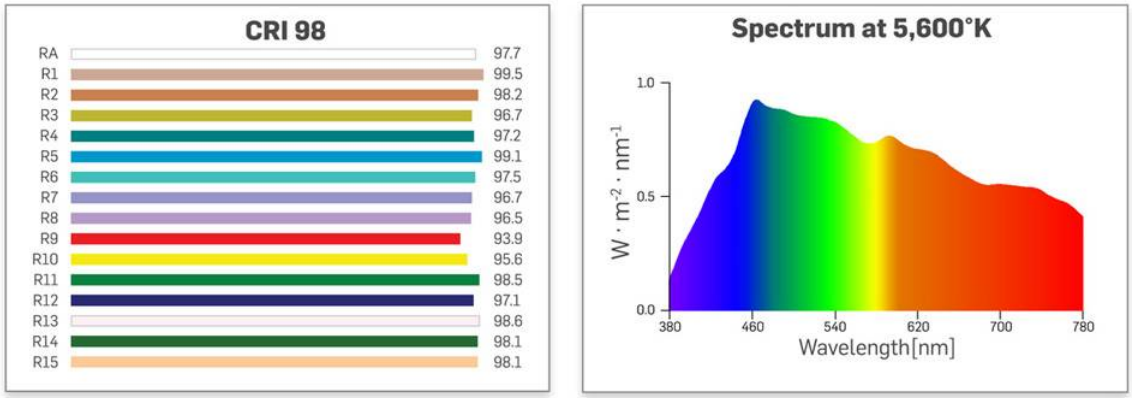

Figure 5 the color rendering index for The Wasp 1000

The Wasp 1000 fixture has output to 1,800 watts and 2,500 watts compared to HMI fixtures or up to 10,000 watts of Tungsten light (Hive, 2019a).

The Wasp 1000 takes on a PAR style, but since it has shallow heat, the lenses for this par light are plastic. No more lugging around a massive case with glass lenses. You do not have to worry about anyone dropping them and breaking them either.

Killer Maxis: Hive's "Killer" arrays are inspired by traditional tungsten Maxi Brutes, but instead

of 1000 Watt tungsten pars, Hive uses 250 Watt plasma par lights, producing almost twice as much light per bulb (Hive, 2019b).

HMI Technology

The HMI lamp - Hydrargyrum (mercury), medium-arc, iodide - originated in Germany in the 1970s as a more efficient replacement of the carbon arc light. An HMI lamp uses mercury vapor mixed with metal halides in a quartz-glass envelope, with two tungsten-coated electrodes of medium arc separation. The light from an HMI source approximates the look and color of raw sunlight. Unlike traditional tungsten lighting instruments using incandescent bulbs, HMIs use ballasts to regulate the electrical supply to the lamp head, and power is fed via a head-feeder cable. HMI lights are high-output sources that produce a daylight spectrum with a color temperature of approximately 5600 degrees Kelvin (Holshevnikoff, 2012).

Plasma VS HMI

Plasma bulb is as a tiny (less than 9 millimeters) discharge lamp see figure 6.

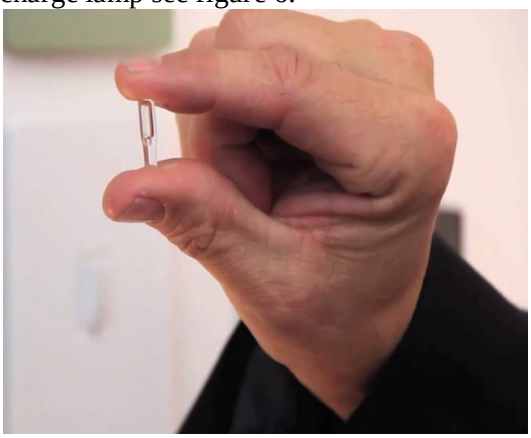

Figure 6 Plasma Bulb

The difference between plasma the HMI, that plasma does not have electrodes. The power of the LEP comes from a high-frequency radio frequency transmitter. The RF waves warm up the materials inside the fixture and convert those materials to the plasma statehouse that the lamp emits a "flicker-free" light**.**

Plasma is very great fixtures in locations which are challenging to bring generators. One of the most pitfall of HMIs it requires a generator. HMI is very versatile light you can use specialized modifiers to overcome heat issue, HMI has color temperature 5600 Kelvin. BEE plasma can be dialed from 4800, 5600,12000 CCT, no need to add gels but the cons you cannot click in a specific color temperature which is very important to keep color consistency between shot to shot. You can use the traditional soft box with plasma without any fear from heat issue. Plasma can be used with a very creative way of shooting songs, high-speed videography. If we compare light quality between wasp Hive 1000 and HMI 400, We notice that wasp is a very focused beam of light and HMI is softer see figure 7.

Figure 7 Comparing between the beam of light in HMI and Plasma

LED Technology

LEDs – Light Emitting Diodes – they have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, smaller size, and greater durability and reliability (Holshevnikoff, 2012). However, they require precise heat management and the color rendering index (CRI) must be considered in fixtures used in production.

Plasma VS LED

LEP lamps have a very high CRIs more than 94. However, what is more, significant than their high CRI ratings, The LEP lamps produce lighting with a full-color spectrum. Which make plasma very identical to the daylight. figure8.

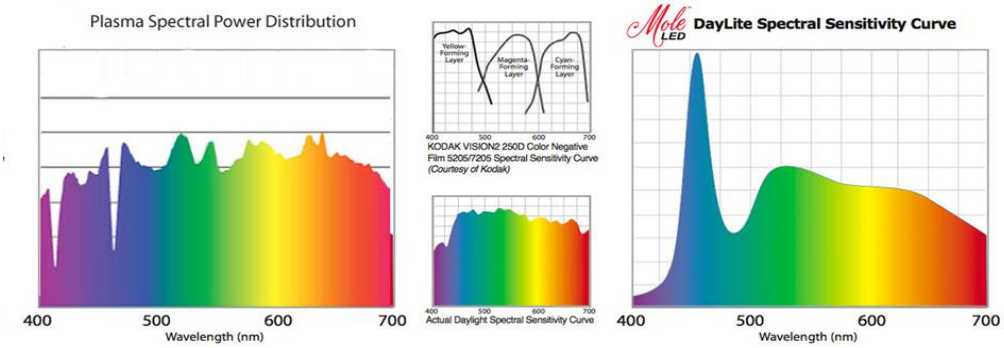

Figure 8 the spectral power distribution for the Plasma and LED

We see that, except for very brief pitfall around 410 nm and again at 451 nm, the light output of LEP fixtures is almost similar to the daylight. if we look at the spectral distribution graphs, figure 8. Plasma light has more continuous color spectrum than even the best-LED fixtures. For example, LEP fixtures, unlike LED fixtures, can produce the light at wavelengths less than 425nm - which means that LEP renders violet colors very good. Moreover, unlike LED fixtures, LEP lamps generate the aqua colors very well 465-510nm. If we compare Skin tones and warm, amber-yellow colors, stand out under LEP fixtures because of the strong presence and the ability to render the complementary colors. Also, since the output of LEP fixtures cover all the long wavelength end (well beyond the 600 nm cutoff of LEDs), such as pinks, reds, oranges, and other long wavelength colors look vivid while using the LEP light in the other hand, they tend to look a little dull under LED lights. Due to LEP is a continuous spectrum source, so colors appear more natural and vibrant under LEP fixtures than under LED fixtures, they also look more accurate on the screen since, as is also evident by the spectral distribution graphs figure 8, the output of LEP fixtures matches the spectral sensitivity of the film emulsions and digital sensors. Color meters, like the Minolta III F that make their calculations of the Color Temperature (CT) based on a light sources continuous spectrum, can generate an accurate reading of the CT and Green/Magenta of LEP lamps (Holt, 2009). LEDs lights have gaps and spikes, meaning they either have a lack or too much of specific wavelengths of light. See figure 9

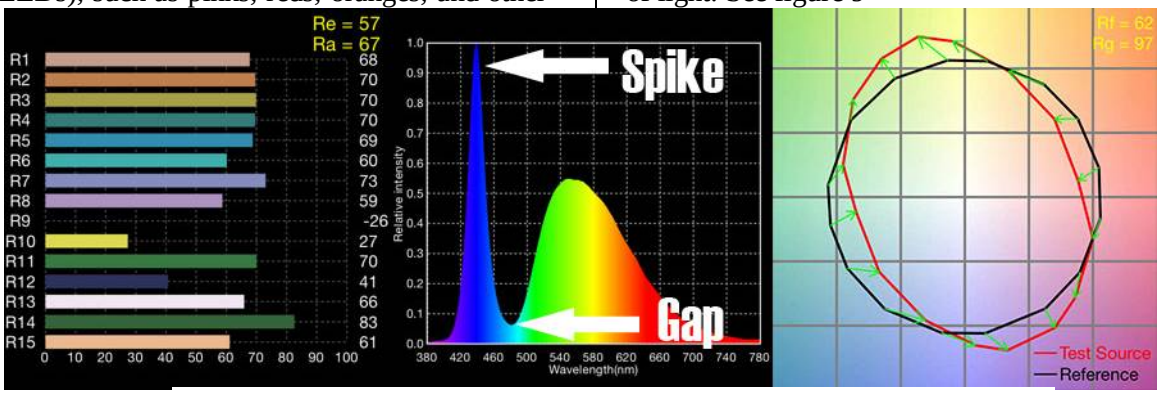

Figure 9 showing the spikes and gaps in The LEDs light color spectrum

This affects how LEDs light sources render color. Unfortunately, most color meters cannot be trusted with today's LED technology measuring the color temperature for LED is a big problem since it is not continuous color spectrum source, LED has gaps and spikes (Tim, 2016).

Plasma VS Daylight

If we look at figure 10 we can notice that the plasma light color rendition is very near the daylight.

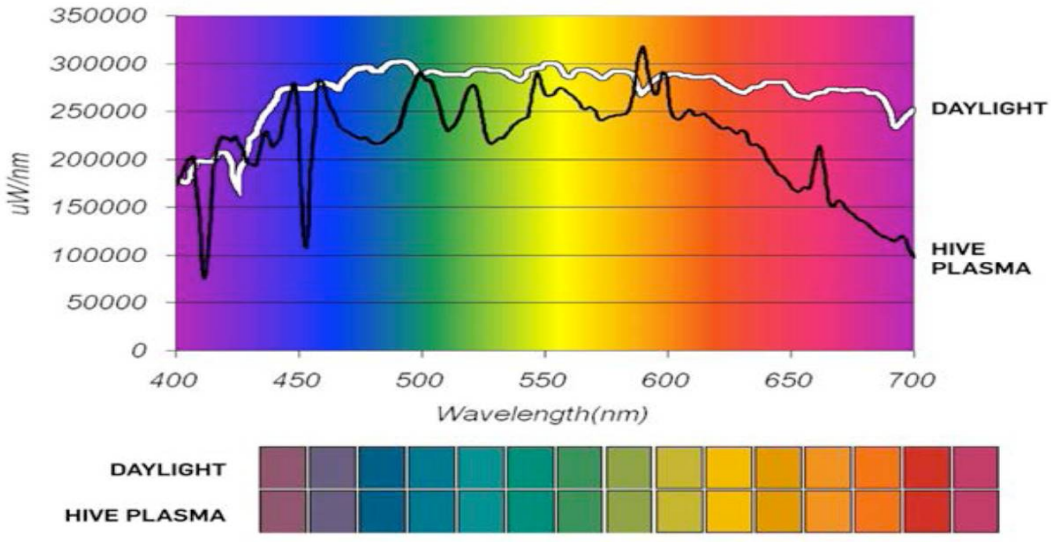

Figure 10 the spectral color distribution for the Plasma light and the Daylight

which makes it ideal in shooting outdoors, Also and it does not suffer from any blue shift like HMIs see figure 11.

Figure 11 Comparison between Plasma, daylight, and HMI

High-efficiency plasma (HEP)

High-efficiency plasma lighting is the class of plasma fixtures that have system efficiencies of 90 lumens per watt or more. Fixtures in this class are potentially the most energy efficient light source for outdoor, commercial, industrial and film production lighting. This is because not only to their high system efficiency but also to the small light source they present enabling very high luminaire efficiency (Adermann, 2013).

Plasma light in the field

Those bulbs do not suffer from the flicker effect. Hence they are suitable for shooting film high speed. Plasma fixtures considered as cool lighting, so you can put them near ice, and, importantly, actors. Tom Camarda a director of photography on the CBS show The Mentalist. "He thinks plasma lights put out nearly the full-color spectrum, so they are an excellent mimic for daylight. However, they are not a good choice for warm light, like lantern light and indoors. Camarda believes that if you want to shoot indoors, it is better to use tungsten light which consumes too much power. Camarda argues that studios and production houses should lead the way on investment in energy efficiency. He is optimistic that will happen (Peterson, 2014).

Conclusion

1- Plasma is "flicker-free" output, and plasma fixtures provide a continuous spectrum that is almost identical to Daylight, long life.

2- The characteristics of plasma make them an ideal source for motion picture lighting applications because they are full spectrum compared to LEDs which suffer from gaps and spikes.

3- Hive's Plasma performs beautifully in soft boxes, space light silks.

4- Plasma is a perfect solution for Chroma key because it vibrates at the right wavelength for Chroma compared to tungsten.

5- Plasma can be used in high-speed cinematography better than HMI because it is flicker free.

6- There are many different types of Plasma such as Fresnel, par, elliptical reflectors which will allow Lighting Designer to work efficiently.

7- Plasma light does not generate noise and less power consumption Compared to HMI.

8- BEE Plasma fixtures have an adjustable color temperature between 4600- 12000 CCT which will allow it to be a very excellent source especially when shooting in fluorescent location and moonlight shooting.

9- The Plasma light is very significant for interviews shooting and small location. Hence it can be a suitable replacement for 1k and 2k of popular HMIs.

10- As an emerging technology plasma still costly compared to HMI but like any technology, the price will go down after some while.

11- BEE Plasma can be used as moonlight source without using any Gels which is very vital in night time shooting because it does not add any extra money in buying Gels or lose in light intensity.

12- Plasma does not contain any harmful material like LED in case if it is broken.

13- Plasma is naturally more than any light source like LED and Compact Fluorescent Lamp which give slightly green or magenta shift.

14- The sun is an ideal light source with 100 CRI, but plasma varies 94-98 CRI.

15- Plasma is not bicolor fixture unlike most of LED are Bicolor.

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