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Dispelling the "Inefficient Neon" Myth

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When considering illuminated signage, probably the most important factor to be taken into account is sign brightness. From the point of view of attracting attention to your business or promoting your corporate identity, generally speaking, brighter is better. For many years neon in its multitude of colors has been the medium of choice for performing this task - either in the exposed form or as a means of illuminating channel letters. This type of gas discharge lighting has always been considered very energy efficient, but this attribute has recently come into question, due mainly to the introduction of LED based products. Schemes such as the LEED system (Leadership in Energy and Environmental Design) and legislation (such as California's Title 24) have also focused attention on the efficiency of light sources. So, just how efficient is neon and how does it compare to other sources? As we shall see, in most instances, neon based illumination systems still provide superior performance in terms of "light out for dollar in" - particularly when we take into account relatively recent advances in the areas of phosphor and transformer technologies.

Light Source Efficiency

Lumens/watt (lm/W) is often used as a measure of the efficiency (or to be technically correct, efficacy) of a source in converting electrical energy to light. The lumen output of a source is a measure of the total amount of light emitted. It is sometimes provided by a light source manufacturer but is very difficult to confirm without employing the services of a testing laboratory. Watts are a measure of power consumed, and there are two types of power - real power, which is measured with a wattmeter, and apparent power, which is obtained by multiplying input voltage by input current (also called VA). Real power is what you pay the electricity company for, and it's important to verify that real power is being referred to when discussing lm/W figures.

Lumens per watt is a fairly good comparative unit, as long as light sources of similar color are being compared. To put things in perspective, for white light sources, an incandescent bulb has an efficacy of 17-20 lm/W, while at 100 lm/W, a modern T5 fluorescent lamp is one of the most efficient common sources. The best white LEDs used for signage have efficacies of 10-20 lm/W. How do neon sources compare?

High efficiency phosphors and transformers

There is an enormous range of colors available to the neon sign manufacturer today, made possible by the blending of different luminescent phosphor types, but this was not always the case. Up until the late 1940's very few, relatively inefficient, phosphors were available. The subsequent introduction of the calcium halophosphate family of phosphors together with improvements in the standard blue and green emitters enabled the neon sign industry to offer a full spectrum of color together with a large range of whites of different color temperature. These phosphors and their blends are still in use today - albeit with some subsequent improvement in efficiency. A typical halophosphate white, for example 6500K Snow White, running on a correctly loaded standard ferromagnetic 30mA transformer has an output of 150 lumens per foot of tube for 15mm diameter glass resulting in an efficacy of 35-45 lm/W.

Source	Efficacy (lm/W)
6500K std. white neon / magnetic transformer	43
6500K tri-phosphor white neon / magnetic transformer	60
6500K tri-phosphor white neon / electronic transformer	78
White LED	10-25
Std green neon / magnetic transformer	48
Rare-earth green / magnetic transformer	69
Rare-earth green / electronic transformer	90
Typical green LED (channel letter module)	12
High power green LED	25
Std blue neon / magnetic transformer	25
Rare-earth blue / magnetic transformer	23
Rare-earth blue / electronic transformer	30
Typical blue LED (channel letter module)	2
High power blue LED	15
Clear red neon / magnetic transformer	8
Clear red neon / electronic transformer	10
Typical red LED (channel letter module)	11

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Dispelling the “Inefficient Neon” Myth

The real breakthrough came in the 1960's with the development of rare-earth phosphors that emit light in narrower wavelength bands giving deeper, more saturated colors. In the 1970's and 80's additional rare-earth phosphors were developed and adopted by the lighting industry for use in fluorescent lamps, resulting in light sources which remain among the most efficient available. The trickle down effect finally reached the neon industry in the mid 90's. Lumen per foot output increased by over 30% for whites, leading to efficacies of 50-60 lm/W. Nowadays, all manufacturers of coated tubing offer a large range of colors and many different color temperatures of white based on blends of these "tri-phosphors".

Rare-earth phosphors are particularly efficient when used to illuminate channel letters. Standard "broadband" phosphors have much of their light filtered by colored acrylic faces, but the narrow wavelength bands emitted by rare-earths means that more of the available light is transmitted, giving a brighter, more vibrant sign. For example using rare-earth green neon behind green acrylic results in the face being 25% brighter than when using standard green, and 300% brighter than with standard 6500K Snow White.

Following the successful introduction of high efficiency electronic ballasts into the fluorescent lamp market, in the early 90's, many companies began to market electronic transformers for driving neon. Today there are several companies that make electronic transformers with excellent reliability records. The use of these high frequency power supplies further boosts the efficacy of neon; for example the 50-60 lm/W figure for tri-phosphor white neon is increased to around 78 lm/W at 30mA.

Watts per foot

For linear light sources such as neon, watts per foot is sometimes used as a measure of energy consumption. Note that this measurement does not have a lumen component and tells us nothing about how bright a sign may be. For example LED channel or border lighting may have a lower W/ft rating compared to the neon equivalent, but yields far less light because it is a less efficient source. Watts per foot figures for LED modules can also be misleading since they depend on how the modules are laid out. One manufacturer provides a guide on its channel letter module spacing and expected sign brightness; for its green LEDs the recommended layout to achieve only 45% of the brightness of rare-earth green neon (green acrylic face) results in an energy usage of 9.9 W/ft. Using its high output white LEDs (white acrylic face) results in a consumption of 11.9 W/ft and a sign only 80% as bright as that with 6500K rare-earth white neon. The neon in both cases, when powered with electronic transformers, would consume around 3.5 W/ft. A study of channel letter lighting by the Lighting Research Institute found that to produce the same amount of light, white LEDs consumed 2-8 times more energy than standard 6500K Snow White neon (30mA ferromagnetic transformer). If a white tri-phosphor and electronic transformer had been used in this comparison, the difference would be even greater.

For the currently available range of LED channel letter modules, only red is able to approach neon in terms of brightness and energy efficiency when used with certain, sometimes specially developed, red acrylic faces. Red (clear) neon has an efficacy of approximately 10 lm/W and a power consumption of 3.5-4 W/ft when run on an electronic transformer. The corresponding figures for the best red LED units used in sign applications are similar at 11 lm/W and 3 W/ft. This small difference is in stark contrast to the often quoted statement from LED proponents that the use of LEDs can result in 90% energy savings. For this to be the case, a red LED would need to have an efficacy of 100 lm/W, or in terms of energy use, the neon would need to consume 30W/ft!

If in doubt- prototype

Whether illuminating channel letters or lighting borders, high efficiency, rare-earth based phosphor neon will almost always result in the brightest, most energy efficient signage, especially when used in combination with electronic (solid state) transformers. Although these phosphor products have been available for several years, there has been a certain amount of resistance to their use from sign companies, due mainly to perceived cost issues. Rare-earth (tri-phosphor) coated tubing may cost double that of standard tubing, but when put in the context of a completed sign the increase is minimal, around 30¢/ft, when compared with the benefits its use brings. In many cases it may be required for a specifier to directly request that the sign company uses these products. If any doubt exists as to the best illumination solution, the coated tubing manufacturer should always be available for consultation and to provide appropriate samples for test. Prototype building is sometimes necessary - in fact this is to be encouraged, since it allows different products to be compared. For example for channel letters, the sign can be scrutinized for pantone color match, comparative surface brightness can be determined with a relatively simple light meter, and power draw (real and apparent) measured with one of any number of commercially available power meters.