Lamp and selection criteria
Date: Venerdì, febbraio 15 @ 12:19:28 CET
Topic: Educational Lighting Site

Criteria for the selection of lamps | Incandescent lamps | Halogen cycle lamps
Discharge lamps | Terminology | Light sources

Selection criteria for lamps

Comparison between the main types of lamps:

	Advantages	*Disadvantages*
Halogen	Small dimensions - higher efficiency - longer duration - excellent RA index - brilliant white light - adjustable	High heat development
Fluorescent	High efficiency - long duration - choice of colour temperature - low operation costs - low heat development - diffused light source	High initial cost - sensible to temperature - limited optical control - needs feeder
Incandescent	Low purchasing costs - small dimensions - excellent Ra - various forms - adjustable	Low efficiency - high heat development - high operation costs - short duration
Metal halides	High efficiency - long duration - good optical control - low operation costs - good colour representation	High initial cost - needs feeder - long cold ignition/hot restrike times
High pressure sodium	Long duration - exceptional efficiency - good optical control - very low operation costs - low luminous flux decay	High initial cost - need feeder - long cold ignition/hot restrike times - scarce colour representation

Torna all'inizio

Incandescent lamps

The lamps commonly defined as incandescent are still the most diffused sources of artificial light in the world, after many technological improvements during more than a century, the time that separates us from 1879, the year in which Thomas Alva Edison presented his prodigious invention to the public convened in Menlo Park, in New Jersey (USA). In reality, Edison, without belittling his exceptional talent as an inventor and his extraordinary ability as an organizer of collective research work, skilfully exploited the results of studies and experiments that had been carried out by numerous researchers since the first years of the nineteenth century. The British man Joseph Wilson Swann preceded him by constructing (in 1878) a functioning prototype of a lamp with a filament made of carbonized Bristol board. Edison had already obtained huge success in other fields of applied Physics, particularly in telegraphy and telephony. He is also the inventor of the phonograph. The lamp he presented in 1879 was made of a glass bulb in which he had applied the degree of vacuum that was possible to obtain with the instruments of the time, in particular the mercury suction pump invented by Herman Spragel in 1865. Efficiency was calculated in 1.4 lm W-1 and the duration amounted approximately to 45 hours.

The merit that history bestows on Edison, a remarkable man ahead of his time, not only consists of having built the first economic lamp, but also of having stubbornly aimed at elaborating all the technologies necessary to diffuse its use in the social and economic context of that time. Indeed, he worked to make this new source of artificial light, destined to rapidly replace the illuminating gas lamp, compatible with all the accessory devices (screw connection - which is still in use today -switches, fuses), electricity-producing machines, electric networks to distribute it over the territory, the societies

and companies to promote and run the production of electricity on a large scale. Despite the long and constant technological evolution of this product, the functioning principle has remains substantially the same: a metal transformed with industrial processes and reduced to a very fine filament, inserted in a glass bulb in which vacuum has been created, and which has been filled with a specific quantity of inert gases, carries electricity, direct or alternating, near to the melting point of the metal, with the emission of light radiations, together with a conspicuous proportion of infrared radiations and a very small quantity of ultraviolet radiations. The core of the source is the metal filament which offers resistance to the passage of electricity. The material it is made of has been patiently researched in order to raise its emissive power and its duration as much as possible. It is known that Edison himself experimented with the most disparate materials. Amongst the metals: platinum, iridium, tungsten; among materials of organic origin: paper, Bristol board, cotton, fibers from bamboo, palms and herbaceous plants coming from exotic countries. After his attempts other researchers followed suit, while the manufacturing of lamps with a filament of cellulose covered with graphite was consolidating. The adoption of metals, which would become definite, became a reality only after the first decade of the new century, because of the high manufacturing costs and the absence of adequate production technologies.

When a metal accumulates, by Joule effect, a lot of thermal energy, the sublimation phenomenon, the change of physical state from solid to vapour, acquires relevance. The freed metal vapour tends to condensate, thus returning to its original solid state at the contact with relatively colder surfaces, such as the inside wall of the glass bulb which surrounds it. The minute metal particles that set down shadow the bulb, causing the absorption of a proportion of the radiation emitted by the incandescent filament. The characteristic darkening of the bulb takes place, with the consequent decrease of the light efficiency of the source. The volatilized atoms reduce the transverse section of the filament, making it increasingly fragile. Sublimation, thus, is at the origin of a reduction of the duration of the lamp too.

Chart of the main technical and performance-linked data for GLS incandescent lamps

Type of source	*Dimensions in mm and Connections*	*Power supply voltage (V)*	*Rated power (W)*	*Absorbed power (W)*	*Luminous flux (lm)*	*Light efficiency (lm/W)*	*Average duration in hours*	*Colour temperature*	*Colour representation index (R a)*
Vacuum bulb	**80x45 (E14)**	**220**	**15**	**15**	**105**	**7**	**1000**	**2750**	**100**
Bulb with inert gases	**105x60 (E27)**	**220**	**15**	**15**	**115**	**8**	**1000**	**2800**	**100**
"	**105x60 (E27)**	**220**	**40**	**40**	**430**	**11**	**1000**	**2800**	**100**
"	**105x60 (E27)**	**220**	**100**	**100**	**1380**	**14**	**1000**	**2850**	**100**
"	**189x90 (E40)**	**220**	**300**	**300**	**5000**	**17**	**1000**	**2850**	**100**
"	**274x130 (E40)**	**220**	**1000**	**1000**	**18800**	**19**	**1000**	**2850**	**100**

Torna all'inizio

Halogen cycle lamps

Thanks to the evolution of classic incandescent lamps, today they are available in a wide range of models, at the normal network voltage (230 V), miniaturized to 12 V, with integrated optics (i.e. a small reflector in aluminium or glass welded to the base). The adoption of these lamps is advisable in all those room that require an optimum representation of colours. Thanks to their minimum dimensions it is possible to use them even in reduced spaces. With 230 V voltage the electric system is very simple. The 12 V ones, on the contrary, require the fitting up of a transformer and the use of cables with a bigger section, and the increase of the entity of electricity.

In the models functioning with 230 V the connection is a normal E27 screw connection, and a double bulb to guarantee safety and to be able to handle them easily. These models are proposed for the installation of devices provided with the common screw lamp holder, with the possibility of immediately substituting the traditional incandescent lamps. Now lamps with an E14 "mignon" connection and a power of 40 and 60W are available. The halogen version of the well known PAR (Parabolic Alumised Reflector) with E27 connection is interesting, they are perfectly interchangeable with the traditional incandescent models (with an average duration of 2500 hours). They offer all the quality of halogen

lamps conveyed in beams with a 100° width (Spot) or a 300° one (Flood). The minimum available power is only 40W (PAR 16 with F14 screw connection replaceable with the R50 reflector one), the maximum 100-120W (PAR 38 with F27 screw connection). The uniformity of the distribution of the luminous flux inside the light cone is excellent, and it is a prerogative that allows to illuminate without striations or disomogeneities in the projected light halo.

The other type of halogen lamp, which has recently undergone interesting improvements, is the small-format, miniaturized on for 12V voltage. The improvements regarded in particular the security of use and the protection of illuminated objects against UV radiations. The European regulation EN 60598-1 establishes that the devices used to illuminate indoor structures, equipped with halogen lamps with double connection supplied with 230V, should be equipped with a protection glass. This glass has the task of limiting the detrimental effects of an eventual explosion of the source. The A1 variance to regulation IEC 596-1 (CEI 34-24), which came into effect in January 1996 for the protection of security, extends this disposition to all devices provided with halogen lamps, even those with a very low security voltage. However, this regulation allows a few exceptions to this rule and namely: lamps equipped with an outer cover (e.g. halogen lamps with a built-in optics and front closing screen), lamps supplied with 230V with a single double bulb and B15d bayonet base, lamps supplied with a very low voltage and with a low pressure bulb. The pressurization is necessary because it has the task of extending the life of lamps, as it tends to limit the sublimation of the tungsten atoms of the filament.

The new halogen technologies are at a low pressure (1bar with switched-off lamp, 2.5 with switched-on lamp): they permit use to use devices without any protection screen. As already said, a lot has also been done to contain the emission of ultraviolet radiations. A special type of quartz is able to filter a high quantity of undesired UVs. The bulb made of this type of quartz acts as a complete barrier against UV-C radiations (100-280 nm) and UV-B radiations (280-315 nm), while UV-A radiations (315-380 nm) are filtered with approximately a 50% reduction.

Torna all'inizio

Discharge lamps

Where a lot of good quality light with a pleasant white tone, a long functioning duration and low consumption is required, the use of discharge lamps is advisable, in particular the metal halide vapours type. It is the case of big rooms (large planimetry and tall ceilings) such as entrances, halls, rooms obtained from spaces that had originally been destined for other uses (industrial sheds, hangars, unused areas).

In halide lamps (also called "halide" lamps), innovations have allowed us to overcome some performance limitations of those model that have already been present in the market for some years. We refer, in particular, to variations of colour temperature from item to item. Indeed, it can happen, with common halide lamps, that in the same group of lamps some may have a warmer or colder tone than others. The new models guarantee tone stability and constancy for their whole life and in any functioning position (horizontal, vertical, oblique). In the last few years a new discharge bulb manufacturing technology has been introduced. A ceramic material has been used, a material already widely and successfully experimented in high pressure sodium lamps, to manufacture the small discharge tube of halide lamps, thus exploiting the advantages of better chemical-mechanic stability of this fundamental component. Sodium, in particular, contained in the mix of halide gases and vapours, develops a corrosive action against the quartz, which is the material used to make the discharge tube in traditional halide lamps. The absorption and the discharge of sodium, by modification of the composition of the salts inside the discharge tube, cause the colour change. The tube is made of polycrystalline aluminium, a material which, apart from resisting very well to the aggression of the sodium, tolerates higher temperatures thus contributing to increase the efficiency of the lamp (values near to 90 lm/W according to voltage).

Torna all'inizio

Terminology

From now on we shall try to introduce the reader to the etymology and the meanings of the letters from "H" of HMI to "T" of Tageslicht (daylight in German).

The letters immediately preceding the voltage data characterize group of belonging of the lamp: HMI, HMP, HTI, HSR.
H - This is fundamentally the first letter of the acronym of mercury, the chemical element (Hg=Hidragirium, i.e. mercury in Latin).

I - Compound with halogens (I=halides, bromides).

M - Metal (rare earths, e.g. dysprosium, holmium, tullium).

P - Projection.

R - Rare Earths (metals) (see also "M").

S - From Safe, meaning safe to handle; it characterizes lamps with an external HSR bulb.

T - Tageslicht which in German means daylight.

The letters that follow the power denomination (including "W" of watt) describe specific structural features of the respective types.

C - Power supply cable and inlet.

D - Generally without connection with 2 bare contact wires coming out of the two opposite ends.

DE - Double Ended lamps with a double connection and threaded inlets.

GS - Gap Short (short gapped, i.e. with near electrodes).

P - Projection, e.g. slide projectors.

PAR - Lamp built in the Parabolic reflector.

S - Short. A lamp that is shorter than the standard one.

SE - Single Ended (lamp with a single connection).

22/24/32 - Denomination of the focal length (i.e. the distance in mm between the edge of the reflector and the area of maximum luminous flux concentration).

There are few possible general information related to multiple performances. With HMI and HMP hot re-strike is possible at any stage of cooling. HTI lamps are short-gapped lamps with maximum luminance. HSR lamps are lamps with a single connection and with external bulb adequate only for cold switching-on (hot re-strike is not possible). These definitions give the user, both in the technical and commercial field, the most general information on individual lamps with regard to its general features. One lamp is defined in a unique way and without any possibility of confusion only if the complete denomination is provided. The lack of just one letter can lead to confuse different types of lamps.

Luminous flux decay for some type of lamps calculated as the per cent variation of the initial flux at the end of the average duration

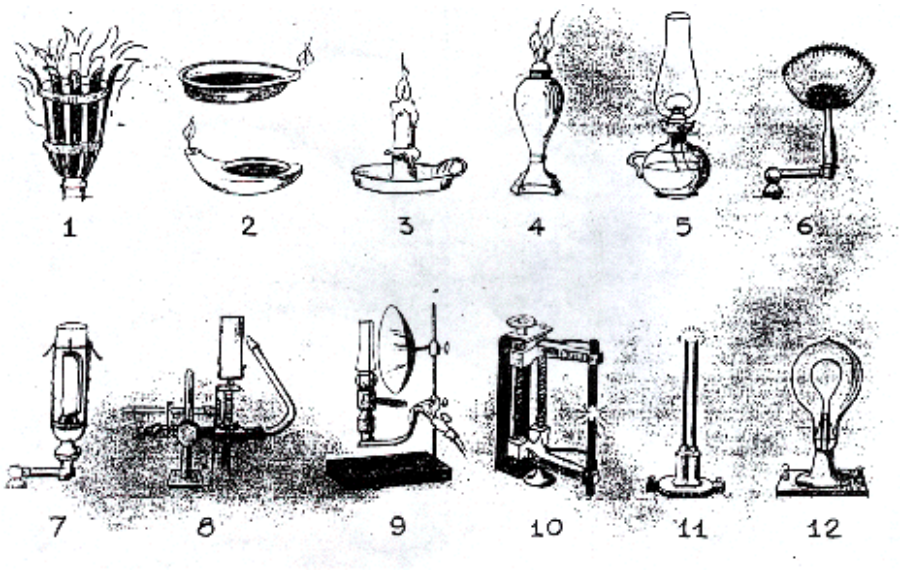
Type of lamps	Luminous flux decay (%)
Incandescent	**87**
Halogen	**94**
Fluorescent	**85**
Mercury vapour at high pressure	**78**
Halide	**70**
Sodium vapour at high pressure	**90**
Sodium vapour at low pressure	**87**

Average cold and hot re-strike times with normal power supply systems (longer times are generally recorded with lamps with a higher voltage)

Type of lamps	*Cold re-strike times*	*Hot re-strike times*
Tubular fluorescent	**1-3 seconds**	**1-2 seconds**
Mercury vapour at high pressure	**3-5 minutes**	**4-6 minutes**
Metal halide	**3-4 minutes**	**4-6 minutes**
Sodium vapour at low pressure	**10-14 minutes**	**almost immediate**
Sodium vapour at high pressure	**5-11 minutes**	**1-2 minutes**

Torna all'inizio

Light sources



Evolution of lighting media

1) The most primitive form of light source was the torch; an iron basket supported the burning wood. 2) Open flame oil lamp. This form of lamp dates back to seven-eight thousand years before Christ. 3) The candle comes after the oil lamp; in theatres it is provided with a screen to protect the flame and hide both the lamp and the candle. 4) Open flame camphor lamp: it is made of one or more wicks placed inside a vase containing oil. 5) Kerosene lamp with adjustable wick, invented in France in 1783. A few years will go by before people start using it. 6) The open flame burner was invented in 1782 and was used for the first time in theatres. 7) The incandescent strainer lamp, associated to the burner spout, was invented in 1895 by Aver, Austrian. He developed it in a considerable way. 8) A lime spout, heated until it is incandescent with a oxyhydrogen blowpipe, it was used for many years as a projector. 9) Acetylene lamp; it was used in theatres (the Sirius spout). The body of the device constitutes a system thanks to which the acetylene mix is made incandescent. 10) In 1908 Sir Humphry Davy perfected the electric or voltaic arc: in the following 40 years it was used in theatres, but later on it was substituted with the lime lamp. 11) The first arc lamp to be marketed was the Jablochkoff candle made of two carbon sticks separated by insulating material. 12) The first incandescent electric lamp was invented by Edison in 1879, it used a filament of carbonized cotton.