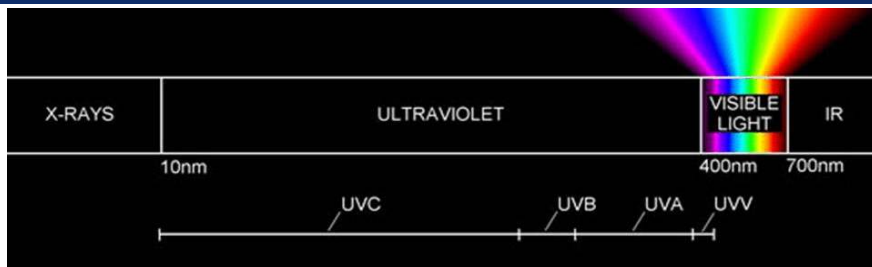


COMPARISON between Continuous and Pulsed UV Sources:



Ultraviolet (UV) belongs to the electromagnetic waves with wavelengths below the darkest visible violet region (<400 nm, >3 eV), but longer than that of soft X-rays which start at <10 nm, >120 eV and is divided into 5 sub-regions:

- 100 -- 170 nm (120-8 eV): vacuum UV, a fused quartz border (170 nm)
- 170 - 200 nm (8-5.8 eV): deep UVC, or ozone generating UV;
- 200 - 280 nm (5.8–4.4 eV): UVC, or germicidal region,
- 280 - 310 nm (4.4-3.9 eV): UVB, limited sterile actions, bio effects,
- 310 - 400 nm (3.9-3.1 eV): UVA, bio-effects, medical applications, UV curing, a small part of the solar UV at the sea level.

$1 \text{ eV} = 1.6 \times 10^{-19} \text{ Joule}$

conventional gas discharge mercury vapor lamps:

Introduced and widely used since 1920's

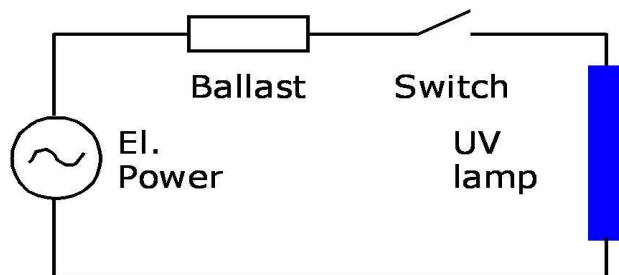


The major UV emission is by fixed few spectral lines. Medium and high pressure lamps have to be air cooled due to its high (200-600°C) surface temperature.

	Lamp load in w/cm	UVC output in %
Low pressure:	1 - 5	20-30
Middle pressure:	10-50	8- 12
High pressure:	50 10	5 - 8
Excimer UV lamps	10-50	5 - 8

Operation:

Power controls for CWUV Sources includes DC or CW Power Supply, ballast and a switch for a UV lamp to provide DC, or continuous sine-wave electrical current (from a few to 10⁴s at voltages from 10² to max 1000 V:



Advantages of CWUV lamps:

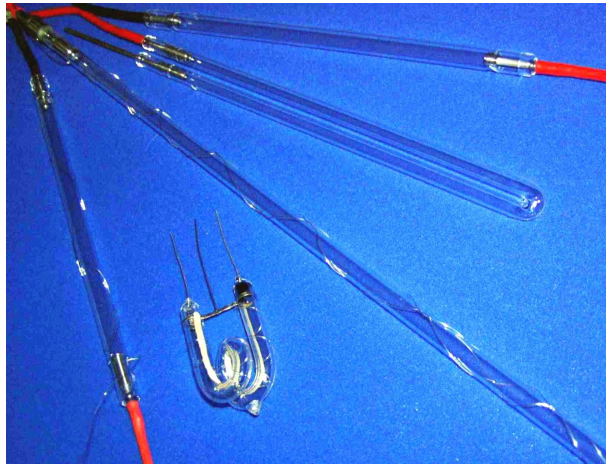
- Simple, low cost,
- the 254 nm line output is 20 to 25% for the best performing (low pressure) lamps,
- hardware/operational costs are satisfactory for many applications.
- lamps life-time up to one year non-stop operation for low pressure lamps, and up to 3 months for medium pressure lamps.

Limitations of CWUV lamps:

- Low 4% - 8 few % UV output for all except HPLP lamps,
- Mercury is a hazard if a lamp is broken,
- UV power is often insufficient for sterilization on conveyor lines,
- Warm-up time and dependence on ambient temperature,
- Fixed UV line spectra which do not allow to sterilize through many packaging materials,
- Inability to fully inactivate UV resistant micro-organisms.

Flashlamps:

Introduced and widely used since 1930's



The main feature:

a pulsed discharge with a BROAD spectral output, which shape solely depends on a lamp circuit and a gas type and pressure

Two major types of UV emissions:

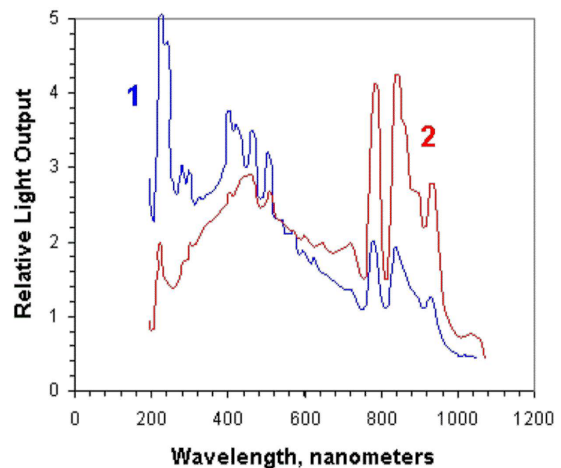
1- Bremsstrahlung- the UV continuum by electrons decelerated in electrical fields of ions; a position of its maximum spectral output can be adjusted by PFN (see below), and
2) recombination (wide) lines by electrons, converting ions to neutral atoms or molecules, these line positions are fixed.

Flash lamp emission spectra at:

- 1) 7 kA/cm²;
- 2) 1.5 kA/cm²

Flashlamps can be air or water cooled.

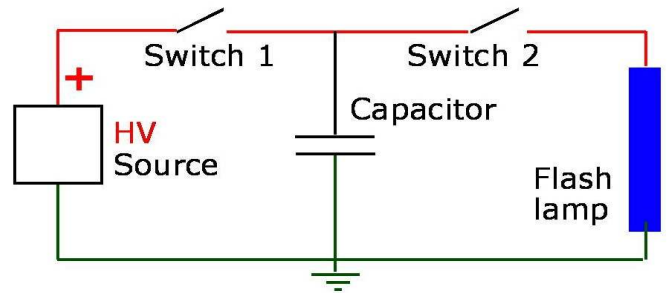
UV flashlamp electrical loads vary from 10 to 50 Joules / pulse / 1 cm of a flash lamp length, resulting in intense PUV emission with UVC+UVB from 15% to 35%, whereas 75% to 85% of the lamp output is a white (sun-like) light.



Operation:

Generation of a pulsed discharge (plasma) by a high compression of the electrical energy with a Pulse Forming Network (PFN) in two basic cycles:

- A. Capacitor is charged through S1=On, S2=Off,
- B. Release of a stored energy in to a flash lamp, S2 =On, S1=Off.



PFN provides pulses of electrical current from a few 100` s Amp to a few kAmp with a duration from sec (10-6) to msec (10-3) sec. Respectively the plasma temperature during the peak of the current pulse can be from about 6000 °K to about 20.000°K.

Advantages PUV:

- High - up to 30% - UV output ,
- Adjustable UV output - by pulse forming network,
- Highest UV intensities - in kw/cm² during a pulse,
- No warm ups: an instant action adjustable to a product flow,
- No Mercury! Environmentally friendly!
- Low operating costs.

Limitations PUV:

- Its life depends on its operating parameters - the lower those from the "one pulse limit" , the longer it lasts, usually from 1 ww at 1 Hz to 12-16 ww which is about an average life of medium and high pressure CWUV lamps.
- A sophisticated and costly design of a lamp and its circuit to reach both a long lamp life and its high UV output.
- Prices are a few times and for it`s driving circuits are 10 to 100 times as much as those for CWUV Mercury lamps.

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