References

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Savile Bradbury has sent the following information about the colour temperature of tungsten halogen bulbs which are so popular for photomicrography.

LAMP VOLTAGE AND COLOUR TEMPERATURE.

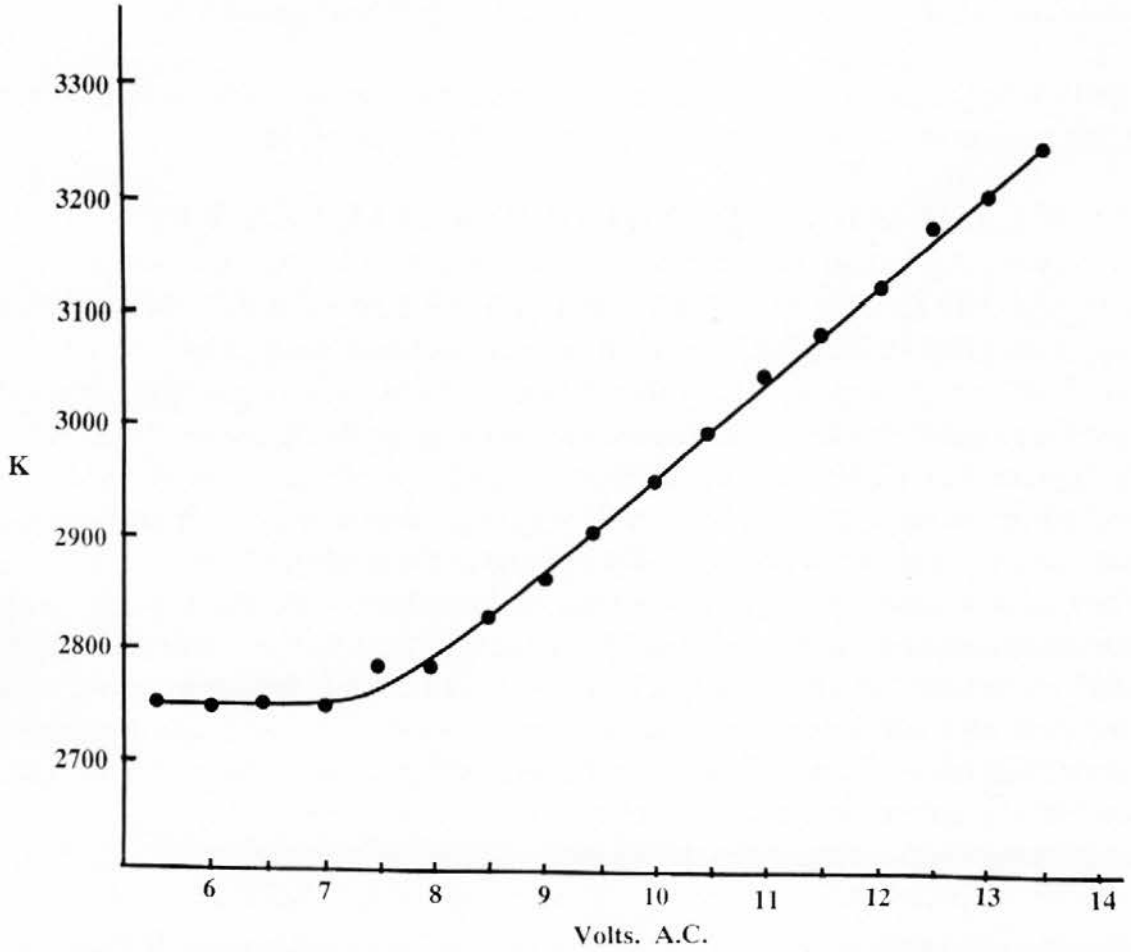
Photomicrography in colour is now very common and most microscopists will use a film which is balanced for correct colour rendering with artificial light. Such films are the opposite of those intended for use in ordinary outdoor photography by daylight. An artificial light film is usually designed to give correct colour rendering when the colour temperature of the light (that is a measure of its 'redness' or 'blueness') is 3200 degrees Kelvin. By contrast films intended for daylight use are rated to give correct colour balance at about 5500 K. If a daylight film is used with artificial light then the colours will be very biased to the red end of the spectrum

The colour temperature of a light source is dependant on the temperature of that source which is, in turn, is governed the voltage applied to the filament, so it was decided to measure the voltage applied to a Q.I. bulb and at the same time measure the colour temperature of the light emitted. This was done with the colour temperature attachment fitted to a Gossen 'Mastersix' photographic exposure meter. The measured results are summarised in the table below.

Measurements on a 12 volt, 100 Watt QI bulb

Volts (AC)	CT (Kelvin)
5.5	2750
6.0	2740
6.5	2750
7.0	2750
7.5	2780
8.0	2780
8.5	2830
9.0	2860
10.0	2940
10.5	2990
11.0	3040
11.0	3080
12.0	3120
12.5	3180
13.0	3200
13.5	3240

It is possible to alter the colour temperature of a light source by filtration In microscopy with colour films such filters are usually blueish and have varying strengths. If 1,000000 is divided by the colour temperature of a light source then we obtain a value which is the MIRED value of that source. For example if we have a source with a colour temperature of 5000 then its mired value is 200. The mired values are



used for determining the amount of filtration needed to convert a light source of one colour temperature to that of another. For example if we have a lamp running at 11 volts giving a CT of 3080, then for use with a film designed for 3200 K we should use filtration of about - 13 mireds. In practice we would use an 82 blue filter (or its Cokin equivalent 024) which changes the mired values by - 10.

Recommended filtration for the given lamp voltages
For 3200 artificial light film (eg Fuji 64T)

Volts	Mireds	Filter
8	-80	80C/or Cokin 022
9	-60	80D/or 82A+82B/or Cokin 024
10	-30	82B/or Cokin 024
11	-10	82
12	Technically needs -5 (none in practice)	
13	No filtration	

Mired values of filters

KODAK series		Cokin Series
80A	-131	020 = 80A = -131
80B	-112	021 = 80B = -112
80C	-81	022 = 80C = - 81
80D	-56	024 = 82B = -32
82C	-45	
82B	-32	
82A	-21	
82	-10	

NB:- a minus value signifies a BLUE filter

A NOTE ON THE OPTICS OF THE 18TH CENTURY CULPEPER-TYPE COMPOUND MICROSCOPE

by D.Jones

This microscope was described in the last Bulletin. The optical data in this report have been obtained by Dr John Reid, of the School of Physics, Aberdeen University.

The objective lenses, in short brass cup-shaped holders with an internal attachment thread, are all in very good condition. Four lenses from the original set of five survive, stamped 2, 3, 4, 5 on the front of their brass casings. Each is a single bi-convex lens with one surface about twice the radius of curvature of the other. All lenses have a very restrictive aperture stop of less than 2 mm in diameter, situated close to the rear glass surface, limiting the emerging pencils of light to the very centre section of the lens. The accompanying table includes the calculated numerical apertures of the lenses based on a photographic measurement of the diameters of the aperture stops.

The main barrel of the microscope is marked with the numbers 1, 2, 3, 4, 5, indicating the position it must be drawn out to focus the object with the different objectives. The range of positions is consistent with an image throw from the rear principal plane of the objective lens of about 110 mm. This distance is considerably less than the distance to the first eyepiece 'field' lens, which is some 190 mm from the objectives. Unfortunately, the complete imaging properties of the microscope could not be reconstructed with certainty because the eyelens was missing when the objectives were measured. However, assuming that 110 mm is correct for the throw of the objectives, then the eyepiece magnification would be $\times 2$ and the total magnification of the microscope for the set of objectives can be calculated. This is shown in the table. Even for the lowest power, the objective provides more magnification than the eyepiece. The calculated performance depends on the objective focal lengths, which were measured on an optical bench by the 'magnification method'. In this method, the image magnification formed at varying distances behind the objective is measured. The object is a calibration slide. The rate at which the magnification increases with increasing image distance is inversely proportional to the focal length of the lens under test. The measured focal lengths are listed in the table below.