

# Radiant emissivity

By J. H. Taylor

*Editor's note: This is the fourth installment of lecture demonstrations on radiation exchange, by J.H. Taylor of Rhodes College in Memphis, Tenn. The May issue will feature the first article in a series on applications of radiation exchange, beginning with an examination of the infrared spectrum of a block of ice.*

## Metals

It is important to point out to students that the radiant emissivity of both metals and gases can be changed. Let us begin with a discussion of metals, using Figs. 1 and 2 to assist in our discussion. Much material has been included in these figures, and the student is encouraged to study them carefully. Many arrows are shown, and their size should be interpreted as being proportional to the radiant emissivity of the object concerned.

Let us begin by considering Fig. 1(a) and (b). By simply bending a piece of metal, one can enhance its radiant emissivity. Such a bend as indicated in 1(b) is referred to as a Mendenhall wedge. By forming a wedge one is causing incident radiation to undergo more reflections, and hence more absorption, and hence approaching more and more closely what is called a "blackbody" or a "hohlraum." As the body becomes a

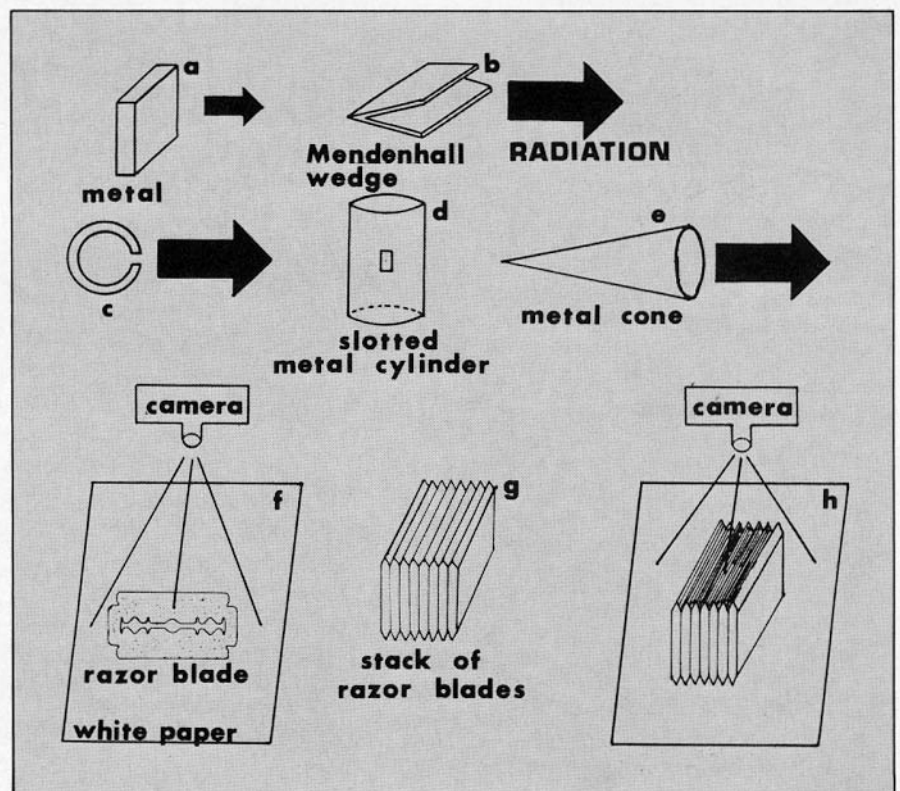


FIGURE 1. Radiant emissivity of metals.

better absorber, it also becomes a better emitter. This, of course, is Kirchhoff's law.

Other approaches to this bending of the metal, and hence trapping the radiation, are shown in Fig. 1(c), (d), and (e). Although we are discussing the shaping of metals, the student should pay close attention to the appearance of the apex in a paper drink-

ing cone the next time you use one. What is the appearance of the apex?

The shape indicated in Fig. 1(e), namely, a cone, is the shape frequently used in the construction of commercial reference radiation sources, i.e., so-called blackbodies. In this case the cones are made of ceramic material rather than metal. Some of these commercial sources can be operated



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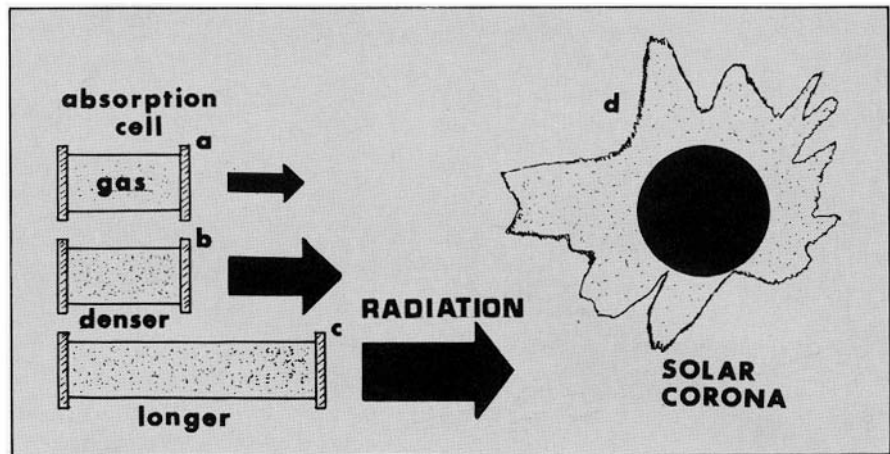


FIGURE 2. Radiant emissivity of gases.

at temperatures as high as 1200°C. It should be appreciated that the radiant emissivity of an object is a function of the temperature and of the wavelength.

I always suggest to my students that they carry out the experiment indicated in Fig. 1(f), (g), and (h). First, one takes a double-edged razor blade and places it on a piece of paper. When the film is developed and printed, one has a print in which there is very little contrast, i.e., both the white paper and the shiny razor blade are good reflectors of visible light.

One next repeats the experiment by stacking together several razor blades as indicated in Fig. 1(g). I suggest to the students that they hold the razor blades together by using a rubber band, (though this is not indicated on the drawing). One then takes this stack of razor blades and places them edge-on on the white paper as indicated in Fig. 1(h). When the photograph is taken and developed, one has a print in which there is now considerable contrast between the edges of the razor blades and the white paper. The Vs between the razor edges are acting like Mendenhall wedges, providing considerable absorption of visible light.

**Gases**

Let us now discuss the radiant

emissivity of gases as indicated in Fig. 2. First, if one were to measure the radiation from a gas (assume carbon dioxide), it would be observed that there was not radiation throughout most of the spectrum, as would be the case with metals, but only those spectral regions where the gas absorbs. This is, of course, simply another manifestation of Kirchhoff's law, which we discussed last month.

One would find that the radiant emissivity could be increased by increasing the density of the gas, by making the column of gas longer, or by both of these methods. If the amount of gas in the path is such that the radiation passing through the column is completely absorbed at one or more wavelengths, then the column of gas at those wavelengths has a radiant emissivity of "unity" and is said to be a "blackbody" at those wavelengths.

The student's attention is invited to the sketch shown in Fig. 2(d). The solar corona is characterized by having an extremely high temperature but a very low radiant emissivity. It should be pointed out that a radiometer, i.e., a spectroscopic instrument that measures radiation over a fairly broad band of wavelengths, is not able to distinguish an object of high temperature and low radiant emissivity from an object of low temperature and high radiant emissivity.