Angle and Temperature

Infrared filter designs are normally based on the assumption that filters will operate at room temperature and will be irradiated by collimated radiation at normal incidence. If filters are intended for use under other conditions, the change in their spectral characteristics must be taken into account. This especially applies to narrow bandpass filters. For other types of filters, the magnitude of these shifts will generally not affect optical system performance.

Infrared filters will shift towards shorter wavelengths as the angle of incidence is increased. On the other hand, an increase in temperature will shift the filter towards longer wavelengths. The exact amount of wavelength shift depends on many factors, including the design of the filter and the refractive indices of the materials used. Computer programs may be written to predict the precise shift of infrared filters due to irradiance by a given energy distribution and cone angle (or angle of incidence). If these parameters are specified, filters can be coated to provide the desired spectral characteristics at the operating conditions of an infrared system. In order for a narrow bandpass filter to be useful, its center wavelength location and bandwidth should be specified along with angle of incidence and temperature.

Filters which are designed to have a minimum wavelength shift with increasing angles will usually be very temperature sensitive and vice versa.

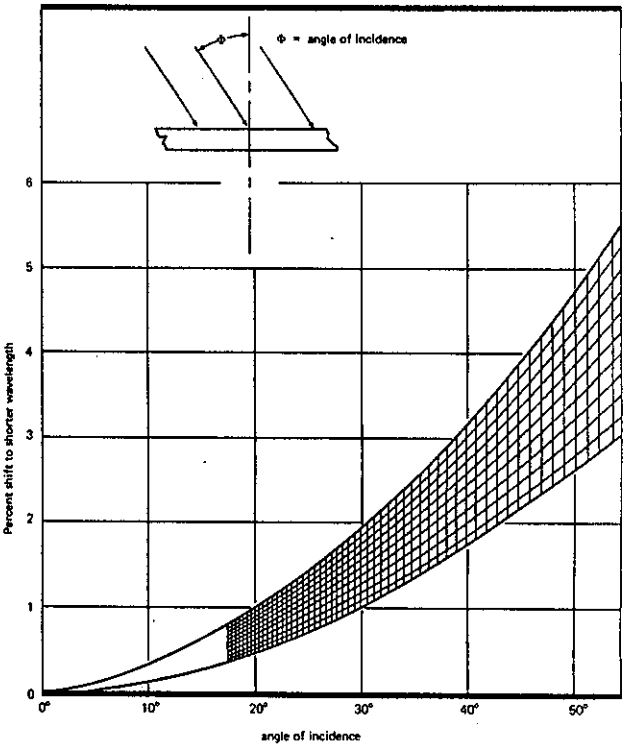
Page 39 shows the expected range of angle shifts of infrared filters coated by one manufacturer, including bandpass, long wavelength pass, and short wavelength pass filters, irradiated by collimated radiation. This figure represents a composite of theoretical and measured data, and emphasizes the importance of including angle shift as a design consideration.

Page 40 shows calculated shape changes and wavelength shift of a filter with a 1.4% half-bandwidth due to variation in f-number of the irradiating optics.

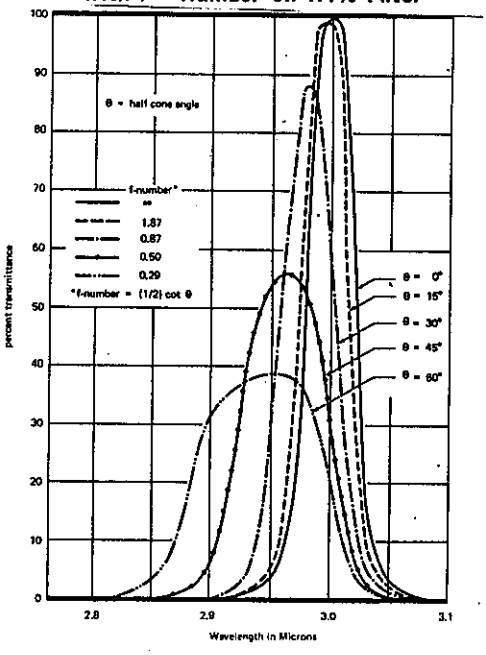
Page 41 shows predicted data about the wavelength shift of infrared filters due to temperature variation.

Studies of the angle and temperature shift characteristics of interference filters are presented in more detail in an article appearing in the August, 1967, issue of "Applied Optics," titled "Effects of Angle and Temperature Variation on Infrared Filter Characteristics."

Wavelength Shift of Interference Filters
as a Function of Angle of Incidence Collimated Radiation



Variation of Spectral Characteristics
with F - Number on 1.4% Filter



Wavelength Shift as a Function of Temperature