

Evaluation of Glass for Heat Insulation and Sun Protection concerning their Suitability for Interior Planting

- Survey in Cooperation with the "Bundesverband der Glasindustrie"

Regulations on Heat Insulation

On the basis of attempts to reduce energy consumption, heat insulation and sun protection glasses are used. The so-called "Wärmeschutzverordnung WSchV" (1995) specifies a reduction of transmission heat loss and hence a reduction of the annual thermal heat use of a building. A balance has to be made for the whole building in which the glazing plays a major role. The glass surfaces contribute to the transmission heat loss (thermal transmittance value U [$W/m^2 \cdot K$]) (DIN 52 619). On the other hand, energy may be gained by transmitted global radiation, characterized by the glasses' total energy transmittance g [%] (DIN 67 507).

Note: DIN 67 507 was replaced by DIN EN 410

Glass - Differences between Heat Insulation and Sun Protection

Heat insulation glass is an insulation glass with an improved U -value whereas heat loss isn't minimized. Sun protection glass isn't necessarily isolation glass, it only reduces radiation from outside (g -value reduced). Mostly, glasses with a special design are used consisting of two panes with special coating and gas in the interspace. With heat insulation glass, the coating is on the inside of the inner glass (SS3), sun protection glass is coated on the inside of the outer glass (SS2) with precious metals (mostly silver) or oxides (e.g. tin oxide). The interspace contains an inert gas (e.g. argon).

Due to the coating, the optical properties of the glasses are changed so that plant growth may be influenced.

The Plants

Apart from temperature, water, CO_2 and nutrients, plants need light for photosynthesis. Photoreceptors (chlorophyll, carotinoids) help to absorb radiation and to convert this kind energy into growth. In the so called action spectrum of photosynthesis (fig. 1) one can see that plants use the total range between 400-720 nm for photosynthesis. This range is called photosynthetic available range (PAR). Most plants reach their photosynthetic maximum in the blue (400-500 nm) and light red (600-700 nm) area, using only 50% of the green radiation (500-600 nm).

Depending on the plant species and other growth factors, each plant shows a minimal need of light for growth (compensation point) and a light saturation point at which photosynthesis stagnates.

Plants can be divided into different categories depending on their light requirements. In horticultural production, a rapid cultivation is imperative. Minimal growth suffices when greening the indoors. Plant species with little light requirements only need 2 W PAR/m² (500 lx), with medium 4 W PAR/m² (1000 lx), and high 6-8 W PAR/m² (1500-2000 lx). Only few plants need 10-20 W PAR/m² (2500-5000 lx).

[Translate to english:]

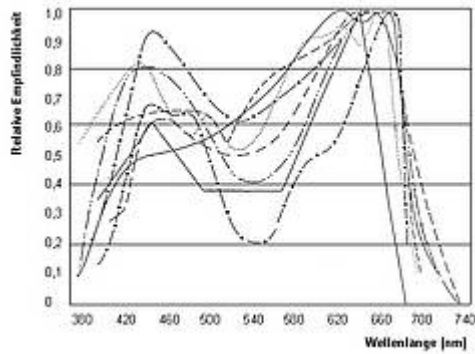


Abb. 1 Action Spectrum of Photosynthesis for some Plants (Geutler und Krochmann, 1979)

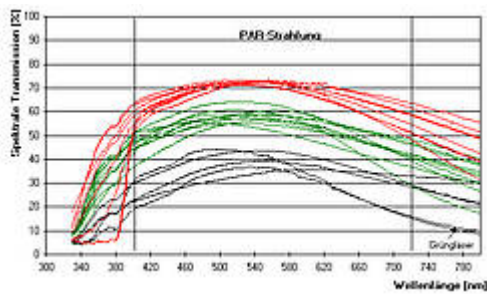


Abb. 2 Spectral Permeability of some Glasses (Own Measurements)

The Glass

Spectral transmission charts can be ordered from the manufacturers of heat insulation and sun protection glasses. As an approximation, the transparency t_v can be consulted for an evaluation of the transmission in the visible spectrum (380-780 nm) weight with the light sensibility of the human eye. A specification of the manufacturers concerning the PAR-transmission (400-720 nm) would be desirable. In a survey, different available heat insulation and sun protection glasses were tested and compared to the manufacturers' data in respect of their PAR-transmission (fig.2).

At a transparency t_v of 50-55%, the PAR-transmission was sufficient (red and green curves). Only few glasses didn't qualify and cannot be recommended for greening the indoors. By the way, some sun protection glasses are comparable to heat insulation glasses in PAR-transmission.

Additionally, the global radiation throughout the year has to be considered in order to evaluate the glasses. The radiation intensity changes depending on the position of the sun and cloudiness. On a clear day in January, the average radiation is 110 W PAR/m², in June 470 W PAR/m², whereas on cloudy days it is reduced to 15 W PAR/m² in January and to 160 W PAR/m² in June. This data was collected on the outer side of the glass. The intensity is reduced with the distance from the glass to the plants so that a span of 3-5 m, at least in winter, reduces the PAR to < 10 W PAR/m². Not only is this the case for heat insulation and sun protection glasses, but also for common greenhouse glass.

The inclination of the built in glass plays a significant role, as well as the daily position of the sun. Furthermore, the adjustment of the glass to a certain direction is relevant. Parts of the construction and other shadowing elements (e.g. bigger plants) influence the amount of light.

In the past, the negative effect of the spectral transparency on plant growth has been discussed in the media. This information shall be corrected hereby.

It is correct that the glasses show a lower transmission of blue and red radiation, but it can't be deduced that the radiation in the blue spectrum isn't sufficient for the plants (Jansen, 1996) and that sun protection glasses can only be used with additional lighting (FLL, 1997). If the percentage of transmitted blue (400-500 nm) and light-red (600-700 nm) radiation is compared to the total PAR-radiation, about 31% of the blue and 30% of the light-red light are transmitted. With common greenhouse glass, the rates are comparable (32% blue, 31% light-red). The transmission of UV-A rays (320-380 nm) is highly reduced by heat insulation and sun protection glasses, but it doesn't influence the photosynthetic activity, unlike mentioned in the media (Jansen, 1996). UV-B rays (300-320 nm) are just as little transmitted by common greenhouse glass. The minimized transmission of dark-red radiation (especially by green glasses) is to be valued positively due to a more compact plant growth.

The spectral permeability of heat insulation and sun protection glasses has only a subsidiary significance. Practical experience with photosensitive foils and assimilation lighting shows that the radiation intensity is more important than its composition.

Finally it is to be said that other growth factors such as aeration, irrigation and plant conservation play an important role in indoor greening and have to be optimized as much as the glazing.

Literature:

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