SHORT REPORT

HEAT DISSIPATION IN WATER-COOLED REFLECTORS

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Toyoki Kozai

Department of Horticultural Engineering, Chiba University, Matsudo, Chiba 271, Japan

The energy balance of a high pressure sodium lamp with and without a reflector is given in Fig. 1. The energy balance of a lamp varies with the thermal and optical characteristics of the reflector. The photosynthetic radiation efficiency of lamps, defined as input power divided by photosynthetically active radiation (PAR, 400-700 nm) emitted from the lamp ranges between 0.17 and 0.26. The rest of the energy input is wasted as longwave (3000 nm and over) and non-PAR shortwave radiation (from 700 nm to 3000 nm), convective, and conductive heat from the lamp, reflector, and ballast, and simply for increasing the cooling load.

Furthermore, some portion of the PAR is uselessly absorbed by the inner walls, shelves, vessels, etc. and some portion of the PAR received by the plantlets is converted into sensible and latent heat. More than 98% of the energy input is probably converted into heat, with only less than 2% of the energy input being converted into chemical energy as carbohydrates by photosynthesis. Therefore, it is essential to reduce the generation of heat in the culture room in order to reduce the cooling load.

Through use of a water-cooled reflector, schematically shown in Fig. 1, the generation of convective and conductive heat and longwave radiation from the reflector can be reduced, without reduction of PAR.

With the water temperatures at the inlet being 13° C and the water flow rate being 3.2 g/s, 50% of the energy input was removed by the water, resulting in a water temperature at the outlet of 25°C. The temperature distribution of the lamps with different reflectors is given in Table 1.

The warmed water coming out of the reflector can be used as a low-temperature heat source and for washing, because the water will not be polluted in the closed-water distribution system. Details of this study are provided in Kozai (1991).

TABLE 1. Temperatures of lamp, reflector and surroundings.

	Lamp type				
	A	B	C	D	E
Lamp bulb	160	177	175	205	180
Inner surface of reflector	-	46.6	58.0	92.3	30.4
Outer surface of reflector	-	-	57.0	78.8	24.6
Ballast	62.6	62.6	62.6	62.6	62.6
Room air	25.1	25.0	25.1	25.0	25.0
Floor	24.7	25.5	25.2	25.2	25.2
Wall	25.7	25.0	25.2	25.0	24.7
Ceiling	25.1	25.0	24.7	24.7	24.7

For lamp types, see legend to Fig.2

REFERENCES

Kozai, T. 1991. Autotrophic micropropagation. p. 313-343. *In* Y.P.S. Bajaj (ed.) Biotechnology in agriculture and forestry 17: High-Tech and Micropropagation I. Springer-Verlag, N.Y., U.S.A.

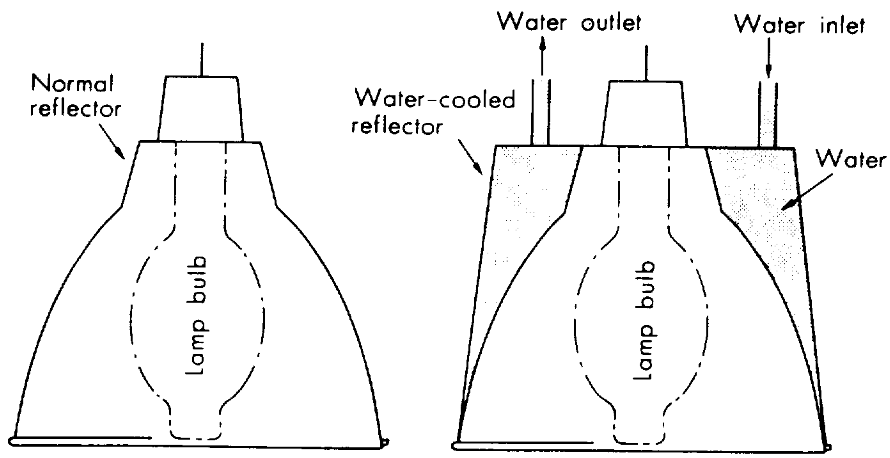

Fig. 1. Schematic diagram of a lamp bulb with normal and water-cooled reflectors.

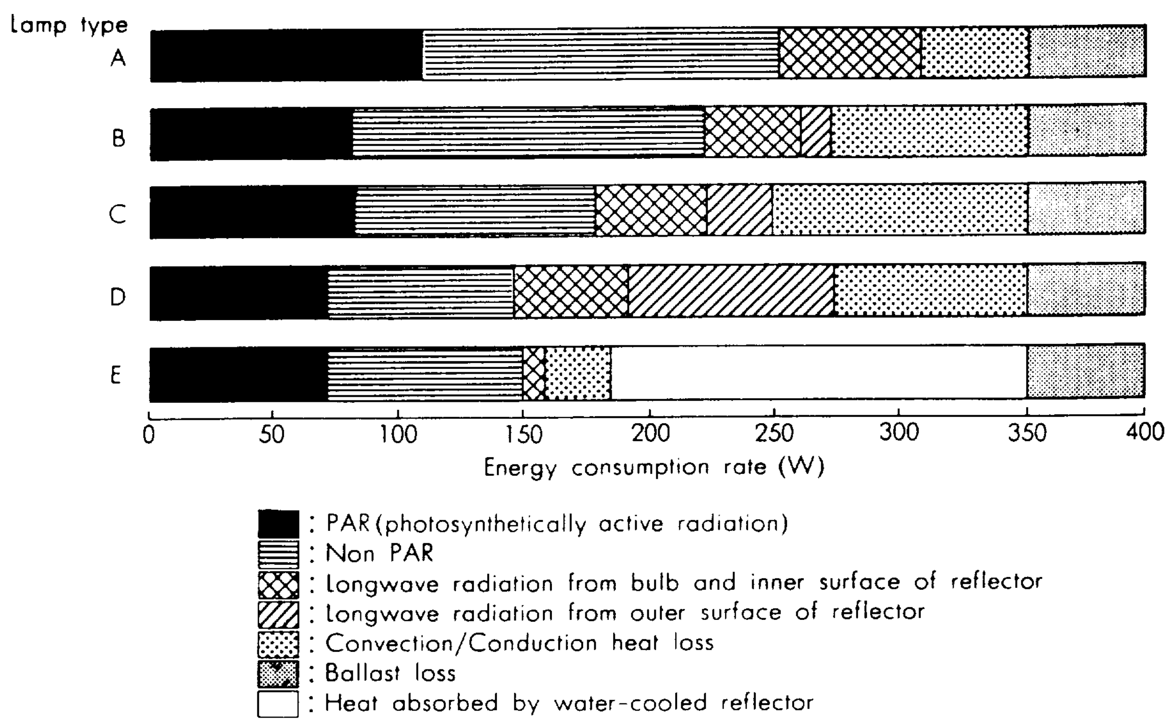

Fig. 2. Energy distribution of a high pressure sodium lamp bulb with or without a reflector Lamp type: A lamp without reflector; B lamp with polished aluminum reflector; C lamp with white-colored aluminum reflector; D lamp with white-colored enameled iron reflector; E lamp with water-cooled white-colored enameled iron reflector.