English "Transport Phenomena", Delft academy press, 2014, ISBN 978-90-6562-3584

"FT" = "Fysische Transportverschijnselen", van den Akker + Mudde, VSSD, ISBN 978-90-6562-105-6

VI. Radiation (FT, section 3.7; BSL, ch. 16, esp. sections 16.2, 16.4)

A. Stefan-Boltzmann law (FT eq. 3.163; BSL Eq. 16.2-10) ← BSLK

$q = \sigma T^4$ T = absolute temperature

1. σ = Stefan-Boltzmann constant = $5{,}67 \cdot 10^{-8}\ W/m^2K^4$

2. Real objects emit some fraction of the value given above. That fraction is e, the emissivity (BSLK 16.2-11; values of e for various materials are in BSL Table 16.2-1)

$q = e\sigma T^4$

"black body": $e = 1$ "white body": $e = 0$

3. Real objects do not absorb all radiation that strikes them. The fraction that is absorbed is the absorptivity, a.

"black body": $a = 1$ "white body": $a = 0$

B. Simple examples. In general, to determine the heat transfer in a given situation, one must account for and a, distance between the objects, and orientation. (For instance, the radiation heat transfer from the sun [per m² surface] is less in the winter because the angle of the sun is farther from 90° in the given hemisphere. But in some simple cases easy estimates are possible.

1. two spherical bodies, far apart (assume black bodies), one much larger and hotter; draw a sphere around the hotter body with r = distance to other body

total heat emitted by hotter body $Q = 4\pi R_{sun}^2 \sigma T^4$ (area)

fraction striking smaller body (use circular cross section for smaller body) $\frac{\pi R_{earth}^2}{4\pi R_{orbit}^2}$

net heat transfer from hotter body to colder body $\frac{\pi R_{sun}^2 R_{earth}^2}{R_{orbit}^2} \sigma T^4$

(see also BSLK ex. 16.4-1_