Contents Find

Simulation: TMG Thermal Analysis User's Guide

Black Body View Factor Calculation

An enclosure is a set of surfaces that divides three dimensional space into two or more compartments between which radiation cannot pass. Imagine a basketball floating in space. The inside surface of the basketball is one enclosure, the outside surface of the basketball is another.

TMG calculates radiation in enclosures. Within an enclosure, TMG computes the view or partial view between each element and all other elements. This reflects the amount of radiative energy a particular element will be able to exchange with the other elements of the enclosure. This view or partial view an element has of other elements is called a *black body view factor*.

Black body view factors are used to calculate IR (*infrared spectrum)* radiative exchanges between elements. If a solar spectrum source has been defined in the model, black body view factors are also needed to calculate diffuse solar spectrum reflection and adjust the solar heat loads accordingly.

Radiation Request is the tool, in TMG, that calculates the black body view factors and identifies the parameters with which the IR (*infrared spectrum*) radiative exchange between the selected elements is calculated.

If a solar spectrum source exists in the model, whether it is a *Diurnal Solar Heating, Orbit/ Attitude Modeling or Radiative Heating* entity, a *Radiation Request* should exist for the elements included in these entities to provide the black body view factors necessary to calculate diffuse reflection. (See *Solar Spectrum View Factor Calculation).*

Black Body View Factor Definition

The black body view factors (also called radiation form factors) are functions of surface geometry only; surface properties do not enter into their calculation.

Black body view factors represent that fraction of the total diffuse radiative energy emitted from a particular surface which arrives at a second surface assuming no intermediate reflections.

$$A_i\,F_{ij} = A_j\,F_{ji} = \frac{1}{\pi}\int_{A_j}\int_{A_i} \cos\phi_i\,\cos\phi_j\,\frac{dA_i dA_j}{r^2}$$

where F_{ij} is the black body view factor from surface i to surface j.

TMG uses one of two methods for computing radiation view factors based on a blockage criterion. TMG first determines if a surface pair has an unobstructed view; i.e. if every point on one surface can be seen from any point on the other without obstruction (or "shadowing") by intervening surfaces. Where it is established that there is an unobstructed view, TMG computes the view factor using the Exact Contour Integral technique. This method is very fast, and gives accurate results regardless of surface geometry or size ratio.

For surface pairs whose view is partially shadowed by other elements, shadowing checks must be performed and the Nusselt Sphere technique is used. (See *Shadowing Checks).*

Black Body View Factor Accuracy

When modeling radiation with *I-DEAS TMG*, surface elements simulate the surfaces of an enclosure. If the model itself does not form an enclosure or if it radiates to the environment, it should be surrounded by a Space Enclosure.

In an enclosure, the sum of any element's view factors is equal to one. Each view factor represents a fraction of the energy an element is radiating in the enclosure. Since all the energy the element is radiating reaches other elements that are inside the enclosure or reaches the Space Enclosure, the sum of the fractions is one.

Although the view factor sum of each element should be to equal one, it is not always the case, usually because of imprecision in the calculation of partial views. Shadowing checks are used to determine which elements have an obstructed view of other elements and a subdivision method is then used to calculate the partial view.

You can control the precision of this calculation with the options explained in the article on *Shadowing Checks.*
