Sage Model Notes

RadSphereEncl.scfn

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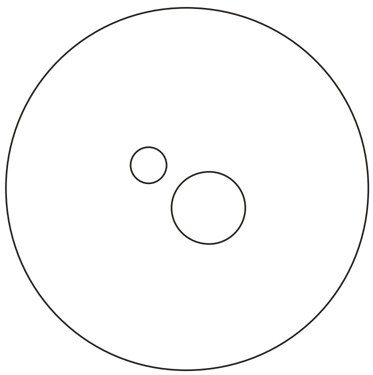
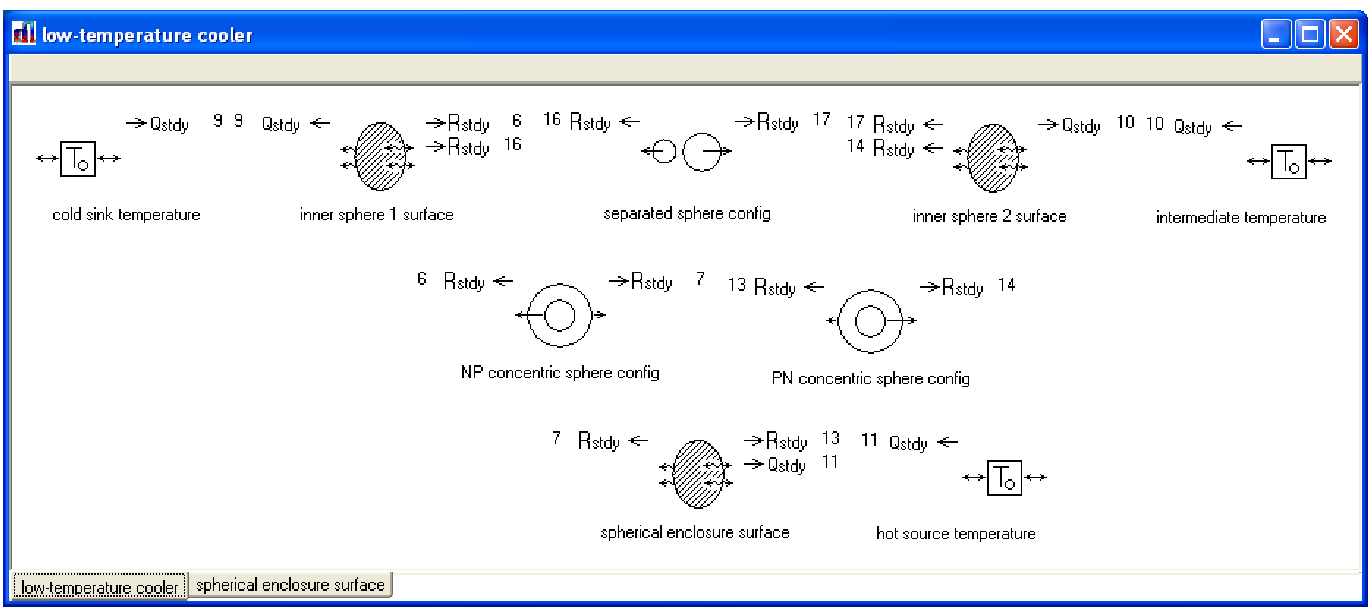
Two small spherical surfaces near the center of an outer spherical enclosure. The outer surfaces of the small spheres exchanging radiation with each other and the inner surface of the enclosure:



All three spherical surfaces are anchored to external fixed temperatures. Of interest is the net radiation exchange to each surface.

This is the Sage model:



It is only an approximate model. The concentric-sphere view configuration connecting each inner sphere to the surrounding enclosure does not consider the partial blocking of the view by the other inner sphere. The *hot source temperature* anchors the *spherical enclosure surface* at 300 K. The *cold sink temperature* and *intermediate temperature* anchor the two inner spheres at 4 K and 20 K. All surface area and emissivity inputs are set independently. There are no input recasts in this model.

Net Radiation transfers

The net radiation transfer to each spherical surface is given by its output Rad.

Inner sphere surface 1 (4 K)
Rad net incoming radiation flow (W) 2.176E-01

Inner sphere surface 2 (20 K)
Rad net incoming radiation flow (W) 2.176E+00

Spherical enclosure surface (300 K)
Rad net incoming radiation flow (W) -2.394E+00

The radiation exchange for each view configuration is given by the output RadNeg or RadPos.

Separated sphere config (between two inner spheres)
RadNeg radiation flow neg view (W) -4.819E-08

NP concentric sphere config (inner sphere 1 to enclosure)
RadNeg radiation flow neg view (W) -2.176E-01

PN concentric sphere config (inner sphere 2 to enclosure)
RadNeg radiation flow neg view (W) 2.176E+00

Very little radiation passes between the two inner spheres compared to the radiation to the surrounding enclosure.

View Factor Consistency Check

According to standard radiation enclosure theory all the radiation leaving any surface of the enclosure must reach another surface or itself. Sage uses this fact to calculate the implied self-view factor for each radiation surface as output Fself.

In the present model the two inner spheres should have self-view factors of zero because they are convex surfaces and no part of the surface can *see* any other part. But due to the approximate use of configuration factors noted above the self-view factors implied by the model are nonzero:

Inner sphere surface 1 (4 K)
Fself implied self view factor -1.071E-02

Inner sphere surface 2 (20 K)
Fself implied self view factor -1.071E-03

Both are negative implying that more than 100% of the radiation leaving the surface reaches the other surfaces of the model. That is because the concentric-sphere view factor to the surrounding enclosure does not consider the part of the view blocked by the other inner sphere.

But both are small too. That means that the relative error caused by using approximate view factors is also small. The largest error is for *inner sphere surface 1* where the incoming radiation from the surrounding enclosure surface is about 1% high.

It would be possible to improve the model accuracy by adjusting the view factors between the inner surfaces and the *spherical enclosure surface* using the FAmult inputs of the concentric sphere view configurations. For example one might set FAmult = 0.99 in *NP concentric sphere config* to eliminate about 1% of the radiation leaving the *spherical enclosure surface* and reaching *inner sphere surface 1.*