CAESIM

STORM Flow Solver Benchmark

(Steady State Results & Solver Performance)

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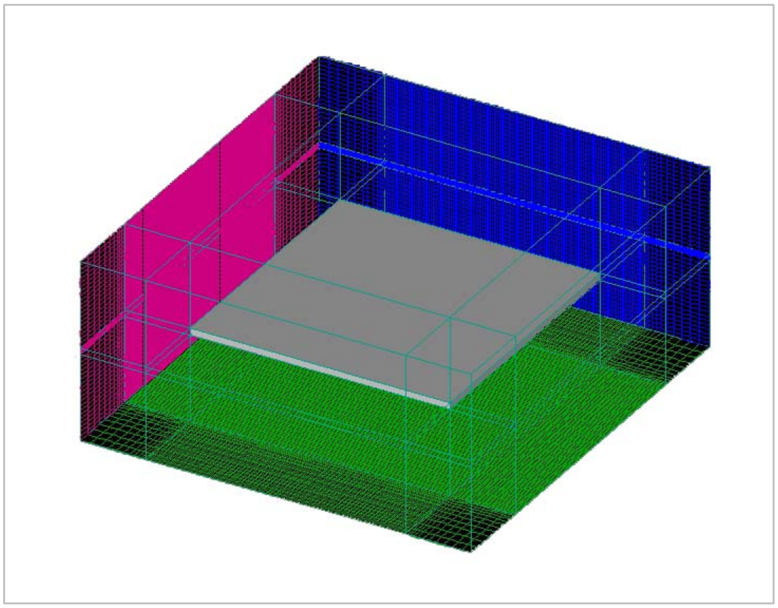
1.0 Introduction

In order to significantly improve the CFD solver computational performance, a bi-conjugate linear equation solver has been implemented for the CFD benchmark application. This linear equation solver allows the CFD models to converge to a steady state solution much faster. AR intends to improve on this method by implementing a multi-grid version of the bi-conjugate linear equation solver. In addition, AR will compare this implementation with other current methods such as SIP and MSI.

This benchmark report introduces a CFD model that allows for a comparison/verification of the filter CFD model solution results. This new CFD model is essentially the same as the filter CFD model, except the copper volume is represented as a single "slab" consisting of the same total volume.



This report provides four CFD solutions for both the new "slab" model and filter model for comparison:

1) 0.025 W heat load – conduction only
2) 0.025 W heat load – conduction + convection
3) 0.25 W heat load – conduction only
4) 0.25 W heat load – conduction + convection

Conduction Only Models

The conduction only models were setup with 6 "cold" walls located on the outer boundaries of the computational domain (set to 20 degrees C). Only the energy equation is solved for these cases.

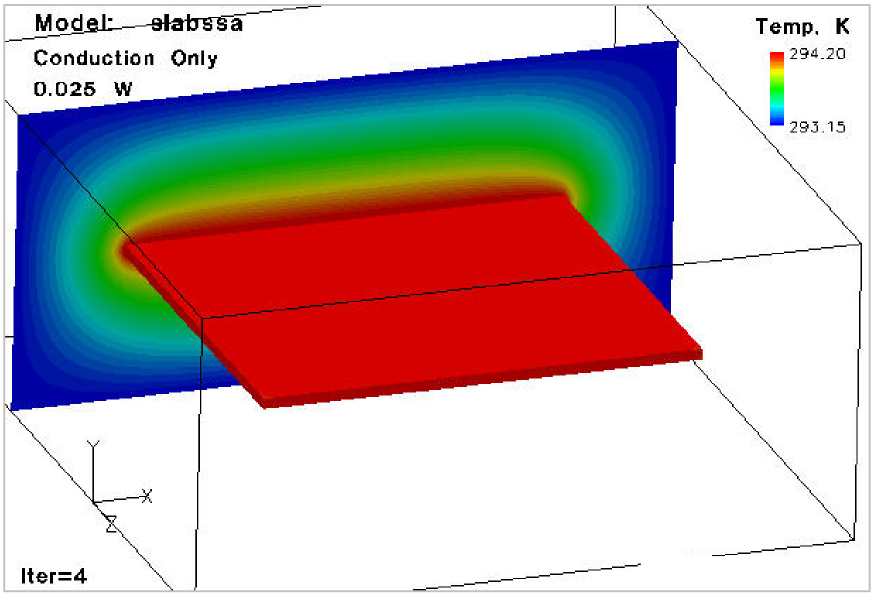
Conduction + Convection Models

The convection models were setup similarly to the conduction models, with 5 "cold" walls and one pressure boundary located on the top (or north) of the computational domain. Pressure, velocity, and temperature were solved for these cases.

2.0 Simplified CFD Slab Model - Conduction

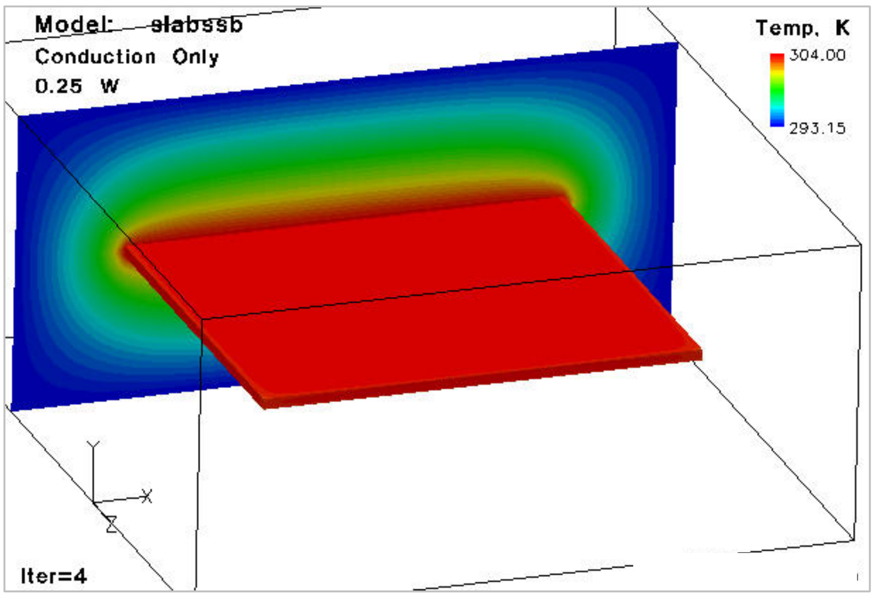
A. 0.025 W Case

The following figure shows the simulation result for the simplified “slab” CFD model with a heat load of 0.025 W. This conduction only steady state case was executed in 4 iterations.



B. 0.25 W Case

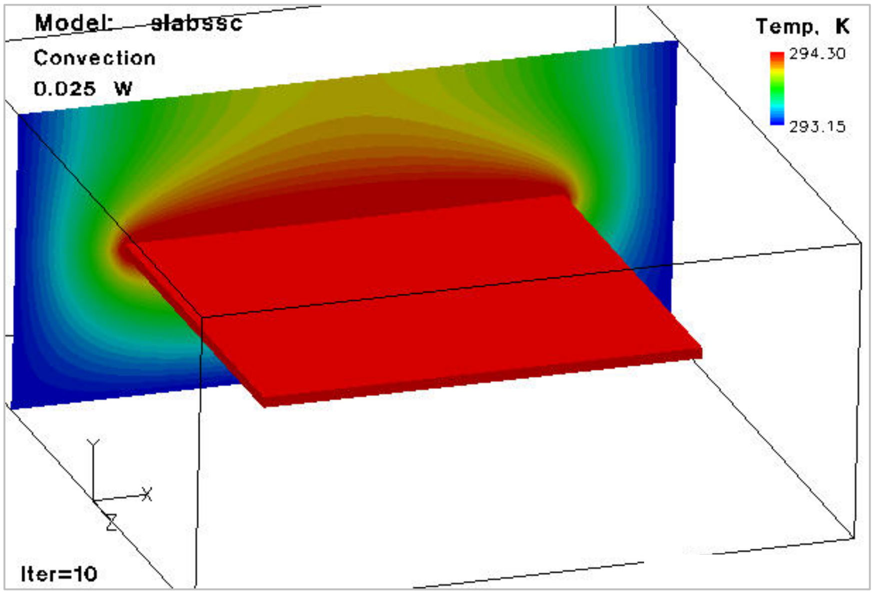
The following figure shows simulation the result for the simplified “slab” CFD model with a heat load of 0.25 W. This conduction only steady state case was executed in 4 iterations.



3.0 Simplified CFD Slab Model – Conduction with Convection

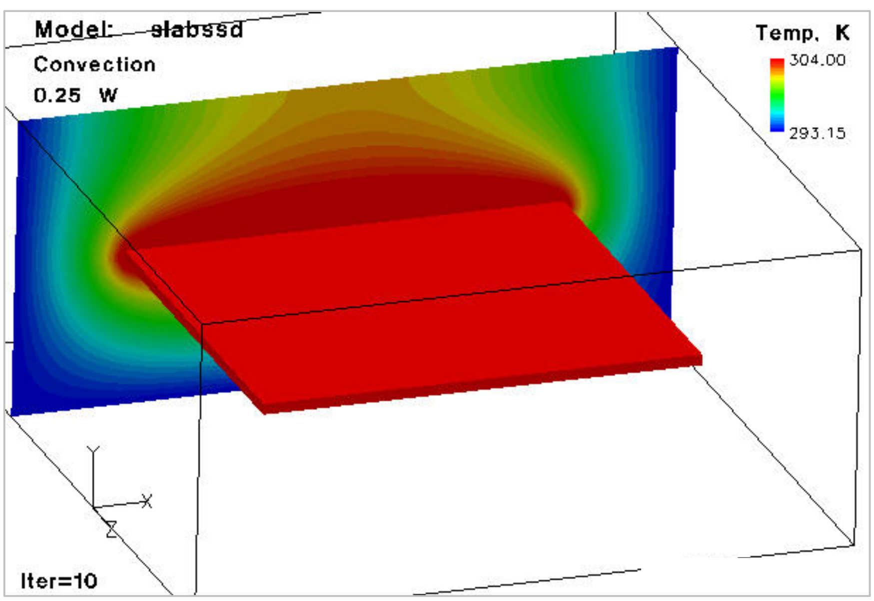
A. 0.025 W Case

The following figure shows the simulation result for the simplified "slab" CFD model with a heat load of 0.025 W. This convection steady state case was executed in 10 iterations.



B. 0.25 W Case

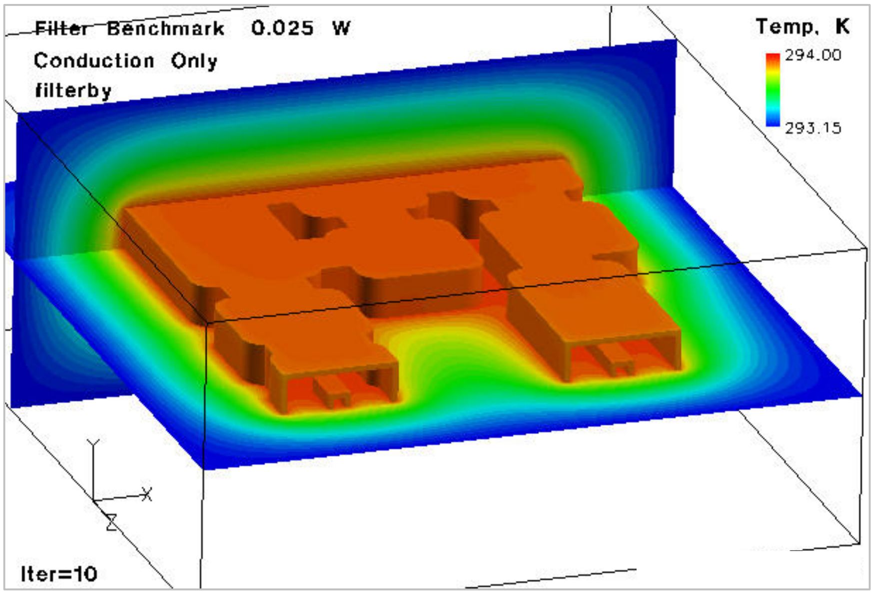
The following figure shows simulation the result for the simplified "slab" CFD model with a heat load of 0.25 W. This convection steady state case was executed in 10 iterations.



4.0 Filter CFD Model - Conduction

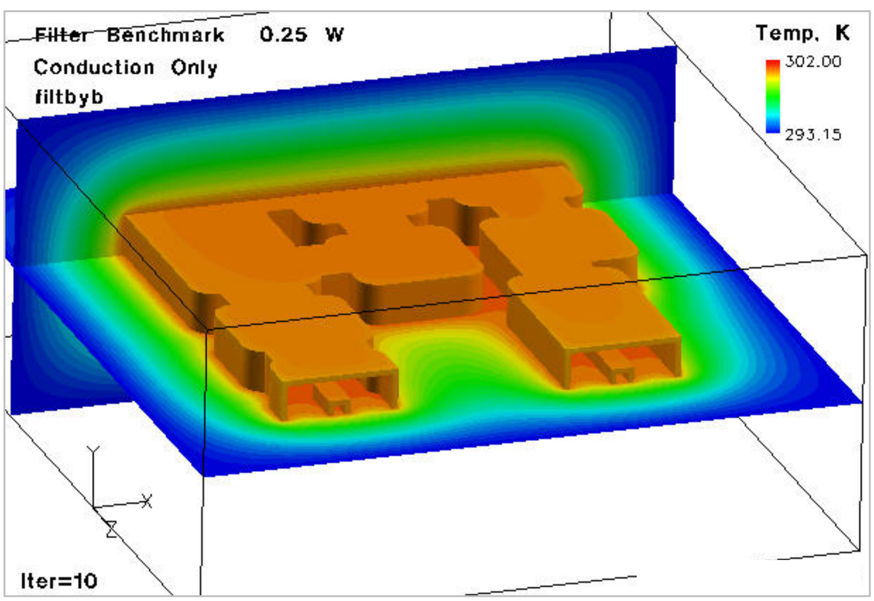
A. 0.025 W Case

The following figure shows the simulation result for the filter CFD model (BFC) with a heat load of 0.025 W. This conduction only steady state case was executed in 10 iterations.



B. 0.25 W Case

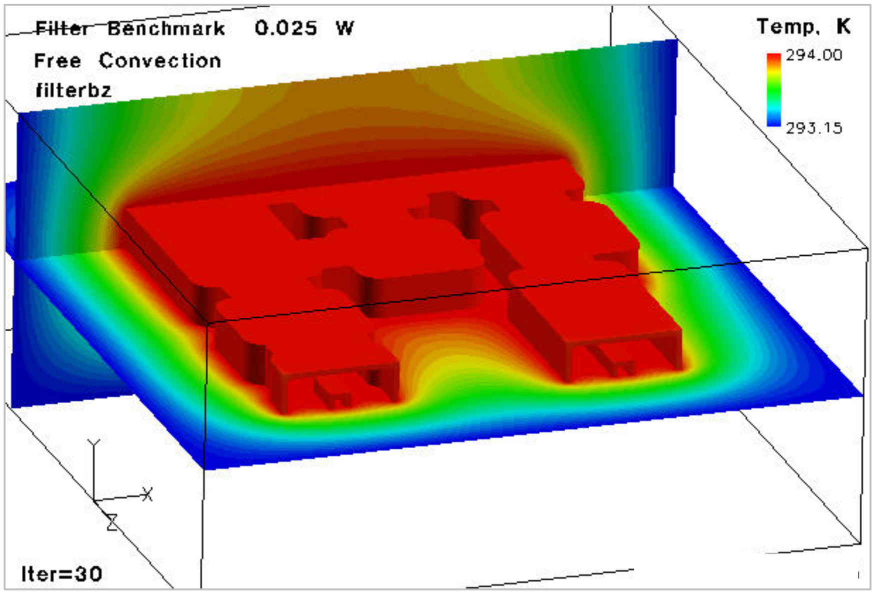
The following figure shows simulation the result for the filter CFD model (BFC) with a heat load of 0.25 W. This conduction only steady state case was executed in 10 iterations.



5.0 Filter CFD Model – Conduction with Convection

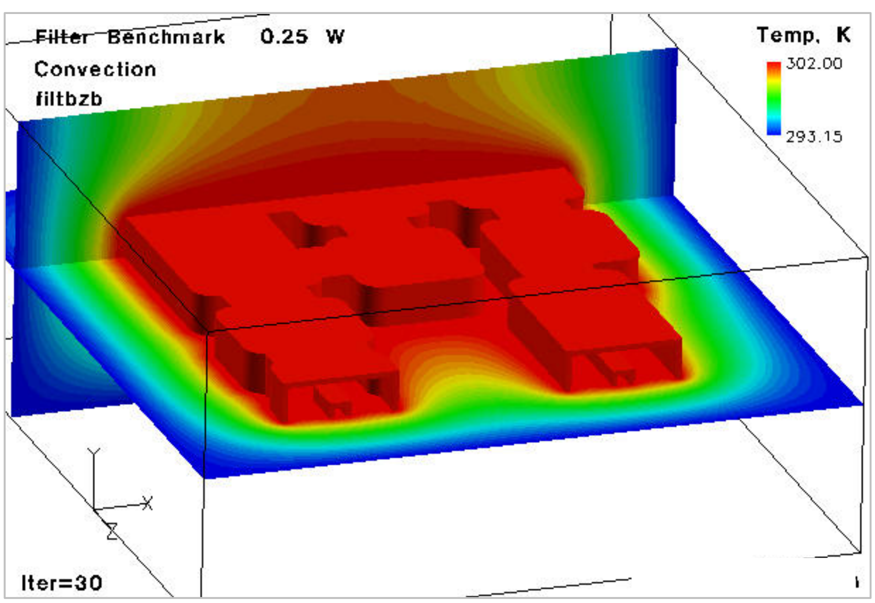
A. 0.025 W Case

The following figure shows the simulation result for the filter CFD model (BFC)with a heat load of 0.025 W. This convection steady state case was executed in 30 iterations.



B. 0.25 W Case

The following figure shows simulation the result for the filter CFD model (BFC) with a heat load of 0.25 W. This convection steady state case was executed in 30 iterations.



6.0 Summary

<u>CFD Model Comparisons – Slab vs Filter Models</u>

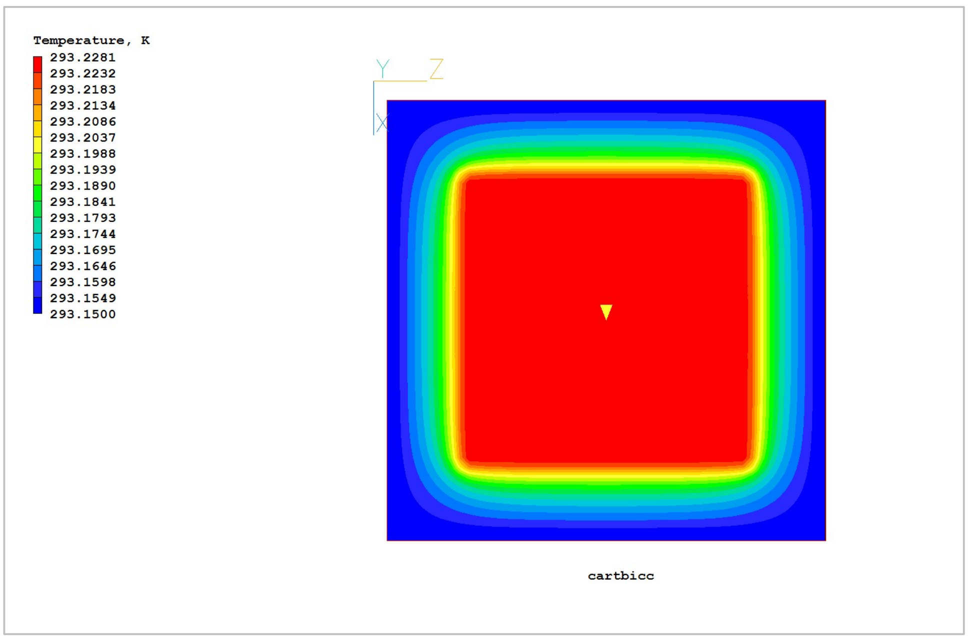
The Slab CFD models are all generally hotter than the Filter models. This is primarily due to the proximity of the Filter model(s) to the cold outer boundaries.

The convection cases are slightly higher in temperature compared to the conduction cases due to the removal of the top cold wall BC.

Note that all cases will increase in temperature if the outer computational domain boundary is relocated further from the heat source.

<u>CFD Results - Verification</u>

The new Slab CFD models provide solver validation/comparison cases. These CFD models were also executed using an independent CFD solver (see solution below for the 0.025 W conduction Slab model case).



<u>Solver Performance</u>

Solver performance is slower for the convection cases as compared to pure conduction (as expected). This will be significantly improved by implementing the additional computational methods outlined in Section 6.0.