Fermilab

Vessel Heat Load Summary Spreadsheet

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Introduction:

This is an excel spreadsheet that calculates the heat load onto a pressure vessel for the MicroBooNE project. It takes into account the heat load from the nozzles, wires, saddle, and vessel itself. At this point in time, it estimates rather than gives a precise number due to the methods employed for simpler calculations such as 1-D conduction and steady-state conditions.

Description:

Using general inputs such as dimensions, material properties, and temperatures, the spreadsheet will take into account radiation, conduction, and sometimes convection. This should result in a usable heat load value for approximation purposes. Some spreadsheets in the workbook utilize circular references for iterative methods, so iteration should be enabled in the Excel options otherwise errors will occur. Steady-state conduction is calculated as one-dimensional. Some values are approximated such as the wall temperature of the nozzles and the inside wall surface of the vessel being equal to the fluid's temperature. Insulated nozzle surfaces are regarded as adiabatic for a conservative approach. Equations for calculating thermophysical properties were pulled from NIST and WPI's websites. The result can be used as a design basis for the cooling system.

Results:

Here are some preliminary values based on current drawings and estimated values for unknowns.

$q_{nozzles}$	210	W
q_{wire}	169	W
q_{saddle}	174	W
q_{vessel}	1965	W
Total heat load:	2518	W

Based on the value of 2518W, this system will be well within range to be cooled by the 5kW cooling system planned for this project. External piping and electronic heat loads still need to be considered.