**Running ‘Raphael\_18Jan2022\_1mmReg\_DCH\_off\_FinEnhancedSurface’: (with or without const temp body) (also with upper small HX removed)**

*Index exceeds the number of array elements (1).*

*Error in Matrix/discretize (line 1032)*

*if length(pnd)>1 || pnd(1).xmin ~= pnd(2).xmin*

* b/c small section of HX was only 1 node
* Matrix must have more than one node (be discretized)

**Running ‘Raphael\_18Jan2022\_1mmReg\_DCH\_off\_FinEnhancedSurface\_ConstT’ without HX matrix in small bodies: (only gets to line 1078 if both small HX are removed)**

Index in position 1 exceeds array bounds (must not exceed 1).

Error in Matrix/discretize (line 1078)

this.Nodes(ncount).ymin = ys(i,:);

**Find source of error in line 1078 (Matrix.m):**

* Error occurs during discretization of the model. Chain of errors we see is the model discretization triggering all groups, bodies, and their subfeatures to discretize.
* Error occurs while discretizing the body iBody = ‘Cooler main part’. Body has 16 nodes.
* While discretizing this body’s matrix
* In Matrix.discretize:
  + ‘pnd’ is ‘this.Nodes’ (1x16 Node) from Body (“parent nodes”)
  + ‘Np’ is number of nodes
  + ‘N’ = ‘HeatExchangerFinDivisions’ from mesher settings
  + From line 1025:
  + Nodes are initialized, count: Np\*N nodes (here: 48)
  + Faces are initialized, count: (Np + 1)\*N\*Np (here: 816)
    - (Np + 1) faces per node
  + Line 1032 (causing error with small HX): Code assumes that HX body is discretized, i.e. has several nodes. Error because small HX in current model has only 1 node.
    - Assumes body is discretized in X if it has more than 1 node!  
      Text

      Description automatically generated  
      🡪 Should be AND (&&) instead of OR (||)

**What is shown in GUI as ‘Node Outlines’ and ‘Node Connections’?  
Status of HX discretization as-is**

* When clicking radio buttons for ‘Node Outlines’, Model.show() is run
* Radio buttons control Booleans Model.showNodes and Model.showInterConnections
* In Model.show(), showNodes plots blue circle for each Node at Node center points, locations from Node.minCenterCoords
* Last Node in Model.Nodes is the environment node. Coordinates (0,0,0,0)
* showInterConnections plots green line for each Face that connects two Nodes. Line between Node center points.
* Added code to plot node outlines in different colors by Node type.
* **‘Fin Connected Channels’ (top)** with (HX Fin Divisions = 5)
  + 5 solid nodes along fin (red), and 1 static volume gas node per ‘row’ (blue). Gas nodes created from discretizing the Gas Body, Solid nodes from discretizing the Matrix.
  + There is 1 solid node in the HX body in the center left, right next to the inner wall. 🡪 Source channel?
  + Outer and inner wall connected to gas nodes only
  + ‘Source Channel’ solid node connected to all gas nodes and the left (inner) solid nodes of HX. It is NOT connected to inner wall.
* **‘Fin Enhanced Surface’ (bottom)** with 3 fin divisions.
  + 3 solid nodes (red) between each pair of gas nodes (blue) because of fin division number
  + Those 3 solid nodes are NOT connected to each other!
  + Bottom and Middle of the 3 solid nodes are connected to outside wall (Temp source)
  + Gas nodes connected to each other

|  |  |
| --- | --- |
| Chart, diagram  Description automatically generated | Fin Connected Channels |
|  | Fin Connected Channels |
| Chart, diagram  Description automatically generated | Chart, line chart  Description automatically generated  Fin Enhanced Surface |

* + Note: Only 1 solid node in inner wall of HX? Should be more.

**Steven’s thesis about matrixes:**

These elements are closely in contact with the gas network and each has a porosity and geometry that merits an **override** of the default defined hydraulic diameter (), volume (), area (), Darcy friction factor () correlation, Nusselt number () correlation, and Axial Mixing enhancement coefficient (). When the matrix takes its parents nodes, it both modifies the provided nodes for the listed properties and adds solid sources, surface nodes and faces which model the solid components of the heat exchanger or regenerator as a nodal network.

|  |
| --- |
| Diagram  Description automatically generated |
| Figure 2.7: How elements are discretized in the fin enhanced surface type heat exchanger |

|  |
| --- |
| Diagram  Description automatically generated |
| Figure 2.8: How elements are discretized in the fin connected channels and finned tube type heat exchanger |

**Fin Connected Channels – Discretization Code**

* N = HeatExchangerFinDivisions (model setting)
* Np = length(pnd)
  + ‘pnd’ is ‘this.Nodes’ (1x16 Node) from Body (“parent nodes”)
* Initializing (Np+1)\*N + 1 Nodes
  + 🡪 N matrix nodes per parent body node
* (Np + 1)\*N\*Np Faces (same as Fin Enh Surf)
* Geometry:
  + lcth = Source channel width
  + lwth = Source channel skin thickness
  + lg = gas channel width
  + lth = fin thickness
  + lb = fin base width / spacing
* Calculating ratios (check later!)
  + SourceV\_V = source channel volume / total volume
  + SourceA\_V = source channel surface area / total volume
  + FinV\_V = fin volume / total volume
  + FinA\_FinV
  + SkinA\_V = Exposed surface of source skin / total volume
  + SkinA\_V = Proportion of channel wall / total volume
* Define Source Node:
  + For vertical HX: SourceNd reaches from lower x bound of parent body to some offset x, and across entire body in Y.
  + SourceNd has const. Temp SourceTemperature
* Following nodes defined for each parent Node:
  + Skin node next to source node
  + Solid-solid face between source and skin node
  + Mixed face between skin and parent (gas) node. Has Nusselt and f correlations of matrix
  + N fin nodes: each has volume ‘Vi’
  + Solid-solid face between 1st fin node and skin node
  + Solid-solid Faces between fin nodes
  + Mixed faces between fin nodes and parent (gas) node. Has Nusselt and f correlations of matrix
  + Solid-solid faces between fin nodes of current gas node and previous gas node (downstream conduction)
  + Perhaps missing: Solid-solid faces between skin nodes of current and previous gas node
* The way this HX type is discretized, the fins are only connected to source channel on one side. Equivalent to fin enhanced surface connected directly to source.
  + 🡪 should model several source channels. Will likely not produce reliable results as-is.
* Skin Nodes are created when discretizing, but don’t show up afterwards:
  + A picture containing text, sky, screenshot

    Description automatically generated (manually plotted skin nodes during discretization)
  + When increasing Skin Thickness, the skin nodes appear! It seems that the skin nodes before were deleted and combined with the fin nodes by some algorithm because they were very thin.
* Assigning properties like: this.Nodes(ncount) = Node(); SkinNd = : this.Nodes(ncount); SkinNd.property = X;
  + 🡪 Does this actually save the modified properties in this.Nodes? I think it would only modify the temporary object ‘SkinNd’ but not the vector ‘this.Nodes’ that is stored later.
  + **YES**, it does modify the parent object ‘this.Nodes’.

**Fixing of Fin Enhanced Surface HX**

**Feb 07**: Reviewed and fixed most of Matrix discretization code. Discretized successfully.

Chart

Description automatically generated Chart, line chart

Description automatically generated

* (close up of outer radius of HX, const temperature body as source on right)
* Faces seem correct **in X direction only**: Source to 1st fin node and gas nodes (on correct side), fins to gas, fin nodes to each other
* **Faces in Y direction irregular.** Solid nodes not connected in Y. Far top solid nodes connected to far bottom ones, as suspected by faulty code using ‘NY’ for internal faces **🡪 FIX**
* Gas nodes very thin?
* Fin nodes oddly stacked
* Solving time: ~10 hours for one setpoint!

**Feb 08**: Fixed the creation of solid faces. Removed ‘Modify node volume’ section of discretization code as I don’t know its purpose. The mesh looks to me like it should be with this section disabled.

Chart

Description automatically generated Chart, diagram

Description automatically generated Chart, line chart, scatter chart

Description automatically generated

* **Left**: Solid faces, **Middle**: Mix (solid-gas) faces, **Right**: Gas faces

**Comparison of the discretized HX types**

Fin Enhanced Surface

Graphical user interface, text

Description automatically generated old geometry

Text

Description automatically generated new geometry

Solving time ~ 16min / setpoint

Fin Connected Channels:

(collapsed node pairs are the HX skin nodes that were observed to disappear because of their small thickness)

Text, letter

Description automatically generated