Heat Transfer in Crossflow Heat Exchangers for Application with Microreactors

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CEO

Pryor Knowledge Systems

COMSOL CONFERENCE

2014 BOSTON

Introduction

What is a Microreactor?

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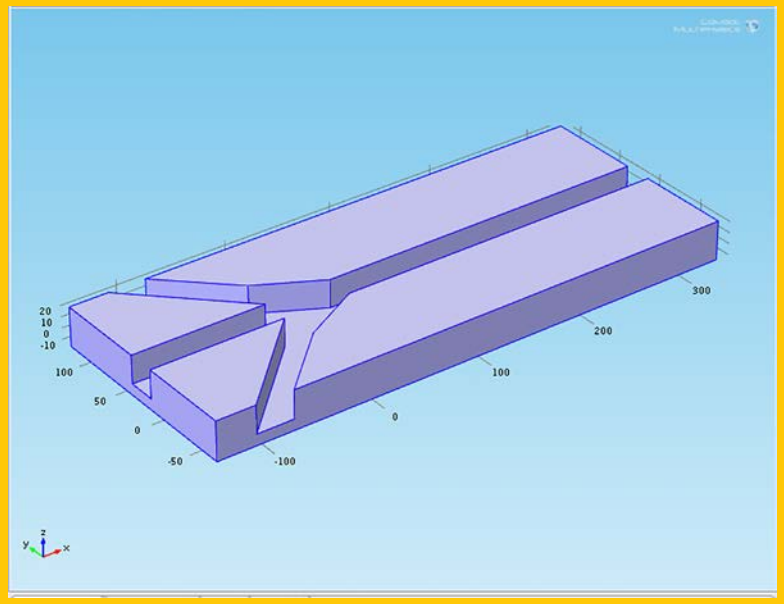

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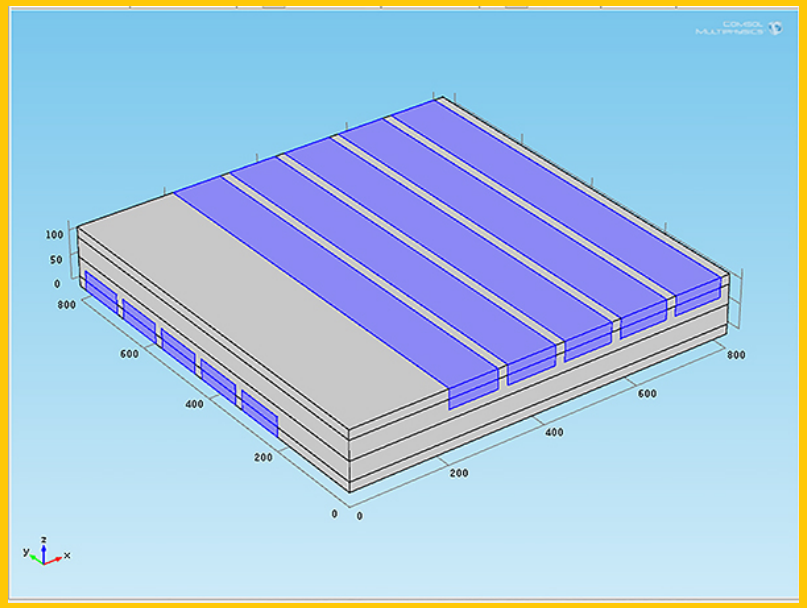

How is a Crossflow Heat Exchanger used with a Microreactor?

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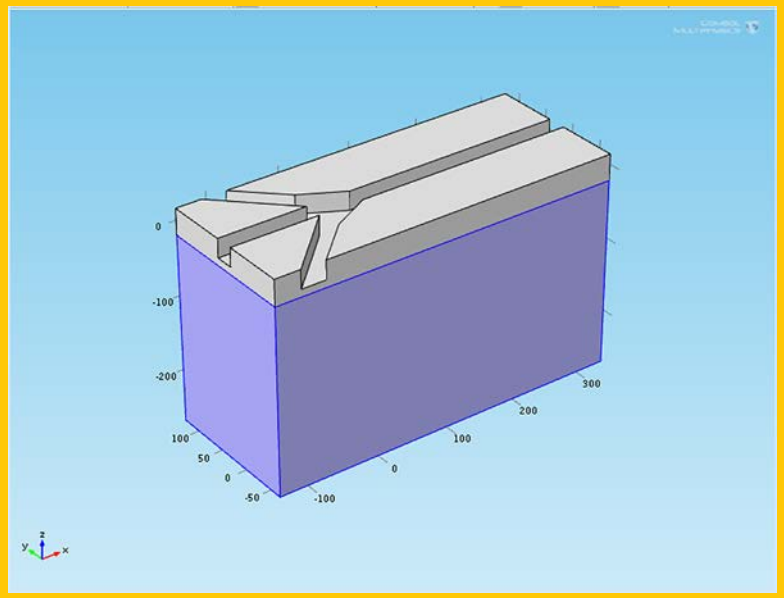

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using difficult, complex and

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Complex exothermic reactions can now be:
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by applying First Principle Techniques.

Heat Exchanger Theory

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$$Amedeo\ Avogadro\,(1811)\ \ \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Physical Relationships Combined, Yield:

$$Emile\ Clapeyon\ (1834)\quad PV = nRT$$

$$P = pressure, V = volume, n = number\ of\ moles$$

$$R = Ideal\ gas$$

$$T = temperature$$

Physical Relationships Combined and Adjusted Yield:

Johannes Diderik van der Waals $(1873, 1910\ NP)$

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

$a = attraction\ factor, b = volume\ excluded\ factor$

Physical Relationships, Solids & Liquids:

Joseph Fourier (1822)

$$\vec{q} = k\Delta T$$

$\vec{q} = local\ heat\ \ flux$

$k = thermal\ conductivity$

$\Delta T = temperature\ gradient$

Heat Exchanger Energy Transfer Theory Summary:

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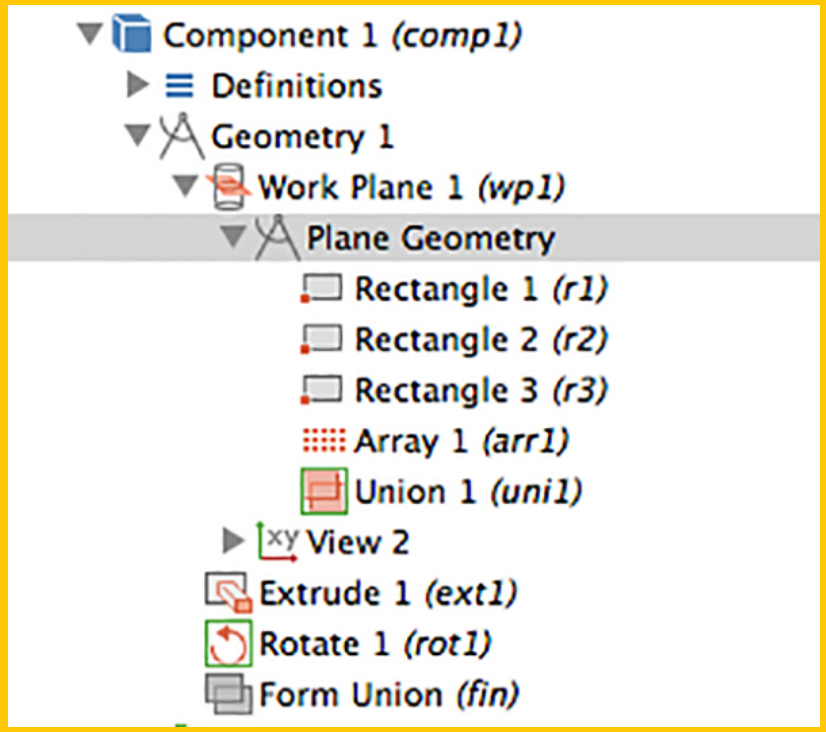
4. Radiation = transfer by emission

Crossflow Heat Exchanger Model

Crossflow Heat Exchanger Geometry



Crossflow Heat Exchanger Geometry

Basic Geometry

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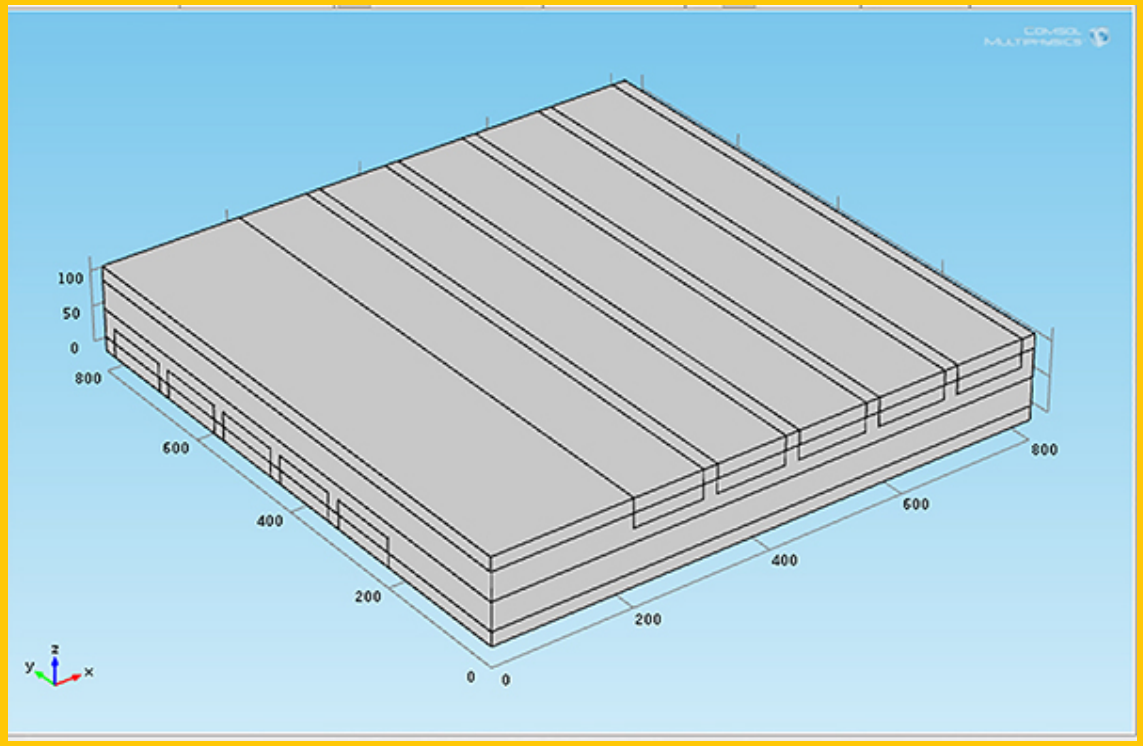

Crossflow Heat Exchanger Geometry

Stainless Steel Highlights

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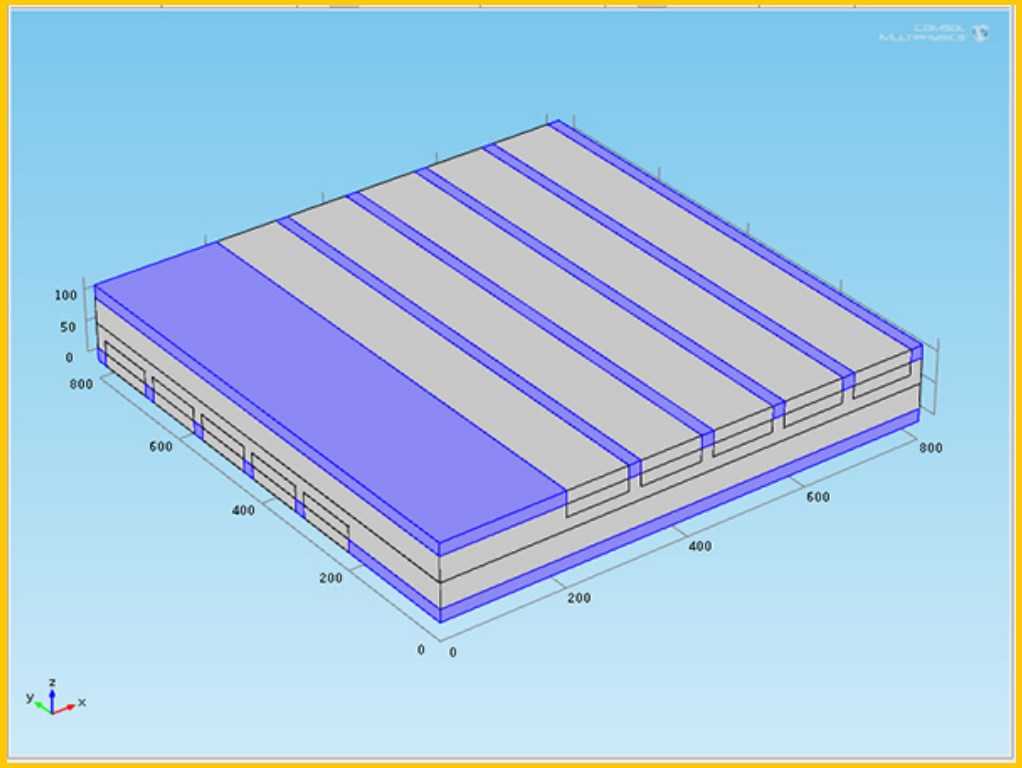

Crossflow Heat Exchanger Geometry

Copper Highlights

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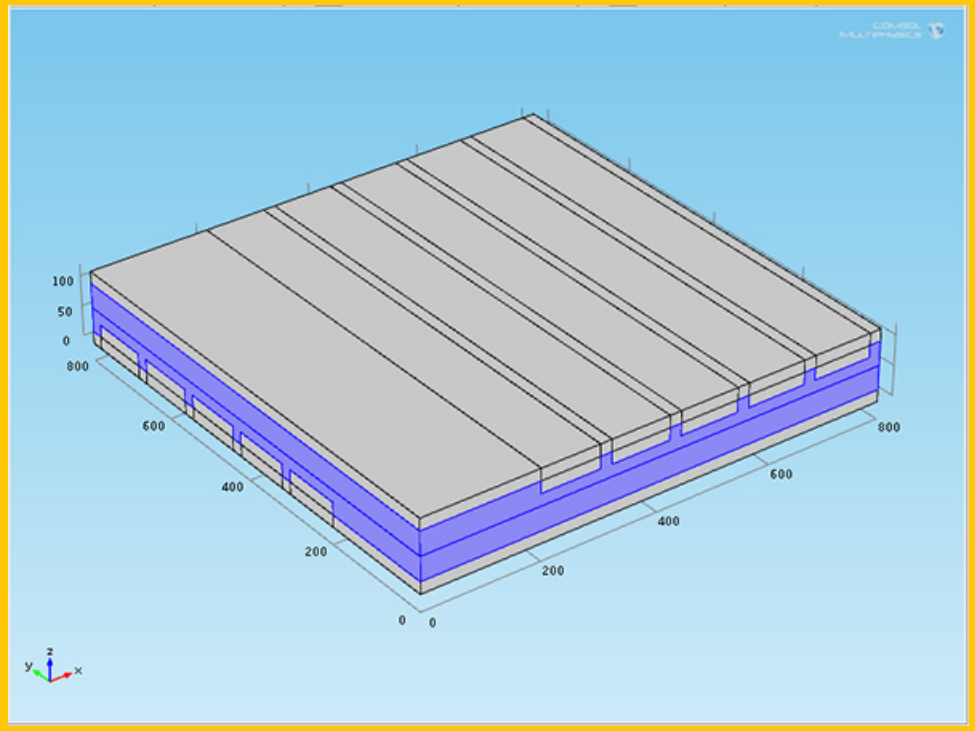

Crossflow Heat Exchanger Geometry

Channels

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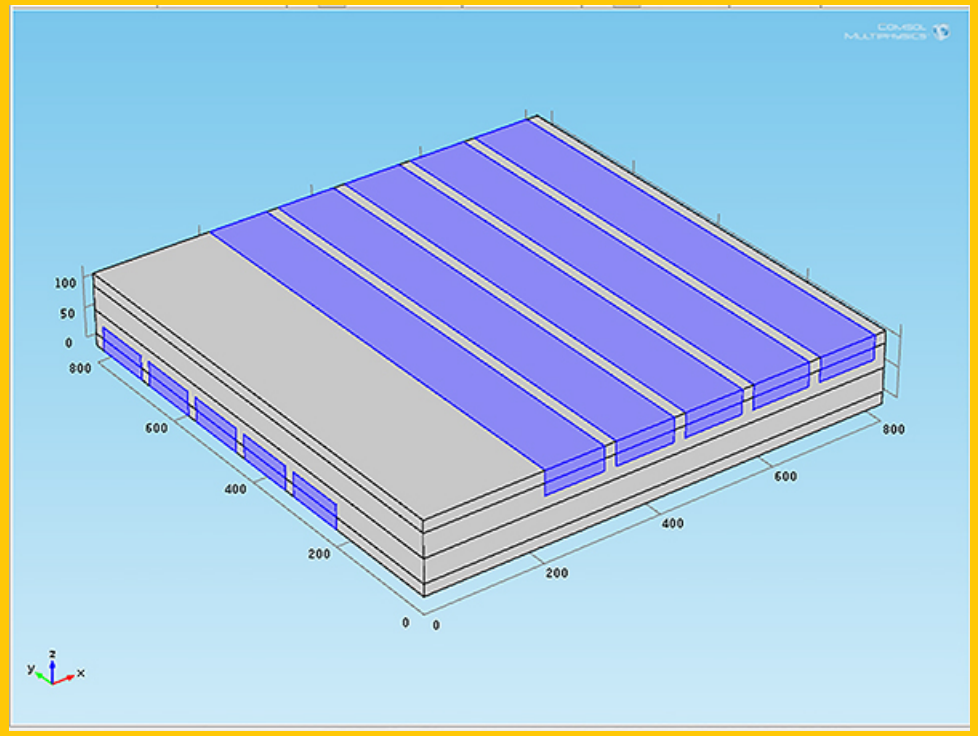

Crossflow Heat Exchanger Geometry

All Stainless Steel

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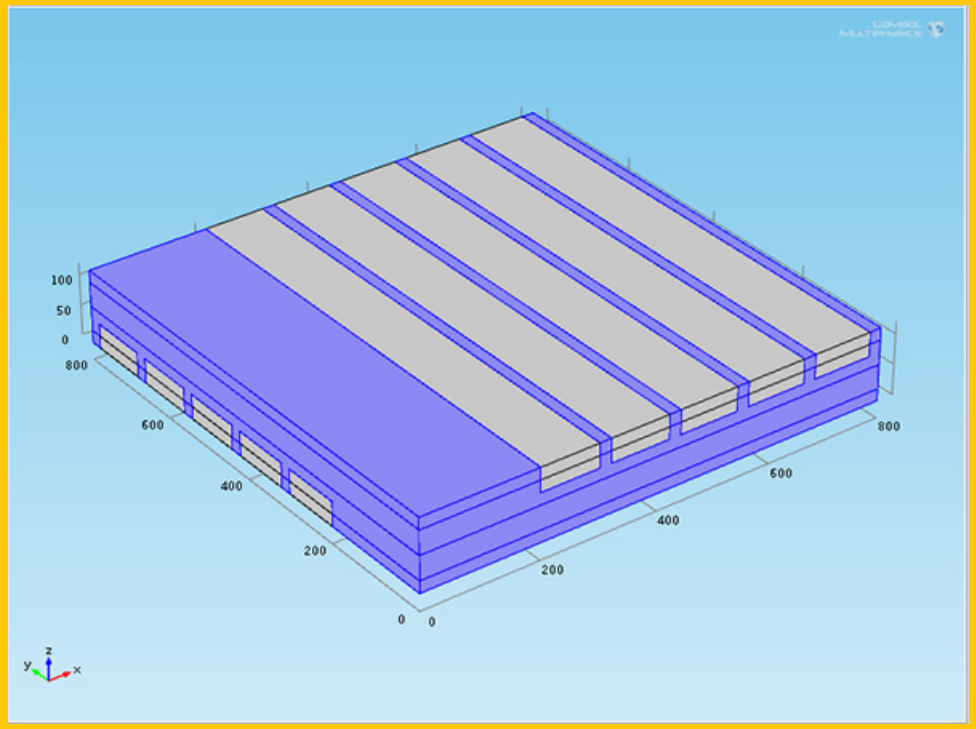

Crossflow Heat Exchanger Model Builder Details

Crossflow Heat Exchanger Model Input Parameters:

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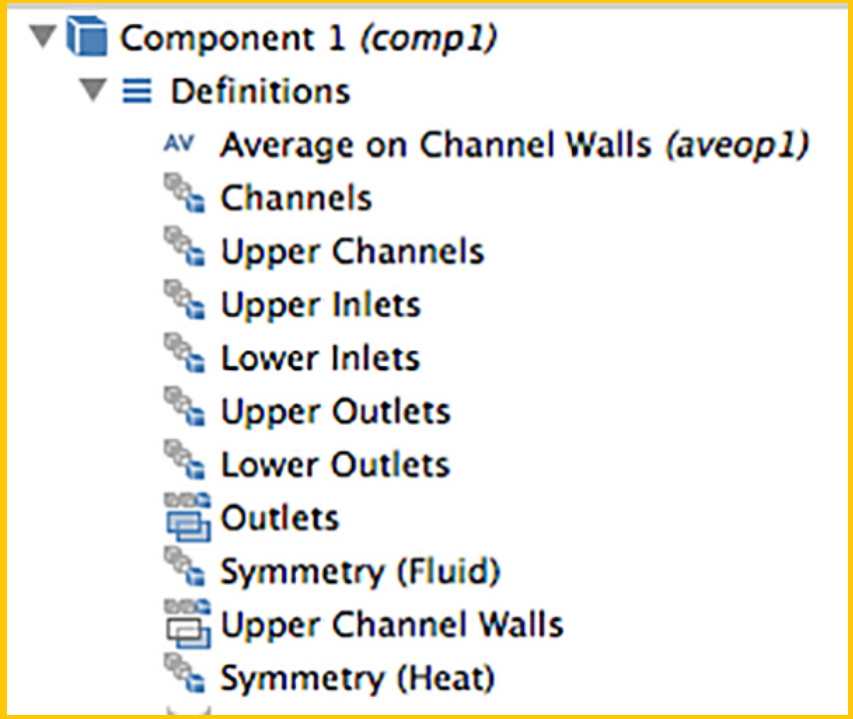
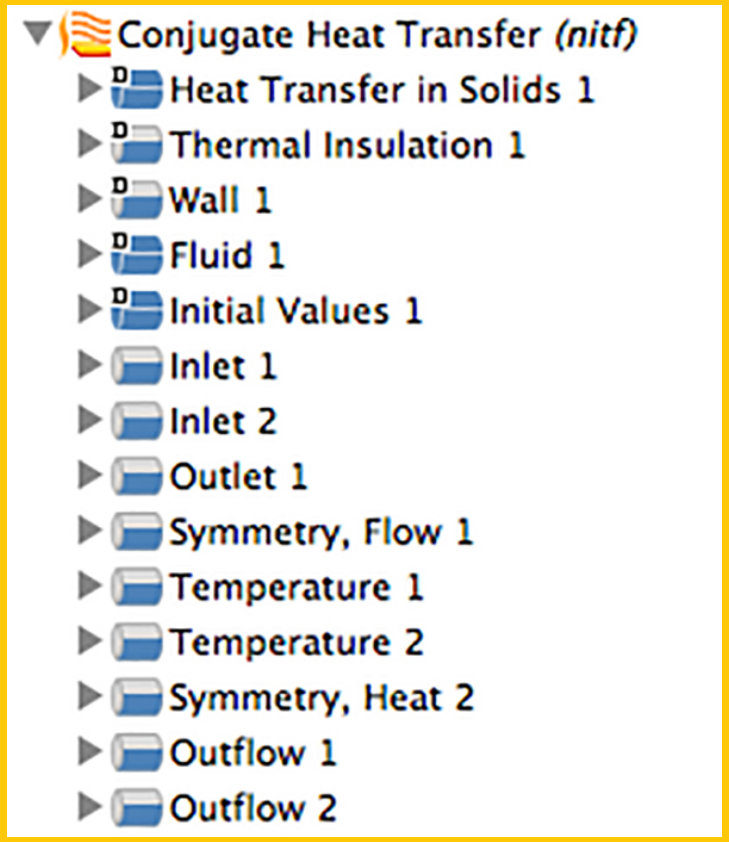
Parameters

Name	Expression	Value	Description
T_cold	300.0[K]	300.00 K	Temperature cold stream
T_hot	330.0[K]	330.00 K	Temperature hot stream
u_avg	2.5[mm/s]	0.0025000 m/s	Average inlet velocity

Crossflow Heat Exchanger
Model Explicit Designations:

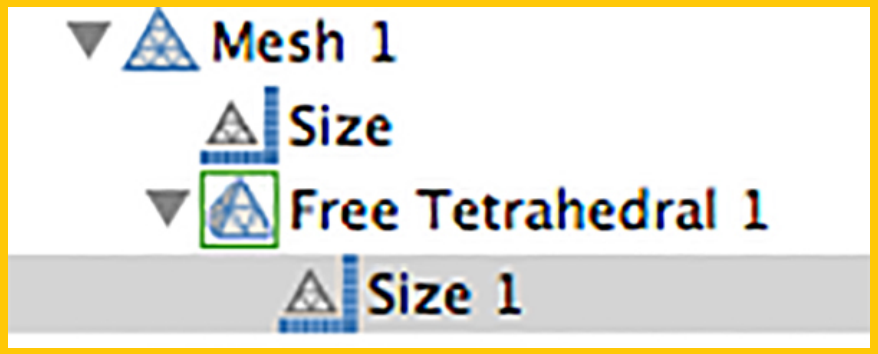


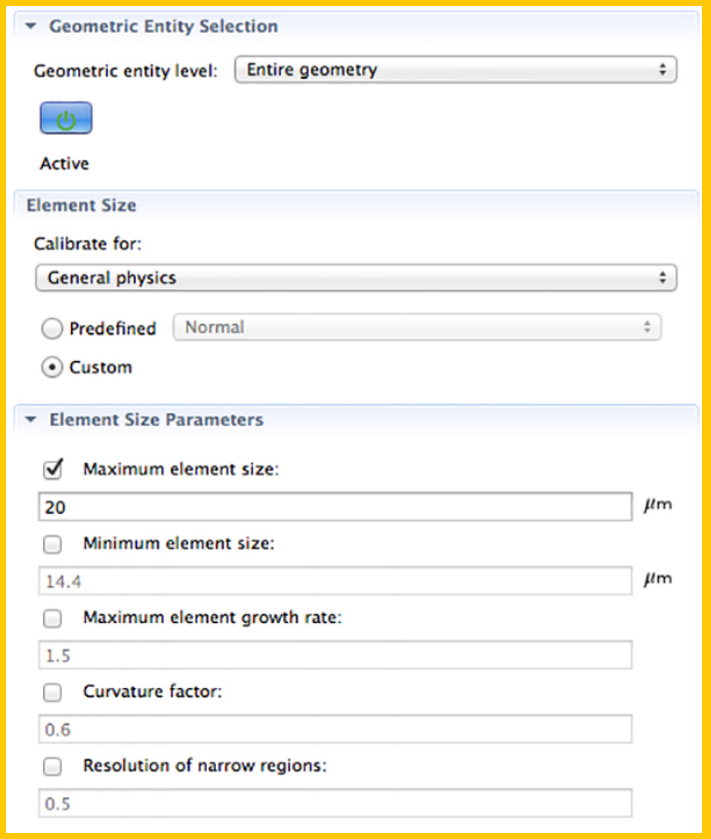
Crossflow Heat Exchanger
Conjugate Model Conditions:



Model: Heat Transfer in Crossflow Heat Exchangers

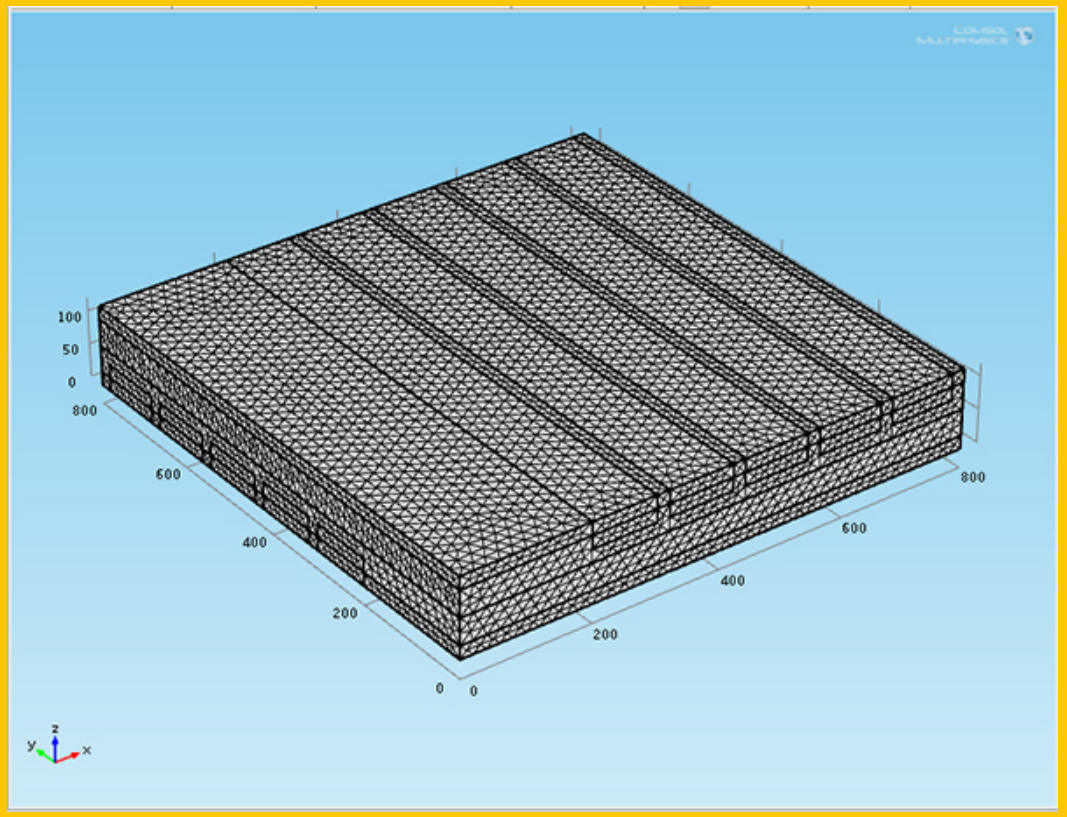
Crossflow Heat Exchanger Mesh Selection:





Model: Heat Transfer in Crossflow Heat Exchangers

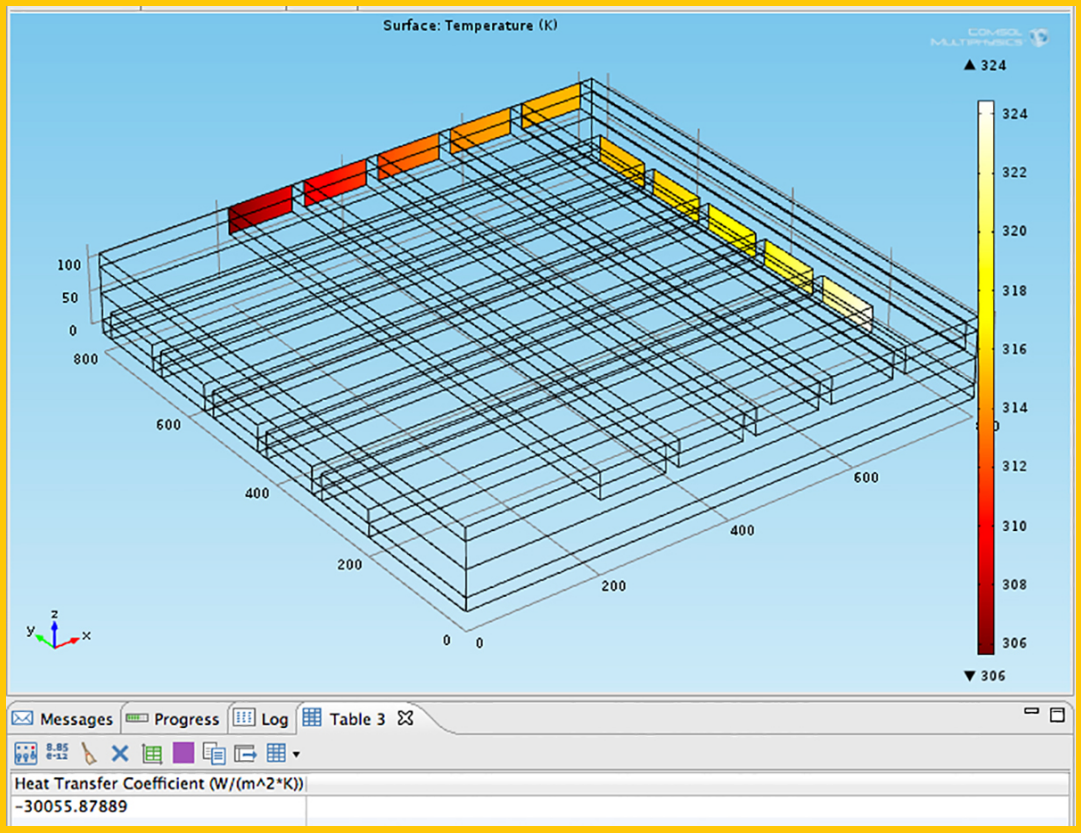
Crossflow Heat Exchanger
Meshed Geometry:



Crossflow Heat Exchanger Model Computation Results

Results: Heat Transfer in Crossflow Heat Exchanger Model

Crossflow Heat Exchanger Final Results:



Thank You!