PCM cavity

Report date

Dec 9, 2020 9:43:01 AM

Contents

1 Global Definitions

Date	Oct 16, 2020 2:42:13 PM

GLOBAL SETTINGS

Name	PCM cavity.mph
Path	K:\Sims-Team-TD\9. Multiphysics Channel\Season 1\S01E01_Pilot_rubi\PCM_cavity.mph
Version	COMSOL Multiphysics 5.5 (Build: 359)

USED PRODUCTS

COMSOL Multiphysics
Heat Transfer Module

1.1 PARAMETERS

1.1.1 Geometry

GEOMETRY

Name	Expression	Value	Description
a	2[mm]	0.002 m	Sidelength of Cavity

1.1.2 PCM

PCM

Name	Expression	Value	Description
rho_l	769[kg/m^3]	769 kg/m³	Liquid Density
rho_s	910[kg/m^3]	910 kg/m³	Solid Density
cp_l	2400[J/(kg*K)]	2400 J/(kg·K)	Liquid Heat Capacity
cp_s	1926[J/(kg*K)]	1926 J/(kg·K)	Solid Heat Capacity
beta	8.161*10^ - 4[1/K]	8.161E−4 1/K	Thermal Expansion Coefficient
T_m	36.4[degC]	309.55 K	Melting Temperature
L	248[kJ/kg]	2.48E5 J/kg	Latent Heat of Fusion
dT	2[K]	2 K	Temperature transition range
k_l	0.146[W/(m*K)]	0.146 W/(m·K)	Liquid Thermal Conductivity
k_s	0.423[W/(m*K)]	0.423 W/(m·K)	Solid Thermal Conductivity

1.1.3 Modeling Parameters

MODELING PARAMETERS

Name	Expression	Value	Description
A_m	10^6[kg/(m^3*s)]	1E6 kg/(m³·s)	Mushy Zone Constant

Name	Expression	Value	Description
epsilon	10^ - 4	1E−4	Avoid Division by Zero
T0	20[degC]	293.15 K	Initial Temperature
T_wall	55[degC]	328.15 K	Wall Temperature

2 Component 1

SETTINGS

Description	Value
Avoid inverted elements by curving interior domain elements	Off

2.1 DEFINITIONS

2.1.1 Variables

Forces

SELECTION

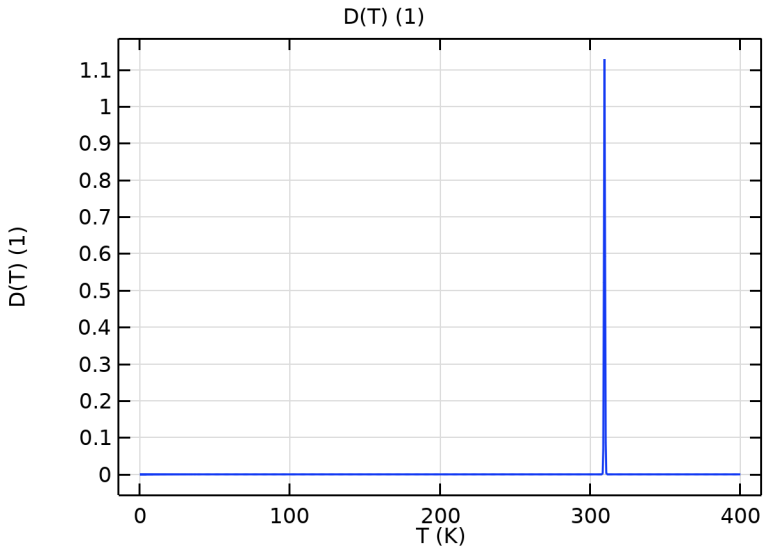
Geometric entity level	Entire model

Name	Expression	Unit	Description
buoy	rho_l*g_const*(1 - beta*(T - T_m))	N/m³	Bouyancy

2.1.2 Functions

Gaussian

Function name	D
Function type	Analytic

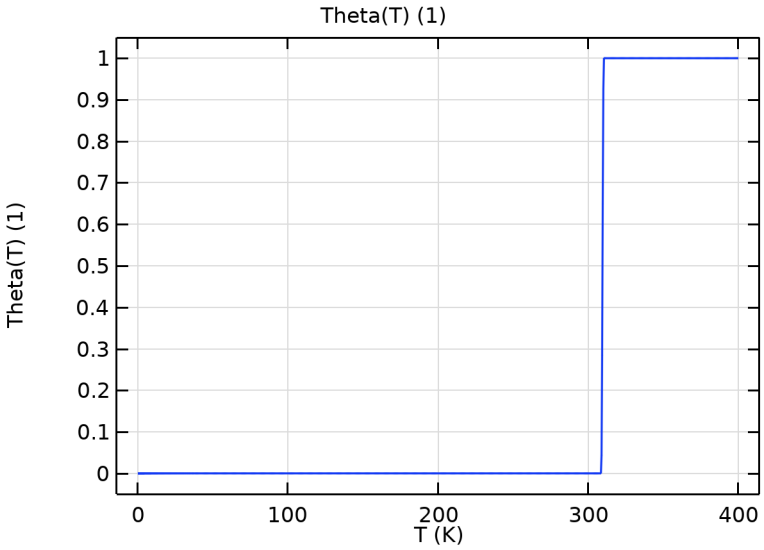


Gaussian

Melt Fraction

Function name	Theta

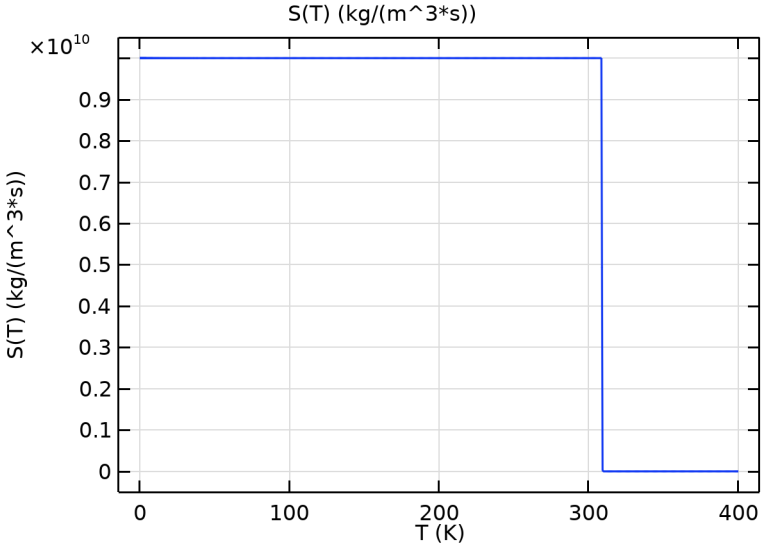
Function type	Analytic



Melt Fraction

Karman-Kozeny

Function name	S
Function type	Analytic

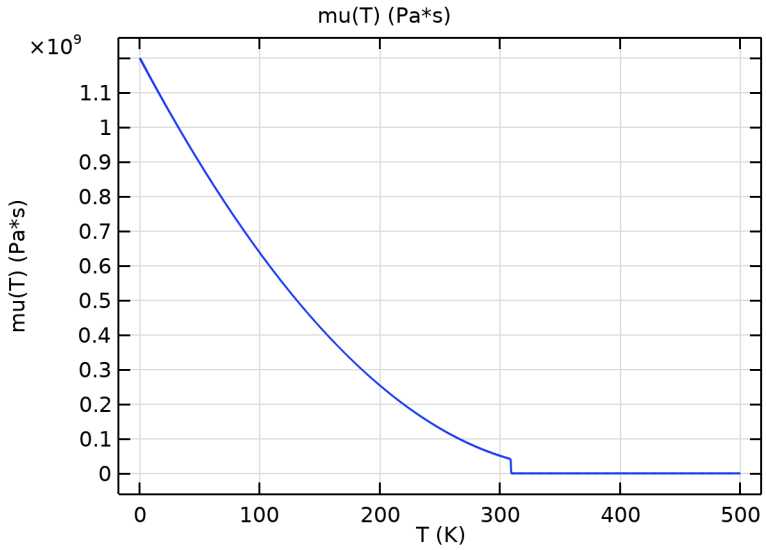


Karman-Kozeny

Viscosity

Function name	mu

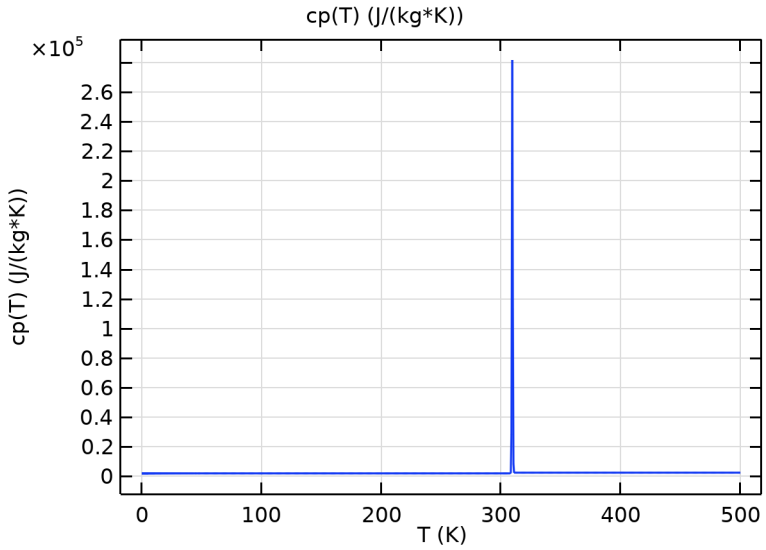
Function type	Analytic



Viscosity

Heat Capacity

Function name	cp
Function type	Analytic

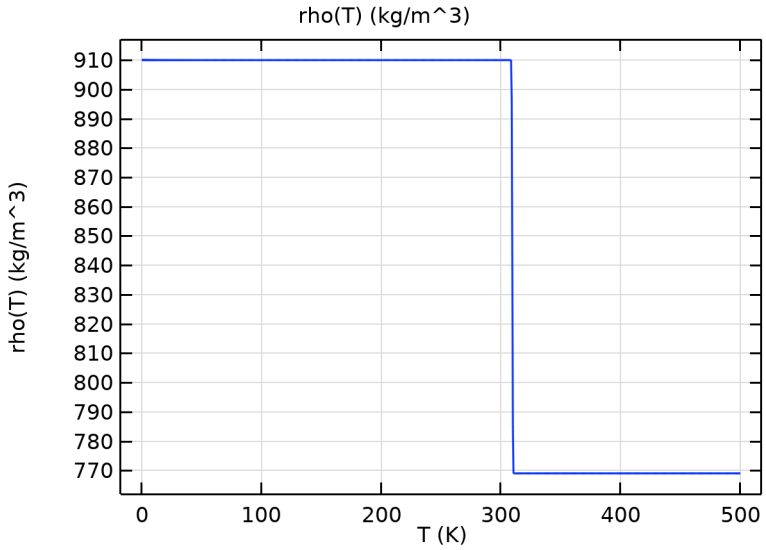


Heat Capacity

Density

Function name	rho

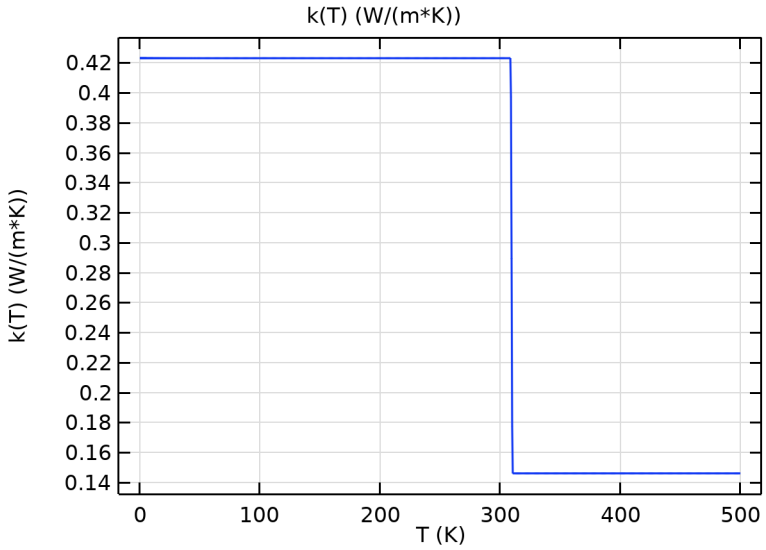
Function type	Analytic



Density

Thermal Conductivity

Function name	k
Function type	Analytic



Thermal Conductivity

2.1.3 Coordinate Systems

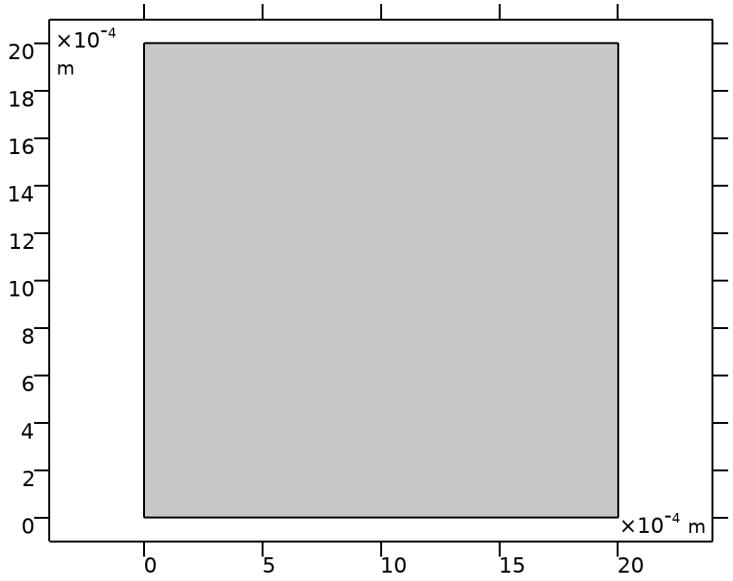
Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

COORDINATE NAMES

First	Second	Third
t1	n	to

2.2 GEOMETRY 1



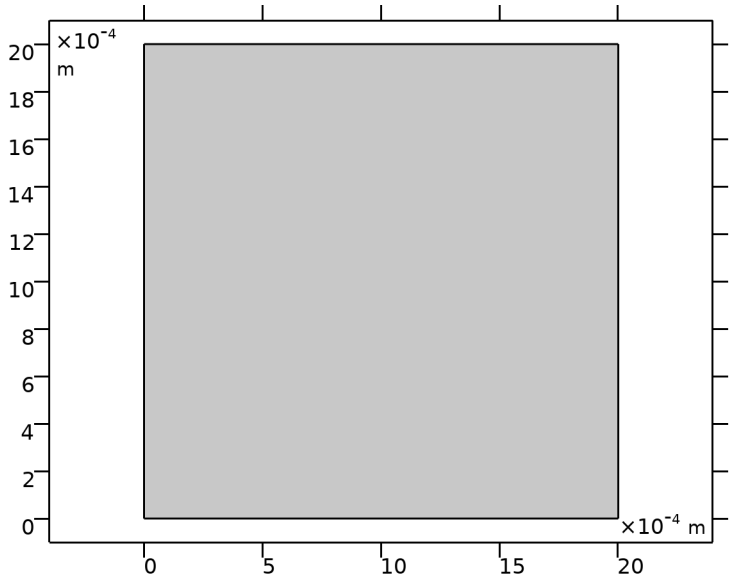
Geometry 1

UNITS

Length unit	m
Angular unit	deg

2.3 MATERIALS

2.3.1 n-eicosane (liquid)

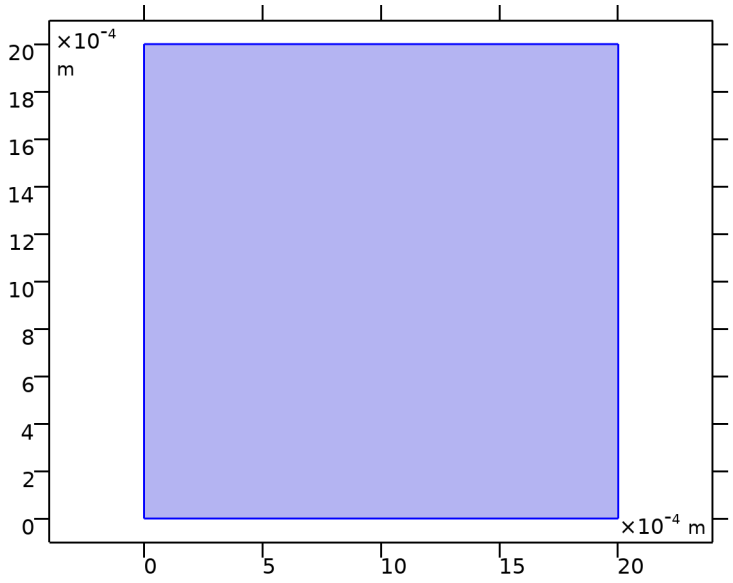


n-eicosane (liquid)

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: All domains

2.3.2 n-eicosane (solid)

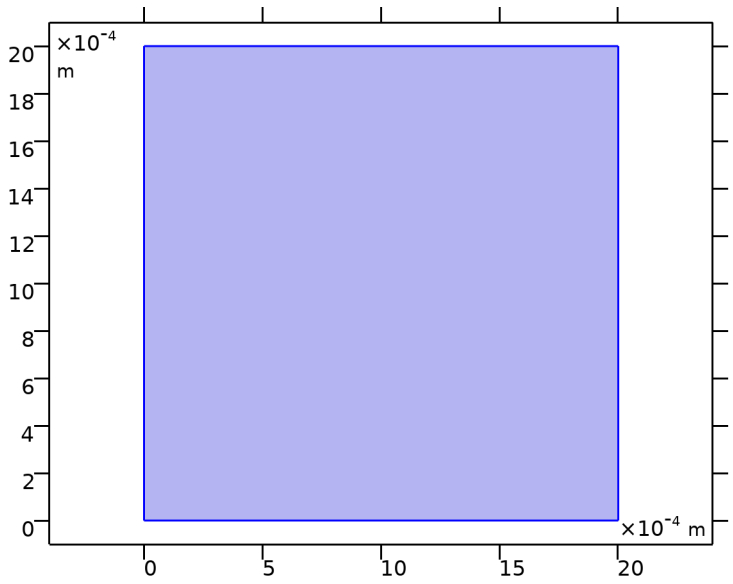


n-eicosane (solid)

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: Domain 1

2.4 LAMINAR FLOW



Laminar Flow

EQUATIONS

$$\rho\frac{\partial \mathbf{u}}{\partial t}+\rho(\mathbf{u}\cdot\nabla)\mathbf{u}=\nabla\cdot[-p\mathbf{I}+\mathbf{K}]+\mathbf{F}+(\rho-\rho_{\mathrm{ref}})\mathbf{g}$$
$$\rho\nabla\cdot\mathbf{u}=0$$

FEATURES

Fluid Properties 1
Initial Values 1
Wall 1
Gravity 1
Volume Force 1
Pressure Point Constraint 1

2.4.1 Fluid Properties 1

EQUATIONS

$$\rho\frac{\partial \mathbf{u}}{\partial t}+\rho(\mathbf{u}\cdot\nabla)\mathbf{u}=\nabla\cdot[-p\mathbf{I}+\mathbf{K}]+\mathbf{F}+(\rho-\rho_{\mathrm{ref}})\mathbf{g}$$
$$\rho\nabla\cdot\mathbf{u}=0$$
$$\mathbf{K}=\mu\left(\nabla\mathbf{u}+(\nabla\mathbf{u})^{\mathrm{T}}\right)$$

2.4.2 Wall 1

EQUATIONS

$$\mathbf{u} = \mathbf{0}$$

2.4.3 Gravity 1

EQUATIONS

$$\rho\frac{\partial \mathbf{u}}{\partial t} + \rho(\mathbf{u}\cdot\nabla)\mathbf{u} =$$
$$\nabla\cdot[-p\mathbf{I} + \mathbf{K}] + \mathbf{F} + (\rho - \rho_{ref})\mathbf{g}$$

2.4.4 Volume Force 1

EQUATIONS

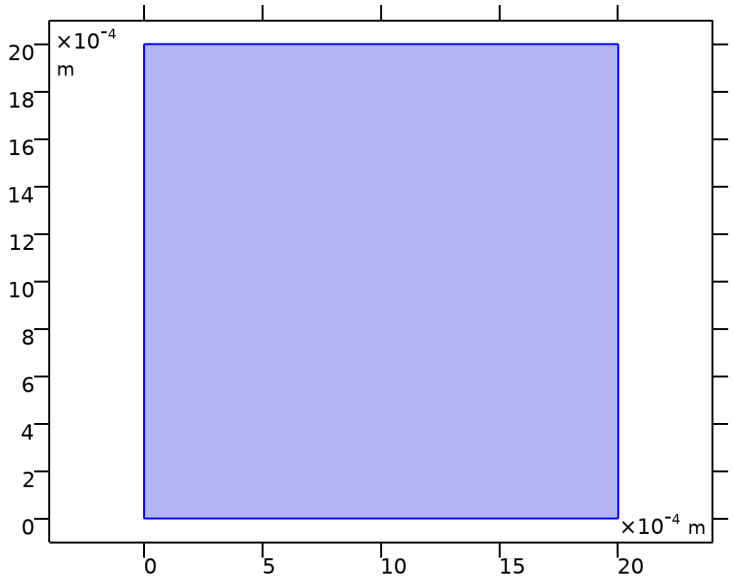
$$\rho\frac{\partial \mathbf{u}}{\partial t} + \rho(\mathbf{u}\cdot\nabla)\mathbf{u} =$$
$$\nabla\cdot[-p\mathbf{I} + \mathbf{K}] + \mathbf{F} + (\rho - \rho_{ref})\mathbf{g}$$

2.4.5 Pressure Point Constraint 1

EQUATIONS

$$p = p_0$$

2.5 HEAT TRANSFER IN FLUIDS



Heat Transfer in Fluids

EQUATIONS

$$d_z \rho C_p \frac{\partial T}{\partial t} + d_z \rho C_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = d_z Q + q_0 + d_z Q_p + d_z Q_{vd}$$

$$\mathbf{q} = -d_z k \nabla T$$

FEATURES

Fluid 1
Initial Values 1
Thermal Insulation 1
Temperature 1

2.5.1 Fluid 1

EQUATIONS

$$d_z \rho C_p \frac{\partial T}{\partial t} + d_z \rho C_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = d_z Q + q_0 + d_z Q_p + d_z Q_{vd}$$

$$\mathbf{q} = -d_z k \nabla T$$

2.5.2 Thermal Insulation 1

EQUATIONS

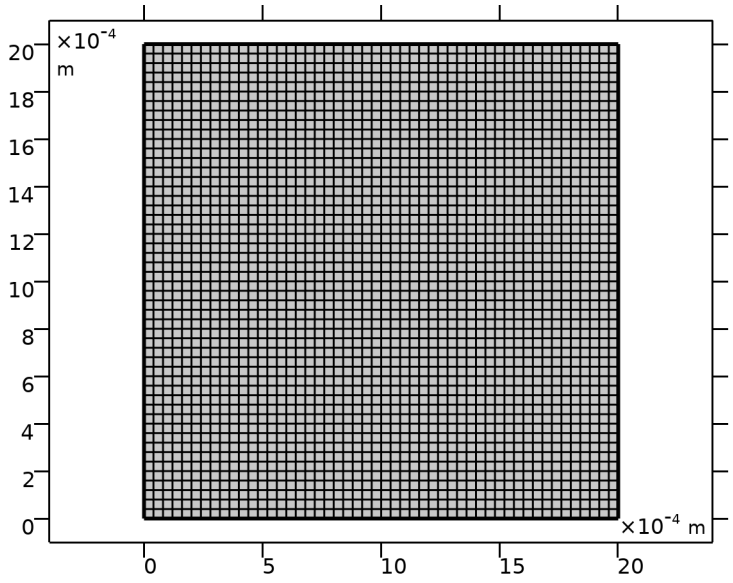
$$-\mathbf{n} \cdot \mathbf{q} = 0$$

2.5.3 Temperature 1

EQUATIONS

$$T = T_0$$

2.6 MESH 1



Mesh 1

3 Study 1

COMPUTATION INFORMATION

Computation time	5 min 32 s
CPU	Intel64 Family 6 Model 78 Stepping 3, 2 cores
Operating system	Windows 10

3.1 TIME DEPENDENT

Times	Unit
range(0,2,150)	s

STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

STUDY SETTINGS

Description	Value
Times	{0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150}

PHYSICS AND VARIABLES SELECTION

Physics interface	Discretization
Laminar Flow (spf)	physics
Heat Transfer in Fluids (ht)	physics

MESH SELECTION

Geometry	Mesh
Geometry 1 (geom1)	mesh1

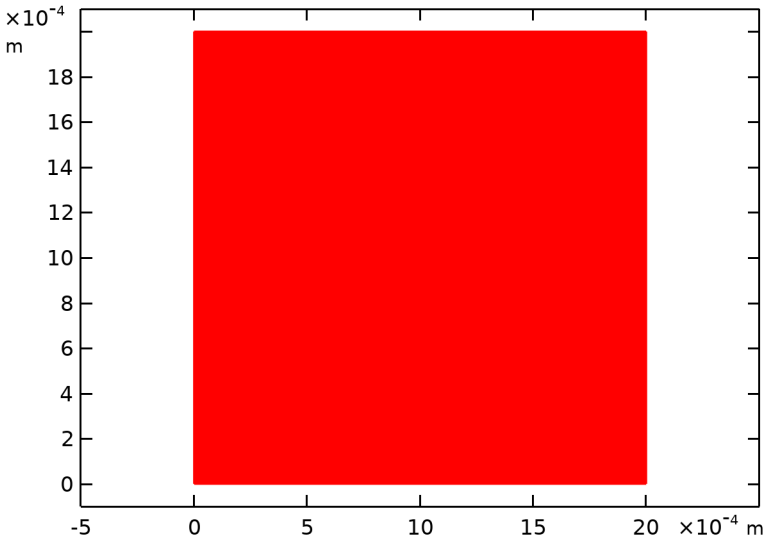
4 Results

4.1 DATA SETS

4.1.1 Study 1/Solution 1

SOLUTION

Description	Value
Solution	Solution 1
Component	Save Point Geometry 1

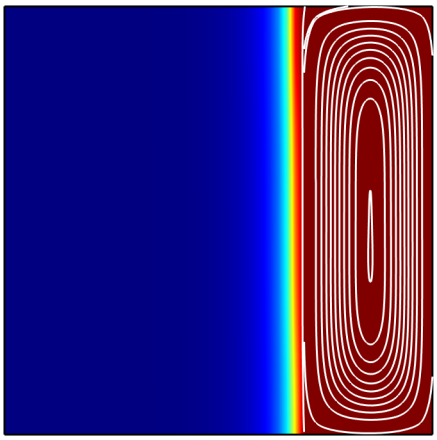


Dataset: Study 1/Solution 1

4.2 PLOT GROUPS

4.2.1 Melted Fraction

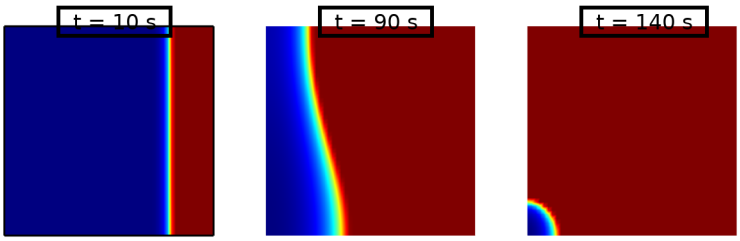
Time=22 s Surface: Melt Fraction (1) Streamline: Velocity field



Surface: Melt Fraction (1) Streamline: Velocity field

4.2.2 Melted Fraction - complete

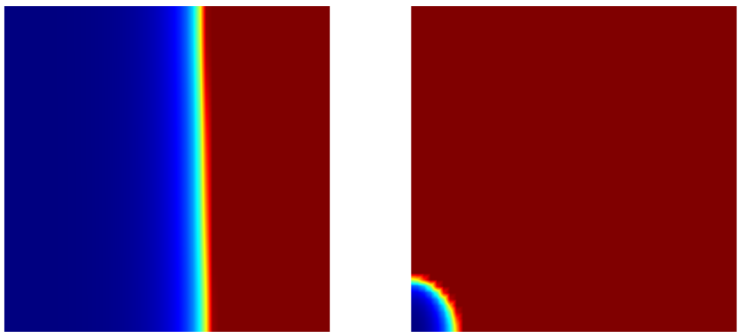
Time=98 s Surface: withsol('sol1', Theta(T), setval(t,10)) (1)
Surface: withsol('sol1', Theta(T), setval(t,90)) (1)
Surface: withsol('sol1', Theta(T), setval(t,140)) (1)



Surface: withsol('sol1', Theta(T), setval(t,10)) (1) Surface: withsol('sol1', Theta(T), setval(t,90)) (1) Surface: withsol('sol1', Theta(T), setval(t,140)) (1)

4.2.3 Melted Fraction 1

Surface: withsol('sol1', Theta(T), setval(t,30))
Surface: withsol('sol1', Theta(T), setval(t,140))



Surface: withsol('sol1', Theta(T), setval(t,30)) Surface: withsol('sol1', Theta(T), setval(t,140))