EDF R&D



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Code_Saturne documentation

Code_Saturne version 5.0 tutorial: three 2D disks

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Part I

Introduction

1 Introduction

Code_Saturne is a system designed to solve the Navier-Stokes equations in the cases of 2D, 2D axisymmetric or 3D flows. Its main module is designed for the simulation of flows which may be steady or unsteady, laminar or turbulent, incompressible or potentially dilatable, isothermal or not. Scalars and turbulent fluctuations of scalars can be taken into account. The code includes specific modules, referred to as "specific physics", for the treatment of lagrangian particle tracking, semi-transparent radiative transfer, gas, pulverized coal and heavy fuel oil combustion, electricity effects (Joule effect and electric arcs) and compressible flows. *Code_Saturne* relies on a finite volume discretization and allows the use of various mesh types which may be hybrid (containing several kinds of elements) and may have structural non-conformities (hanging nodes).

The present document is a tutorial for *Code_Saturne* version 5.0. It presents five simple test cases and guides the future *Code_Saturne* user step by step into the preparation and the computation of the cases.

The test case directories, containing the necessary meshes and data are available in the examples directory.

This tutorial focuses on the procedure and the preparation of the *Code_Saturne* computations. For more elements on the structure of the code and the definition of the different variables, it is higly recommended to refer to the user manual.

Code_Saturne is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version. *Code_Saturne* is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

Part II

Three 2D disks

1 General description

1.1 Objective

The aim of this case is to train the *Code_Saturne* coupling with a thermal conduction and radiation code SYRTHES on a simplified 2D problem. It corresponds to a natural convection inside a sheath with different electric wires.

We can see with this test-case the conjugate heat transfer phenomenon between the solid and fluid domains.

1.2 Remarks

• Remark - 1: Create the 🗇 3disks2D study directory, two subdirectories 🗇 fluid and 🗇 solid as below:

\$ code_saturne create -s 3disks2D -c fluid --syrthes solid

• Remark - 2: The fluid mesh must be copied in the directory \bigcirc MESH. The solid mesh must be copied in the subdirectory \bigcirc solid.

• Remark - 3: Launch the SYRTHES Graphical User Interface (Gui) (\$ syrthes.gui &) inside the subdirectory \boxdot solid for the first solid computation alone.

• **Remark - 4**: Launch the *Code_Saturne* Graphic User Interface (GUI) inside the subdirectory fluid for the fluid computation alone.

• **Remark - 5**: Launch the *Code_Saturne*-SYRTHES coupling computation with the top-level runcase script.

1.3 Description of the configuration

The 2D configuration represents a simplification of the real 3D geometry of the wires inside an electric sheath. As we can see, we have 3 different wires represented as 3 different disks inside a bigger disk for the sheath. We assume that the 3 disks are in contact with an air flow inside the electric sheath.

The geometry is shown on figure II.1.



Figure II.1: Geometry of the test-case with [1,2,3,4] the solid domain and [5] the fluid domain. The 4 disk physical properties are specified for the solid domain.

For the fluid domain, there are two symmetry conditions and walls conditions imposed to the faces

coupling with the solid domain. We have no velocity imposed to create movement inside the fluid area and gravity force is taken into account.

Nevertheless, we define a density which is variable in function of the temperature for the air flow. The 3 disks, which are warmer than the air flow, generate a temperature difference creating a fluid movement. The warmer air flow is moving to the top and the colder air flow to the bottom of the fluid domain.

With this test-case, we can easily observe the effect of the solid disks on the air flow contained in the electric sheath.

1.4 Characteristics

• <u>Solid domain</u>:

The initial and boundary conditions to choose without conjugate heat transfer for the solid domain are defined hereafter:

Initial conditions	
Temperature condition	$T_{ini,s} = 20^{\circ} \mathrm{C}$

Boundary conditions	Value	Surface reference
Heat exchange conditions $(q_{w,ext})$	$T_{ext} = 90^{\circ}$ C. ; $h_{ext} = 1000 (W/m^2.K)$	color 2 or 5 or 8

Characteristics of the solid domain with the 4 different disks (1 to 3 for the electric wires and 4 for the disk for the electric sheath):

	Conductivity type	Values $(W/m/^{\circ}C)$	Volume reference
Disk 1	Isotropic	$k_{11} = 25$	color 1
Disk 2	Orthotropic	$k_{11} = 25$; $k_{22} = 5$	color 2
Disk 3	Anisotropic	$k_{11} = 25$; $k_{22} = 5$ $\alpha = 45^{\circ}$	color 3
Disk 4	Isotropic	$k_{11} = 25$	color 4

Physical properties	Values	
Density $[\rho]$	7700	(kg/m^2)
Specific heat $[C_p]$	460	$(J/kg/m^3)$

• <u>Fluid domain</u>:

The characteristics of the air flow inside the fluid domain are defined as following:

Thermophysical models	Choosen type
Time step	constant in time and uniform in space
Turbulence model	k-arepsilon
Scalar	Temperature (°C)

The initial and boundary conditions to choose without conjugate heat transfer for the solid domain are defined below:

Initial conditions	
Temperature condition	$T_{ini,f} = 20^{\circ} \mathrm{C}.$

Boundary conditions	Values	Surface reference
Walls (Heat exchange $q_{w,ext}$)	$T_{ext} = 30^{\circ}\text{C}$; $h_{ext} = 10(W/m^2.K)$	color 1
Symmetry		color 2 or 3

In this case, the fluid density is function of the temperature, the following ideal gas law is specified in the Graphical User Interface (GUI):

$$\rho = \frac{p_0}{R_g \ (T+273.15)} \tag{II.1}$$

where ρ is the density, T is the temperature (°C), ideal gas constant $R_g = 287 \ (m^2 \cdot s^{-2} \cdot K^{-1}), \ p_0 = 101325 \ (Pa)$ the reference pressure choosen as $p \approx p_{atmos}$.

1.5 Mesh characteristics

• Description of the solid mesh:

The solid mesh used in the conduction problem contains 11688 nodes (P_1 discretization) and 5688 elements. We have to take care of the references allowing to identify materials properties and boundary conditions which are specified in this solid mesh by reference colors.

Type: unstructured mesh Mesh generator used: SIMAIL Color definition: see figure II.3.



Figure II.2: Colors of the solid zones and boundary faces

• Description of the fluid mesh:

The fluid mesh contains 3866 nodes. We have to use the Mesh Quality Criteria run type in the *Code_Saturne* Graphical User Interface (Calculation management, Pepare batch calculation section) to check the quality criteria and identify the reference colors associated to the boundary conditions (color 1 is used for all sides, 2 for the bottom surface, and 3 for the top surface.

Type: unstructured mesh Mesh generator used: SIMAIL Color definition: see figure II.3.



Figure II.3: Colors of the fluid boundary faces

2 CASE 6: 3 2D disks

The post-processing containing the **temperature** field will be post-processed on a sub-mesh with ParaView. A 2D clip plane will also be extracted along the symmetry plane of the fluid domain and temperature will be written on it.

2.1 Parameters

All the parameters necessary to this study can be defined through the *Code_Saturne* (GUI) and SYRTHES (GUI) respectively, as below:

Numerical parame	ters of solid computation
Reference time step	10 (s)
Number of iterations	100
Numerical parame	ters of fluid computation
Numerical parame Reference time step	ters of fluid computation 0.1 (s)

These numerical time steps and iterations number have been defined to run the fluid and solid computations independently one from each other. Thus, we can test the setting data for the fluid computation with *Code_Saturne* and the solid conduction computation with SYRTHES. After that we will be able to run the coupling computation with the computation option **Conjugate heat transfer** activated on both data settings.

2.2 Output management

The standard options for output management will be used. Only one monitoring point will be created for the solid conduction computation at the following coordinates:

Probe	x (m)	y (m)
1	0.003	-1.2

For this probing, we choose to save the temperature value every 10 time steps and the temperature field every 25 time steps.

2.3 Coupling computation

The numerical parameters used for the coupling computation must be modified to be sure to see the conjugate heat transfer phenomenon between the solid and fluid domains. For this reason, we increase the iterations number and the time step for the fluid and solid data setting.

By default, the smaller iterations number will be used to drive the coupling computation. If we choose an iterations number of 10000 for the fluid domain and 5000 for the solid domain, the coupling computation will be stopped after 5000 instead of 10000.

Numerical parame	ters of solid computation
Reference time step	0.5~(s)
Number of iterations	600
Numerical parame	ters of fluid computation
Numerical parame Reference time step	ters of fluid computation 0.5 (s)

The Improved pressure interpolation in stratified flow algorithm will be used.

2.4 Results

Figure II.4 shows the evolution of the temperature in the solid domain without **Conjugate heat transfer** with the fluid domain. We have represented in Figure II.5 the evolution of the temperature in the fluid domain without coupling with SYRTHES.

Figure II.6 shows the evolution of the temperature in the solid and fluid area with the **conjugate heat transfer activated**. The natural convection in the fluid domain due to the temperature difference imposed by the solid disks is clearly visible with the velocity field and vector.



Figure II.4: The temperature evolution in the solid domain without coupling method



Figure II.5: The temperature evolution in the **fluid domain without coupling method**





Figure II.6: Evolution of temperature and velocity magnitude

Part III

Step by step solution

1 Solution for case1

• Step 1: check the post-install required for coupling *Code_Saturne* with SYRTHES.

The first step is to check the post-install required for coupling with SYRTHES and verify if the SYRTHES PATH is correctly known in the system environment. We just need to edit the batch file¹ name code_saturne.cfg as below:

```
$ vim <install-prefix>/etc/code_saturne.cfg
>### Set the location to the SYRTHES installation directory.
> syrthes = <install-prefix-syrthes>
```

• Step 2: source the synthes.profile file in your user environment.

Before using SYRTHES alone, you have to copy and source this file to define SYRTHES environment variables (like **\$SYRTHES4_HOME**) in your terminal, as follows:

```
$ cp <install-prefix-syrthes>/bin/syrthes.profile .
$ source syrthes.profile
$ echo $SYRTHES4_HOME (to check the SYRTHES PATH in your environment)
```

After having defined correctly your environment, to be able to launch a coupling computation *Code_Saturne-*SYRTHES or a SYRTHES computation alone, you just have to create the coupling study directory.

• Step 3: create the \boxdot 3disks2D study directory, and the two case subdirectories \boxdot fluid and \boxdot solid.

This is done using the standard command:

• Remark: The fluid mesh must be copied in the directory \square MESH. The solid mesh must be copied in the subdirectory \square solid.

¹see the installation guide, name install.pdf, in <install-prefix>/share/doc/code_saturne/ directory.

1.1 Launching the SYRTHES computation alone

The preparation of the computation for case5 is defined below:

- Step 1: Launch the SYRTHES Graphical User Interface (syrthes.gui),
- Step 2: Create a New Data File,
- Step 3: Check the name of the mesh and convert this one in .syr format,
- Step 4: Define the initial and boundary conditions for the conduction problem,
- Step 5: Define the physical properties of each disk {1, 2, 3 and 4},
- Step 6: Running the SYRTHES computation alone.

• Step 1: launch the SYRTHES Graphical User Interface (GUI).

The SYRTHES Graphical User Interface is launched by the following command lines in the solid subdirectory:

\$ cd 3disks2D/solid/
\$ syrthes.gui &

• Step 2: choose New Data File inside the (GUI).



Figure III.1: Running the SYRTHES IHM with syrthes.gui

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Filo Tools Droford	ncas Halp		
	ances <u>H</u> eip	Run SYRTHES (>) Stop SYRTHES	🔇 Calculation Progress 📈
Home File Names	Case title : Dimension of Additional Therms Humid SYRTH SYRTH Conjug	3Disks2D - Conductivity only in 3 different disks User description of the case If the problem : 2D_cart 2D_axi_OX 2D_axi_OY it y Heat, moisture, total air pressure transfer IV HES 1D fluid flow ate Heat Transfer	V 4.3

Figure III.2: Define the dimension and physical modelling of the treated problem

<u>T</u> ools Prefere	nces <u>H</u> elp			
	Select File			
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🗟 TM178B				
🛅 Bureau				
🖾 Système				
			Com	npatible 🗸
		A	nnuler	Ouvrir

Figure III.3: Choose the 2D solid mesh file with the format .des.

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Eile Tools Prefere Control Control Control Output Running options	ences Help Conduction input file name and location Conduction mesh: Goddation Conduction mesh: Message Format conversion from "des" to "syr" finished Results names prefix : resul	RTHES S Calculation Progress

Figure III.4: The SYRTHES (GUI) directly converts the .des to the .syr format.

• Remark: Inside the SYRTHES Graphical User Interface (GUI), we can load the SIMAIL format *.des for the solid mesh. This one will be automatically transformed to the *.syr format. It can also be done with the following command line:

\$ convert2syrthes4 -m 3rond2d.des

• **Remark**: You can convert the ***.syr** format into a ***.med** format. Like that, you can load the ***.med** file inside SALOME, after having used this command line below:

\$ syrthes4med30 -m 3rond2d.syr -o 3rond2d.med

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File Tools Prefere	ences <u>H</u> elp Run SYRTHES Stop SYRTHES Calculation	on Progress 📈
File Names ← Conduction User C functions Control Output Running options	Conduction mesh: 3disks2d.syr Radiation mesh:	
	Conduction output files names prefix and location — Results names prefix : resul	

Figure III.5: Choose a name for the results files $\tt.res, .his$ and $\tt.rdt$

Figure III.6: Define the initial temperature conditions inside the different disks.

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File Tools Prefere	nces <u>H</u> elp				Ru	ın SYRTI	HES 🕒) Sto	p SYRTHES 🔞	Calculation Pro	gress 📈
File Names Conduction Initial condition	ns ditions	Heat e> Heat	«change exchange	Flux e coef	condition [[ficient (W/m	Dirichlet c 2/Deg C)	ondition	Con	tact resistance	Infinite radiation	1
Boundary con Physical prope	rties		Тур	е	External T	Coef h	Refere	nces	User	comments	^
Volumetric cor	nditions	1	Constar	t 🗸	90	1000	258		Extern faces o	f the disks	
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Output			Constar	nt 🗸							
Running options			Constar	nt 🗸	1						
			Constar	nt 🗸	1						
					" 						

Figure III.7: Define the temperature boundary conditions for the extern faces of the three disks.

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Physical properties		Туре		ρ	Ср	k	References	User comments
Volumetric conditions	2	Constant	~	7700	460	25	14	Isotropic conductivity for disk 1 and 4
Periodicity		Constant	~	1				
Control		Constant	~					
Output		Constant	~					
Running options	2	Constant	~	1				
		Constant	~	1				v

Figure III.8: Define the physical properties for the disk 1 and 4 with isotropic conductivity.

• **Remark**: To correctly identify the volume references associated to a specific physical property, we can check the mesh regions directly inside ParaView after having used following command line:

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File Tools Preferen	ces <u>H</u> elp						Run SYF	THES	▶ Stop SYRTI	HES 🔞 Calculation Progress
Home File Names Conduction Initial conditions		sotrop ρ (kg	ic Orthotrop /m³), Cp (J/kg	pic	Anisotr g C), kx	opic ky : Orth	otropic c	onductivi	ity (W/m/Deg C))
Boundary condi Physical propert	ions		Туре		ρ	Ср	kx	ky	References	User comments
Volumetric cond	itions		Constant	~	7700	460	25	5	2	Orthotropic conductivity f
Periodicity			Constant	~						
Control			Constant	~						
Output			Constant	~						
Running options			Constant	~	1					
			Constant	V	1					u u

Orthotropic conductivity table (use 'help/What's this' for details)

Figure III.9: Define the physical properties for the disk 2 with isotropic conductivity.

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Home File Names Conduction	Isotropi	c Orthotro	pic	Anisotr	opic						
Initial conditions	ρ (kg	/m³), Cp (J/kợ	g/Deg	C), kx	ky : Anis	otropic c	onductiv	ity (W/m/Deg C)			
Physical properties		Туре		ρ	Ср	kx	ky	Angle (in Deg)	References	r comme؛	1
Volumetric conditions		Constant	~	7700	460	25	5	45	3	Anisotr	
Periodicity		Constant	~								
Control		Constant	~			_					
Output		Constant	~								
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		Constant	~								
	<									3	

Figure III.10: Define the Physical properties for the disk 3 with anisotropic conductivity.

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File Tools Preferent Image: Second state Image: Second state Image: Second state Home File Names Image: Second state Conduction Initial conditions Boundary conditions Boundary conditions Physical properties Volumetric condet Volumetric condet Periodicity User C functions Control Output Running options	s itions ditions	Time management Run SYRTHES Time management Solver information Time step management Solver information Time step management Information Clobal number of time steps : 100 Time step : Constant Ime step Constant time step Time step (in seconds) : Time step (in seconds) : 10	Calculation Progress

Figure III.11: Define the global number of time steps and the time step for the 2D solid conduction computation.

Figure III.12: Define the probe coordinates for output management.

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<u>File</u> <u>T</u> ools Preferen	ices <u>H</u> elp		
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Home File Names	Pro	bes Result fields Surface balance Volume balance	
Conduction Initial conditions Boundary condi Physical proper Volumetric cond Periodicity User C functions Control Output Running options	s F tions (ditions (requency at which the result fields are written in the transient result file (e 2D Fields Every n time steps 25 2D heat flux field 2D maximum temperature field Disable final 2D fields	extension ".rdt") :

Choice for 3D fields results



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📄 🔚 🏝 🦫 💐	Run SYRTHES 🕟 Stop SYRTHES 🔕 Calculation Progress 🗾
Home	
File Names	
Conduction	
Initial conditions	Scalar/ Parallel calculation : number of processor used for conduction : 1
Boundary conditions	
Physical properties	Scalar/ Parallel calculation : number of processor used for radiation :
Volumetric conditions	
Periodicity	
User C functions	Listing name: listing
Control	
Output	
Running options	Advanced options
	Preprocessing automatic preprocessing for OD/1 D fluid mesh
	The processing is a contact of the proprocessing for object had mean in the
	Domain partitioning : automatic mesh partitioning using SCOTCH 🔽
	Convert result for softwares : Ensight/Paraview
	STRINES (F)

Figure III.14: Define the file name of the SYRTHES listing and the number of processors used.



Last 200 lines of the listing file



• **Remark**: We can visualize the temperature results fields by applying the following command line to the results file resul.res or resul.rdt (for the results saved at the last time step or the results saved at each time step):

\$ syrthes4ensight -m 3rond2d.syr -r resu1.res -o Results_Temp \$ syrthes4ensight -m 3rond2d.syr -r resu1.rdt -o Chrono_Temp



Figure III.16: Screenshot of the 2D solid temperature Field.

1.2 Launching the *Code_Saturne* computation alone

The main steps of the preparation of the fluid computation alone for the fluid case is defined below:

- Step 1: Launch the Code_Saturne Graphical User Interface (./SaturneGUI),
- Step 2: Create a New case,
- Step 3: Check the quality of the fluid mesh by running a Mesh quality criteria calculation,
- Step 4: Define the physical properties of the disk for the air flow,
- Step 5: Define the initial and boundary conditions for the air flow problem,
- Step 6: Running the Code_Saturne computation alone.

dy: 3disks2D				
e: fluid				
L file: /home/TM178B0N/Code_Saturne	/Tutorials/3disks2D/fluid/DATA/fluid	d_3disks_alone.xml		
o x _				
ldentity and paths	Meshes Meshes options Peri	odic Boundaries		
🛅 Calculation environment				
Meshes selection	Mesh import			
Thermophysical models	 Import meshes 	existing mesh input		
Physical properties				
Volume conditions	Local mesh directory (option	nal)		
Boundary conditions	/MESH			🗁 🏷
Numerical parameters				
	List of meshes			
	File name	Format	Reorient	Path
	3disks2d_fluid.des	Simail/NOPO		
	Face joining (optional)	4		
	Fraction Plane Verbosity	Visualization	Select	ion criteria
		4	-	

Figure III.17: Choose the fluid mesh with Code_Saturne (GUI)

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Case: fluid			
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ML floy /home/TM178RON/Code Saturn			
The life. The source satur	e/Tutorials/3disks2D/f	luid/DATA/fluid_3disks_alone.xml	
ନ ସ			
	Steady/Unsteady f	low algorithm	
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🗄 📋 Numerical parameters	Electrical models		
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	compressible mod	-#	
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		оп	~

Figure III.18: Define the physical modelling associated to the air flow inside the fluid domain.

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Study: 3disks2D			
Const Ruit			
Case: fluid			
XML file: /home/TM178B0N/Code_Saturne/	Tutorials/3disks2D/fluid	d/DATA/fluid_3disks_alone.xml	
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ldentity and paths	Thermal scalar		
+ Calculation environment		Temperature (Celsius)	
🗆 🛅 Thermophysical models			
Calculation features			
Deformable mesh			
🗒 Turbulence models			
📄 Thermal model			
🖹 Radiative transfers			
🗎 Conjugate heat transfer			
📄 Species transport			
🗎 Turbomachinery			
🗎 Fans			
🕀 🛅 Physical properties			
🕀 🛅 Volume conditions			
🕀 🛅 Boundary conditions			
🕀 🛅 Numerical parameters			
Calculation control			
🕀 🛅 Calculation management			

Figure III.19: Choose the Temperature scalar.

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ldentity and paths		
🕀 🛅 Calculation environment	material user material 🗸	
🕀 🛅 Thermophysical models	method user properties	
E Physical properties	Mathematical expression editor	
Eluid properties		
Gravity	User expression Predefined symbols Examples	
🕀 🛅 Volume conditions	<pre>density = p0 / (287*(temperature + 273.0));</pre>	
🕀 🛅 Boundary conditions		
Numerical parameters	ka/m ³	
Calculation control Calculation management	Appular 40K	
	constant 🖌 🖳	
	Reference value	
	Specific heat	
	constant 👻 📆	
	Reference value Cp 1017.24 J/kg/K	
	Thermal conductivity	
	constant 🔽	
	Reference value λ 0.02495 W/m/K	
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Figure III.20: Define the variable density with an ideal gas law inside the Code_Saturne (GUI).

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Figure III.21: Define the gravity

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Figure III.22: Initalization of the velocity components and temperature variables.

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Figure III.23: Load the preprocessor.log file inside the *Code_Saturne* (GUI).

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Figure III.24: Once the boundary regions automatically loaded, define the boundary conditions.

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Figure III.25: Define a thermal transfer condition as wall boundary condition with a extern wall temperature $T_{ext} = 30^{\circ}C$ and a exchange coefficient $q_{ext} = 10 \ (W/m^2.K)$.

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Figure III.26: Define the iterations number and time step.

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Figure III.27: Define the writer and frequency output inside the *Code_Saturne* (GUI).



Figure III.28: Visualization of the 2D fluid velocity field



Figure III.29: Visualization of the 2D fluid temperature field

1.3 Launching the *Code_Saturne***-SYRTHES coupling computation**

The last modification to prepare the coupling computation are given below:

- Step 1: Activate the conjugate heat transfer in the SYRTHES GUI,
- Step 2: Activate the conjugate heat transfer in the Code_Saturne GUI,
- Step 3: Give identical iterations number and time step for both codes,

• Step 4: Check the coupling_parameters.py python script and launch the calculation by executing the runcase.

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	🗆 Humidity	Heat and moisture transfer	
	SYRTHE:	S OD fluid flow	
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	🗹 Conjugate	e Heat Transfer	

Figure III.30: Activate the conjugate heat transfer for the solid domain.

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Running options			V

Figure III.31: Specify the reference zone for the coupling surfaces with Code_Saturne.

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Figure III.32: Change the iterations number and time step for the solid domain.

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Figure III.33: Activate the conjugate heat transfer for the fluid domain.

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Figure III.34: Change the boundary conditions for the wall temperature.

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	Relaxation of pressure increase 1.0	
	Improved pressure interpolation in stratified flow $\table \label{eq:strategy}$	
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Figure III.35: Activate the Improved pressure interpolation in stratified flow algorithm.

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Figure III.36: Change the iterations number and time step for the fluid computation.

• **Remark**: After having modified the data setting for the fluid and solid domains to activate the conjugate heat transfer on both sides, one just has to increase the iterations number and check the coupling_parameters.py script.

One just needs to edit the coupling_parameters.py script and give the name of your SYRTHES script saved in the SYRTHES GUI as below:

```
$ vim coupling_parameters.py
> domains = [
>
> 'solver': 'Code_Saturne',
> 'domain': 'fluid',
> 'script': 'runcase',
> 'n_procs_weight': None,
> 'n_procs_min': 4,
> 'n_procs_max': 4
>
> 'solver': 'SYRTHES',
> 'domain': 'solid',
> 'script': 'solid-coupling.syd',
> 'n_procs_weight': None,
> 'n_procs_min': 2,
> 'n_procs_max': 2,
> 'opt' : '-v ens'
>
> ]
```

Finally, one just has to launch the **runcase** present in the study directory (named in our case \boxdot 3disks2D) and run the coupling computation, as follows:

\$ runcase

• Remarks: in the coupling_parameters.py, the number of processors can be specified for each code (as this example with 4 processors for *Code_Saturne* and 2 processors for SYRTHES). It can be either both codes in parallel, one in parallel and the other one in sequential, or both in sequential.

One can specify the ouput results format for SYRTHES with an option (opt) which takes the value -v ens for a 3D fields output with a EnSight format or -v med for a 3D fields output with a SALOME format).