Successive compression cycles of a 2D quasi-adiabatic cavity

Click here to come back to the previous page

grid setup file

data_meshgen.dat

```
================================================================================
========================================
================================================================================
========================================
            DATA FILE FOR THE MESH GENERATOR MESHGEN (DESCRIPTIONS OF
DATA ARE GIVEN BELOW)
================================================================================
========================================
--------------------------------------------------------------------------------
----------------------------------------
Blocks of data are associated to segments along a specific direction
(There are as many blocks as segments)
See below the TEMPLATES to select your own block of data associated to
the selected distribution law)
--------------------------------------------------------------------------------
----------------------------------------
----------------------------------------
I-DIRECTION
----------------------------------------
Choice of the metric system :  in meter or dimensionless  (0)  -
angular in degrees (1)     :
&METRIC_UNIT         Type_of_Metric= 0 /
&MESH_FUNCTION_DATA Function_Name="TANH_ONE_SIDE"   Number_of_Cells= 32
Length= 0.01  Left_Cell_Size= 1.00d-04 Reverse_Ordering= .true. /
&MESH_FUNCTION_DATA  Function_Name="REGULAR"           Number_of_Cells=
200   Length= 0.0200 Reverse_Ordering= .false. /
&MESH_FUNCTION_DATA  Function_Name="TANH_TWO_SIDES"    Number_of_Cells=
280  Length= 0.09 Left_Cell_Size= 1.0d-04  Right_Cell_Size= 1.0d-04
Reverse_Ordering= .false. /
&MESH_FUNCTION_DATA End_of_Data_Block = .true./
----------------------------------------
J-DIRECTION
----------------------------------------
Choice of the metric system :  in meter or dimensionless  (0)  -
angular in degrees (1)     :
&METRIC_UNIT         Type_of_Metric= 0 /
&MESH_FUNCTION_DATA Function_Name="TANH_ONE_SIDE"   Number_of_Cells= 49
```

```
Length= 0.0141  Left_Cell_Size= 6.00d-05 Reverse_Ordering= .true. /
&MESH_FUNCTION_DATA  Function_Name="REGULAR"        Number_of_Cells= 15
Length= 9.e-4 Reverse_Ordering= .false. /
&MESH_FUNCTION_DATA End_of_Data_Block = .true./
---------------------------------------
K-DIRECTION
---------------------------------------

&MESH_FUNCTION_DATA End_of_Data_Block = .true./

------------------------------------------------------------------------
--------------------
                    DATA DESCRIPTION
------------------------------------------------------------------------
--------------------
```

Main setup file

input3d.dat

```
================================================================================
====
================================================================================
====
            MAIN INPUT DATA FILE :

           SUCCESSIVE COMPRESSION CYCLES OF A 2D QUASI-ADIABATIC CAVITY
           LMN APPORACH

                        Wall Qh=0
        ------------------------------------------------------------|
               |                                                    |
               |                                                    |
           <-- | -->                                                |
Wall Qh= 0
        T= T0  |                                                    |
               |                                                    |
        ------------------------------------------------------------|
                  Symmetric plan

            DIMENSIONAL SETUP

               fluid : air  at P= 101325 Pa and T= 294.146 K (initial
condition at t=0)
               cavity size= 0.10m * 0.015m
               volume variation : A.sin(2pi.f.t- w0)    w0= pi/2
                                  A= 0.01 m
                                  f= 50 Hz
```

```
================================================================================
====
================================================================================
====
&Version File_Version="VERSION2.0"/
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++
                     GENERAL LAYOUT
                     (DIMENSIONLESS)
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++
&Fluid_Properties  Variable_Density           = .true. ,
Constant_Mass_Flow          = .false. ,
                   Variable_Fluid_Volume= .true. ,
                   Molecular_Mass=  0.02896421357024561   ,
                   Heat_Transfer_Flow          = .true.  ,
                   Reference_Dynamic_Viscosity = 1.795D-05,
                   Reference_Density           = 1.2 ,
                   Reference_Temperature       = 294.146  ,
                   Prandtl                     = 0.726 ,
                   Reference_Heat_Capacity     = 1004.7093960142244 ,
                   Heat_Capacity_Ratio         = 1.4  /

&Velocity_Initialization  I_Velocity_Reference_Value  = 0.0 ,
J_Velocity_Reference_Value = 0.0 , K_Velocity_Reference_Value = 0.0 /
&Temperature_Initialization Temperature_Reference_Value= 294.146 ,
Initial_Field_Option_For_Temperature= 0 /
================================================================================
====
                      DOMAIN FEATURES
                       (DIMENSIONLESS)
================================================================================
====
&Domain_Features Start_Coordinate_I_Direction=-0.020 ,
End_Coordinate_I_Direction= 0.10,
                 Start_Coordinate_J_Direction= 0.00 ,
End_Coordinate_J_Direction= 0.015,
                 Start_Coordinate_K_Direction= 0.00 ,
End_Coordinate_K_Direction= 0.00,
                 Cells_Number_I_Direction= 512
,Cells_Number_J_Direction= 64 ,Cells_Number_K_Direction= 1,
                 Regular_Mesh= .false. /
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
               DEFINITION OF BOUNDARY CONDITIONS
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
================================================================================
======
                   WALL BOUNDARY CONDITION SETUP
```

```
                      (DIMENSIONLESS)
================================================================================
======

================================================================================
======
               INLET AND OUTLET  BOUNDARY CONDITIONS
                      (DIMENSIONLESS)
================================================================================
======

&Inlet_Boundary_Conditions  Type_of_BC= "INLET", Direction_Normal_Plan=
1 ,
                            Plan_Location_Coordinate= -0.0200  ,
                            Start_Coordinate_of_First_Span =  0.00  ,
End_Coordinate_of_First_Span = 0.015 ,
                            Start_Coordinate_of_Second_Span= 0.0    ,
End_Coordinate_of_Second_Span= 0.0  ,
                            Flow_Direction= 1 ,
                            Define_Velocity_Profile= 0,
                            Normal_Velocity_Reference_Value= 0.0  ,
                            Temperature_Reference_Value= 294.146 ,
                            Density_Reference_Value= 1.2 ,
                            Temperature_BC_Type="Neumann",
                            Density_BC_Type="Neumann",
                            Variable_Flowrate= 0/
                           !Time_Fct_Name= "Sinus_zero_average" ,
Time_Fct_Threshold= 0.0 ,
                          !Time_Fct_Time_Scale= 2.0E-02 ,
Time_Fct_Magnitude= 4.712 /

================================================================================
======
               IMMERSED BOUNDARY METHODS : PENALIZATION METHOD
================================================================================
======
&Immersed_Boundary_Methods  Immersed_Boundary_Method_Type= 1 ,
                            Name_of_Solid="RECTANGLE",
                            Linked_IBM_Inlet_Number = 1 ,
                            Gravity_IBM_Enabled = .false. ,
                            StrongPenaltyForVelocity_Enabled=.true.,
                            Coordinate_Gravity_Center_At_Rest_I=-0.04 ,
Coordinate_Gravity_Center_At_Rest_J= 0.0075 ,
Coordinate_Gravity_Center_At_Rest_K= 0.0 ,
                            Coordinate_Gravity_Center_Init_I= -0.05   ,
Coordinate_Gravity_Center_Init_J= 0.0075    ,
Coordinate_Gravity_Center_Init_K= 0.0    ,
                            Coordinate_Restricted_Motion_I=-0.04      ,
Coordinate_Restricted_Motion_J= 0.0 , Coordinate_Restricted_Motion_K=
0.0 ,
                            Size_Object_I= 0.08                       ,
```

```
Size_Object_J= 0.015                        , Size_Object_K= 0.0
,
                            Reference_Velocity_I= 0.0                ,
Reference_Velocity_J= 0.0                , Reference_Velocity_K= 0.0
,
                            Motion_Magnitude_I= 0.010
, Motion_Magnitude_J= 0.00           , Motion_Magnitude_K= 0.0
,
                            Mass= 1.2 ,
                            Spring_Stiffness_Constant_I= 0.0         ,
Spring_Stiffness_Constant_J= 0.0         , Spring_Stiffness_Constant_K=
0.0         ,
                            Transitional_Time= 0.00, Forced_Frequency=
5.0D+01 , OffSet= 0.5,
                            Heat_Transfer_Type= 0,
                            Reference_Temperature= 294.146 ,
Reference_Heat_Flux= 0.0 ,
                            Material_Thermal_Conductivity= 2.4841D-02 ,
Material_Mass_Heat_Capacity= 1004.7094, Material_Density= 1.2 /

================================================================================
               ENDS BOUNDARY CONDITIONS
================================================================================
&Border_Domain_Boundary_Conditions West_BC_Name  = "None" ,
East_BC_Name  = "None" ,
                                   Back_BC_Name  = "Symmetric" ,
Front_BC_Name = "None" ,
                                   North_BC_Name = "None" ,
South_BC_Name = "None" /
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                   NUMERICAL METHODS
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
&Numerical_Methods
                     !!!NS_NumericalMethod= "BDF2-SchemeO2",
                     NS_NumericalMethod= "CN-SchemeO2",
                     !!!NS_NumericalMethod= "CN-SchemeO2-
SpecialLowMachFlow",
                     !!MomentumConvection_Scheme="Centered-O2-
Conservative" ,
                     MomentumConvection_Scheme="Centered-O2-
Convective_2" ,
                     !!!MomentumConvection_Scheme="Upwind-O1-
Convective" ,
                     TemperatureAdvection_Scheme="Centered-O2-
Convective_2" ,
                     !!!TemperatureAdvection_Scheme="Upwind-O1-
Convective" ,
```

```
                      !!!TemperatureAdvection_Scheme="Centered-O2-
Convective" ,
                     !Poisson_NumericalMethod="Home-
PartialDiagonalization"  ,
                     !Poisson_NumericalMethod="Home-SORMultigrid-
ConstantMatrixCoef"  ,
                      Poisson_NumericalMethod="Home-SORMultigrid-
VariableMatrixCoef"  ,
                      Off_Set_Poisson_Source_term= .true./

!HomeData_PoissonSolver
      Direction_1= 2,
      Direction_2= 1,
      Direction_3= 3/

&HomeData_PoissonSolver SolverName="SOR"           ,!Successive Over-
Relaxation (SOR) method based on the red-black algorithm
                        MultiGrid_Type="V_Cycle",
                        Relaxation_Coefficient= 1.45     ,!Relaxation
coefficient of the SOR method ( 1 <= Relaxation_Coefficient < 2)
                        Number_max_Grid= 7          ,!Number of grid
levels
                        Number_max_Cycle= 9
                        Number_Iteration_FineToCoarseGrid=3   ,!number
of SOR iterations applied on any grid level during the restriction step
(before the coarsest grid computation)
                       Number_Iteration_CoarseToFineGrid= 15   ,!number
of SOR iterations applied on any grid level during the prolongation
step (after the Coarsest grid computation)
                      Number_Iteration_CoarsestGrid= 30   ,!number of
SOR iterations applied on the coarsest grid
                      ResidualNormalisation_Enabled= .true.,
                      ConvergenceStrengthening_Enabled= .true. ,
                      Convergence_Criterion= 1.D-04
/!convergence tolerance on the residu of the Poisson's equation

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
                   SIMULATION MANAGEMENT
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++
The numerical time step is dynamic and is estimated by the constant CFL
coefficient

&Simulation_Management    Restart_Parameter= 0 ,
                          Steady_Flow_Stopping_Criterion_Enabled =
.true. , Steady_Flow_Stopping_Criterion = 1.D-16,
                          Temporal_Iterations_Number = 4000000
, Final_Time = 4.00D-00  ,
                          TimeStep_Type     = 0 ,
                          TimeStep_Max      =  1.0D-05,
```

```
                          CFL_Max      = 0.3 ,
                          Simulation_Backup_Rate                  = 1000
, Simulation_Checking_Rate = 101 /
================================================================================
======
                    PROBES MANAGEMENT
================================================================================
=======

&Simulation_Management    Probe_Recording_Rate = 100     /

&Probe_Quantities_Enabled  Temporal_Series_For_Quantity_Enabled(:)=
.true. , .true., .false., .false., .false., .false. /

&Probe_Location  Xi=-0.011 , Xj= 0.007 , Xk= 0.0 /

================================================================================
======
           FIELDS RECORDING DECLARATION
================================================================================
======

!------------------------------
!--- Instantaneous fields
!------------------------------

&Field_Recording_Setup    Precision_On_Instantaneous_Fields= 1 /
&Simulation_Management    InstantaneousFields_TimeRecordingRate =
1.0D-03 InstantaneousFields_RecordingStartTime=0.0  /

&Instantaneous_Fields_Listing  Name_of_Field = "U     "  /      First
velocity component
&Instantaneous_Fields_Listing  Name_of_Field = "V     "  /      Second
velocity component
&Instantaneous_Fields_Listing  Name_of_Field = "P     "  /
&Instantaneous_Fields_Listing  Name_of_Field = "T     "  /
&Instantaneous_Fields_Listing  Name_of_Field = "TRACE "  /
&Instantaneous_Fields_Listing  Name_of_Field = "RHO   "  /
!Instantaneous_Fields_Listing  Name_of_Field = "divU  "  /
!Instantaneous_Fields_Listing  Name_of_Field = "divRU "  /
!Instantaneous_Fields_Listing  Name_of_Field = "PHI   "  /
!Instantaneous_Fields_Listing  Name_of_Field = "drho  "  /
!Instantaneous_Fields_Listing  Name_of_Field = "SRC_P "  /

!------------------------------
!--- Statistic fields
!------------------------------

&Simulation_Management    Start_Time_For_Statistics= 2.D-01
, Time_Range_Statistic_Calculation = 3.8D-01  /
```

```
&Statistical_Fields_Listing  Name_of_Field = "<U>   "  /
&Statistical_Fields_Listing  Name_of_Field = "<V>   "  /
&Statistical_Fields_Listing  Name_of_Field = "<T>   "  /
&Statistical_Fields_Listing  Name_of_Field = "<P>   "  /
&Statistical_Fields_Listing  Name_of_Field = "<Rho> "  /

!------------------------------
!--- Time series
!------------------------------
&Time_Series_Data Title= "MassFlowBalance" , Filename= "check_mass.dat"
, iter_rec= 10 ,
                  Time_Start_Mean_Calculation= 40.
,Range_Mean_Calculation= 80.
                  Restart_Enabled= .false. /

&Time_Series_Data Title= "VolumeFlowBalance" , Filename=
"check_vol.dat" , iter_rec= 10 ,
                  Time_Start_Mean_Calculation= 40.
,Range_Mean_Calculation= 80.
                  Restart_Enabled= .false. /

&Time_Series_Data Title= "LMN_Data" , Filename= "check_lmndata.dat" ,
iter_rec= 10 ,
                  Time_Start_Mean_Calculation= 40.
,Range_Mean_Calculation= 80.
                  Restart_Enabled= .false. /

&Time_Series_Data Title= "KE_Average" , Filename=
"check_kin_energy.dat" , iter_rec= 10 ,
                  Time_Start_Mean_Calculation= 40.
,Range_Mean_Calculation= 80.
                  Restart_Enabled= .false. /
```

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