Namelist "Fluid_Properties"

Most of data are initialized with a default value that could be used by the code if this data is not set to the user's value.
Data are used or not depending on the context. For this reason, useless data could be omitted in the data set.
The user must therefore ensure that useful data are explicitly stated unless he is sure that the default value is correct (if there is any doubt, you can check the file named “check_namelist_data.dat”).
Some examples are given here for helping the user about this namelist.

Full data set of the Namelist

The values are arbitrary chosen.

```
 &Fluid_Properties  Variable_Density             = .true. ,
                   Incomp_Multifluids            = .false.    ,
                   Constant_Mass_Flow            = .false. ,
                   MultiSpecies_Flow             = .true. ,
                   Heat_Transfer_Flow            = .false.   ,
                    Heat_Capacity_Ratio          = 1.4   ,
                   Reference_Dynamic_Viscosity   = 1.84D-05 ,
                   Reference_Dynamic_Viscosity_2= 1.84D-05 ,
                   Reference_Density             = 1.2058789 ,
                   Reference_Density_2           = 0.4 ,
                   Surface_Tension_Coefficient   = 0.0 ,
                   Prandtl                       = 0.71 ,
                   Reference_Temperature         = 293.0     ,
                   Molecular_Mass                = 2.9D-02            ,
                   Thermal_Expansion_Coefficient= 0.0
                   Reference_Heat_Capacity       = 1000.00   ,
                   Sutherland_Law_Enabled                              =
.false.   ,
                   Multi_Species_Mixture_Law_for_Viscosity_Enabled          =
.false. ,
                   Multi_Species_Mixture_Law_for_Thermal_Conductivity_Enabled=
.false. ,
                   Multi_Species_Mixture_Law_for_Mass_Diffusion_Enabled      =
.false.  ,
                   Soret_Effect_Enabled                                =
.false. ,
                   Axisymmetric_Case_3D_Enabled                        =
.false. /
```

The reference values of physical quantities are used in different ways :

- For incompressible flows with heat transfer, the “Reference_Temperature” is used to define the reference temperature implied in the buoyancy force (see the

namelist "Gravity".
- If the incompressible fluid is a gas, the “Reference_Temperature” can be also used by the code in order to calculate automatically the thermal expansion coefficient (**for that, the user must set the variable “Thermal_Expansion_Coefficient” to zero**).
- For incompressible two-phase flows, the “Reference_Density” and the “Reference_Density_2” are used in order to initialize the density field. This field must be explicitly defined by an user's function in the module “module_user_define_init_fields.f90”. The dynamic viscosity field is automatically initialized from the data “Reference_Density” and “Reference_Density_2”.
- For low Mach number flows, the reference pressure value is calculated from the “Reference_Density”, the “Reference_Temperature” and the “Molecular_Mass” by using the equation of state of perfect gas.
This pressure, that is uniform over the domain, is thus used for initializing the density field, knowing the temperature field (defined with the namelist "Temperature_Initialization") and the species mass fraction fields (defined with the namelist "Species_Initialization") in the particular case of multi-species flows.
- For low Mach number flows or incompressible two-phase flows, the “Reference_Density” is also implied in the gravity/buoyancy force (see the namelist "Gravity".
- The “Reference_Dynamic_Viscosity” must be in accordance with the “Reference_Temperature” when the viscosity depends on the temperature (Sutherland's law).

Find here some examples

Definition of the data set

Variable_Density

- type : Boolean value
  - true : low mach number hypothesis (**Not for the release SUNFLUIDH_EDU**)
  - false : incompressible flow
- Default value = .false.

Incomp_MultiFluids

- type : Boolean value (**Not for the release SUNFLUIDH_EDU**)
  - true : incompressible two-fluid flow (only whether Variable_Density=true).
  - false : single phase flow
- Default value = .false.

Constant_Mass_Flow

- type = Boolean value
  - true : mass conservation
  - false : mass variation possible
- Default value = .true.

Constant_Pressure_Flow

- type = Boolean value
- true : Thermodynamical pressure is imposed and constant
- Default value = .false.

Variable_Fluid_Volume

- type = Boolean value
  - true : The volume of fluid can vary in time
- Default value = .false.

MultiSpecies_Flow

- type = boolean value
- true : heterogeneous gas mixture (**Not for the release SUNFLUIDH_EDU**)
- false : homogeneous gas mixture
- Default value = .false.

Heat_Transfer_Flow

- type = boolean value
  - true : flows with heat transfer
  - false : isothermal flows
- Default value = .false.

Reference_Temperature

- type = real value
- Reference value of the temperature
- Default value= 300.0

Reference_Density

- type = real value
- reference value of the density
- Default value = 1.0

Reference_Density_2

- type = real value (**Not for the release SUNFLUIDH_EDU**)
- reference value of the 2nd fluid density for incompressible two-fluid flows (used with Incomp_MultiFluids= .true.)
- Default value= 1.0

Reference_Dynamic_Viscosity

- type = real value
- Reference value of the dynamic viscosity (used if the viscosity is independent of the mixture components)
- Default value = 1.84D-05

Reference_Dynamic_Viscosity_2

- type = real value (**Not for the release SUNFLUIDH_EDU**)
- Reference value for the 2nd dynamic viscosity of incompressible two-fluid flows (used with Incomp_MultiFluids= .true.)
- Default value= 1.84D-05

Surface_Tension_Coefficient

- type = real value (**Not for the release SUNFLUIDH_EDU**)
- Surface tension coefficient for the simulation of two-fluid flows with capillary effects (used with Incomp_MultiFluids= .true.).
- Default value = 0.0

Prandtl

- type = real value
- Prandtl number (used for calculating the thermal conductivity if it is independant of the mixture components)
- Default value= 0.71

Molecular_Mass

- type = real value
- Reference value of the molecular mass (in kg/mol) of the fluid, this parameter is used if the fluid is a homogeneous gas defined in a low mach number context, without taking into account the mixture components. Equations and physical quantities are defined in a dimensional form.
- Default value= 0.029

Thermal_Expansion_Coefficient

- type = real value
- This data is mainly used for incompressible flows, when the gravity/buoyancy force depends on the temperature variation.
  If this variable is set to zero, it is automatically defined as 1/Reference_Temperature by the code - perfect gas hypothesis).
  For low Mach number or incompressible two-phase flows, the gravity/buoyancy force depends on the density variation, this variable can thus be omitted.
  See the namelist "Gravity" to understand how this variable is implemented in the gravity/buoyancy force.
- Default value = 1.0.

Reference_Heat_Capacity

- type = real value
- Reference value of the mass heat capacity of the fluid.
  This value is only used if the fluid is incompressible. Otherwise, it is calculated from the formulation for a perfect gas :
  Cp= (R/Molecular_Mass)*(Heat_Capacity_Ratio/(Heat_Capacity_Ratio - 1)
  where R is the perfect gas constant of perfect gas.

Sutherland_Law_Enabled

- type : boolean value
- true : The Sutherland 's law is used to calculate the viscosity and the thermal conductivity in respect with the temperature only. Mixture components are not considered)
- false : The Sutherland's law is not activated
- Default value = .false.

Multi_Species_Mixture_Law_for_Viscosity_Enabled

- type : boolean value (**Not for the release SUNFLUIDH_EDU**)
- true : The dynamic viscosity is defined from the mixture components and temperature (from the kinetic gas theory)
- false : The dynamic viscosity is defined from the Sutherland's law or is constant
- Default value = .false.

Multi_Species_Mixture_Law_for_Thermal_Conductivity_Enabled

- type : boolean value (**Not for the release SUNFLUIDH_EDU**)
- true : The thermal conductivity is defined from the mixture components and temperature (from the kinetic gas theory)
- false : The thermal conductivity is defined from the Sutherland's law or is constant
- Default value = .false.

Multi_Species_Mixture_Law_for_Mass_Diffusion_Enabled

- type : boolean value (**Not for the release SUNFLUIDH_EDU**)
- true : The species diffusion coefficients are defined from the mixture components and temperature (from the kinetic gas theory)
- false : The species diffusion coefficients are calculated from the Schmidt number
- Default value = .false.

Soret_Effect_Enabled

- type : boolean value (**Not for the release SUNFLUIDH_EDU**)
- the Soret mass diffusion is considered (flow with multi-components gas and temperature gradients)
- Default value = .false.

Axisymmetric_Case_3D_Enabled

- type : boolean value
- true : the third velocity component is taken in to account for a 2D axisymmetric problem (You must set Geometric_Layout = 2)
- false: the third velocity component is not taken in to account for a 2D axisymmetric problem
- Default value = .false.