

Using a Passive Scalar for Residence Time

You can use the *Passive Scalar* model to simulate residence time (the mean age of air) for a single phase.

Consider a chamber with air flowing in at one opening and flowing out at another, modeled as a steady-state Eulerian flow. A passive scalar is defined on the air, increasing steadily over time in value. In effect, defining the passive scalar attaches a clock to each volume element of air. These virtual clocks can be used to measure the residence time of the air in different parts of the chamber.

Example procedure:

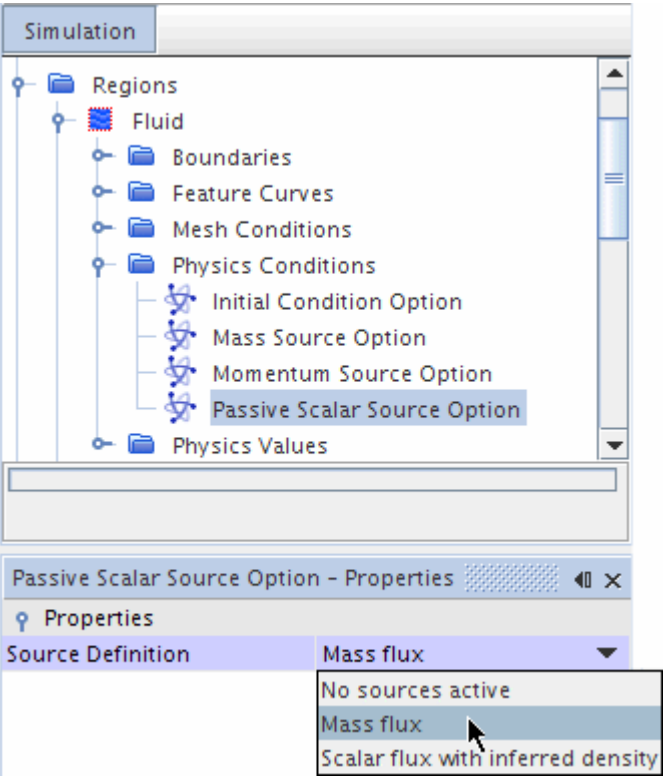
- 1. Set up all your necessary models, boundary conditions, and initial conditions.
- 2. Activate the **Passive Scalar** model.
- 3. Create a passive scalar and rename it **ResidenceTimeAir**.
- 4. For all wall boundaries, set the *Physics Conditions* > **Wall Passive Scalar** option to **Zero Flux**.
- 5. Create a field function and rename it **ResidenceTimeAirSource**.
- 6. In the definition of the field function, supply this syntax:

```
($ResidenceTimeAir >1000)?0:$Density
```

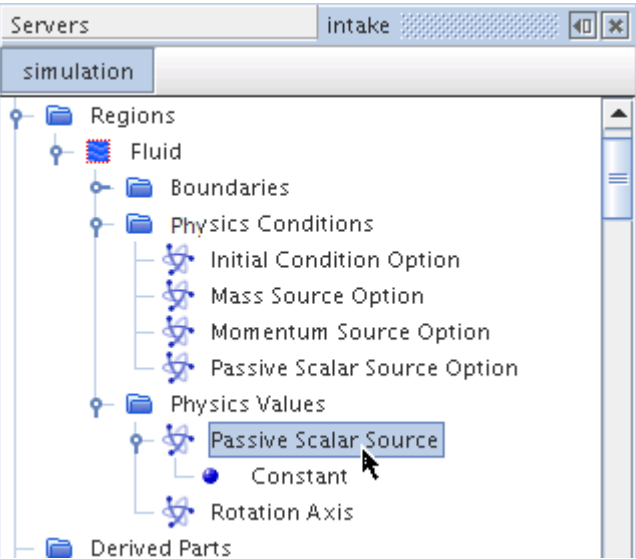
The value of 1000 represents a maximum time, which is necessary if the flow field has a vortex or recirculation. Otherwise, time would grow to infinity.

The \$Density value is present to scale the source term in the passive scalar transport equation.

- 7. Select the **Regions** > (and then)**Fluid** > (and then)**Physics Conditions** > (and then)**Passive Scalar Source Option** node and select **Mass flux** for **Source Definition**. (See [Passive Scalar Properties](#).)

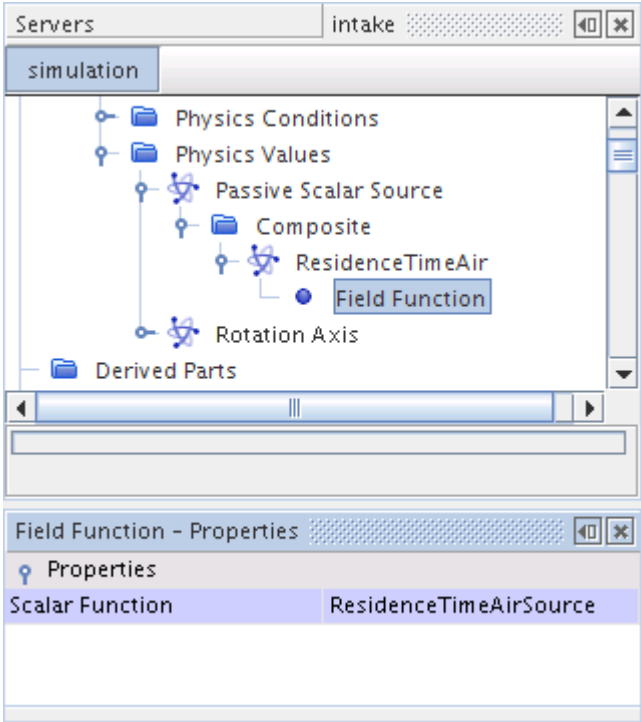


- 8. Open the **Regions** > (and then)**[Region]** > (and then)**Physics Values** node and select the **Passive Scalar Source** node.



- 9. In the **Method** property, select **Composite**.
- 10. Open the **Composite** node and select the **ResidenceTimeAir** node.
- 11. In the **Method** property of the **ResidenceTimeAir** node, select **Field Function**.

12. Select the **Field Function** node and set its *Scalar Function* property to ***ResidenceTimeAirSource***, which is the field function that you defined.



13. Create a scalar scene to display ***ResidenceTimeAir***.

The simulation is ready to run.

A similar approach can be used for unsteady simulations.