

# **Mass-Conservation Tests**

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# 1 PorousFlowFluidMass postprocessor

## 1.1 Single-phase, single-component

The total fluid mass of species  $sp$  within a volume  $V$  is

$$\int_V \phi \sum_{ph} \rho_{ph} S_{ph} \chi_{ph}^{sp} . \quad (1.1)$$

It must be checked that MOOSE calculates this correctly in order that mass-balances be correct, and also because this quantity is used in a number of other tests

A 1D model with  $-1 \leq x \leq 1$ , and with three elements of size 1 is created with the following properties:

Constant fluid bulk modulus	1 Pa
Fluid density at zero pressure	1 kg.m <sup>-3</sup>
Van Genuchten $m$	0.5
Van Genuchten $\alpha$	1 Pa <sup>-1</sup>
Porosity	0.1

The porepressure is set at  $P = x$ .

Recall that in PorousFlow, mass is lumped to the nodes. Therefore, the integral above is evaluated at the nodes, and a sum of the results is outputted as the PorousFlowFluidMass postprocessor. Using the properties given above, this yields:

$x$	$p$	Density	Saturation	Nodal mass
-1	-1	0.367879441	0.707106781	0.008671002
-0.333333333	-0.333333333	0.716531311	0.948683298	0.02265871
-0.333333333	-0.333333333	0.716531311	0.948683298	0.02265871
0.333333333	0.333333333	1.395612425	1	0.046520414
0.333333333	0.333333333	1.395612425	1	0.046520414
1	1	2.718281828	1	0.090609394
Total				0.237638643

MOOSE also gives the total mass as 0.237638643 kg. This test is part of the automatic test suite that is run every time the code is updated.

## 1.2 Single-phase, two-components

The same test as Section 1.1 is run but with two components. The mass fraction is fixed at

$$\chi_{\text{ph}=0}^{\text{sp}=0} = x^2 . \quad (1.2)$$

$x$	$p$	Density	Saturation	$\chi_{\text{ph}=0}^{\text{sp}=0}$	Nodal mass <sub>sp=0</sub>	Nodal mass <sub>sp=1</sub>
-1	-1	0.367879441	0.707106781	1	0.008671	0
-0.333333333	-0.333333333	0.716531311	0.948683298	0.111111	0.00251763	0.02014108
-0.333333333	-0.333333333	0.716531311	0.948683298	0.111111	0.00251763	0.02014108
0.333333333	0.333333333	1.395612425	1	0.111111	0.00516893	0.04135148
0.333333333	0.333333333	1.395612425	1	0.111111	0.00516893	0.04135148
1	1	2.718281828	1	1	0.09060939	0
				Total	0.11465353	0.12298511

MOOSE produces the expected answer.