

Application of a User-defined Source Term to a Scalar Transport Equation

This technical data sheet documents the definition and implementation of a generic, volumetric source term in a scalar transport equation of the STORM flow solver. It relates the nomenclature used in the software to that of Patankar-1980, and states the acceptable ranges for the components of the source term. These restrictions are due to the definition of the source term and the nature of the algorithm being used to implement it.

Definition and Nomenclature of a Volumetric Source

The general transport equation for a scalar, ϕ is given by:

$$\frac{\partial \rho \phi}{\partial t} + \frac{\partial (\rho u_i \phi)}{\partial x_i} = \frac{\partial}{\partial x_i} \left[\Gamma_\phi \frac{\partial \phi}{\partial x_i} \right] + S_\phi$$

Where S_ϕ is a volumetric source term. The STORM solver assumes that this generic source term is of the form,

$$S_\phi = COEF * (VALUE - \phi) \quad (1)$$

In the nomenclature followed by Patankar, volumetric sources are expressed as,

$$S_\phi = S_c + S_p \phi \quad S_p < 0 \quad (2)$$

From Equations (1) and (2), the nomenclature is related to Patankar's as follows:

$$S_p = -COEF \quad S_p < 0 \quad (3)$$

$$S_c = COEF * VALUE \quad S_p < 0 \quad (4)$$

From Equation (1), to introduce a constant volumetric source term S_ϕ , the value for COEF should be set to a very small value (say 1e-30, but NOT zero), and set VALUE to $S_\phi / COEF$.

It should be noted that whenever there is a source term in the simulation, COEF should not be zero.