SfePy Documentation

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Contents

1 List of all terms

d_div	$\int_{\Omega} \bar{p}\ \nabla \cdot \underline{w}$
d_surface_dot	$\int_{\Gamma} pr$, $\int_{\Gamma} \underline{u} \cdot \underline{w}$
d_surface_integrate	$\int_{\Gamma} y$, for vectors: $\int_{\Gamma} \underline{y} \cdot \underline{n}$
d_volume	$\int_{\Omega} 1$
d_volume_dot	$\int_{\Omega} pr$, $\int_{\Omega} \underline{u} \cdot \underline{w}$
d_volume_integrate	$\int_{\Omega} y$
d_volume_wdot	$\int_{\Omega} ypr$, $\int_{\Omega} y\underline{u} \cdot \underline{w}$
de_sdcc_strain	vector of $\forall K \in \mathcal{T}_h : \int_{T_K} \underline{\underline{e}}(\underline{w})$
di_volume_integrate_mat	$\int_{\Omega} m$
dq_grad	$(\nabla p)\|_{qp}$
dq_lin_convect	$((\underline{b} \cdot \nabla)\underline{u})\|_{qp}$
dw_convect	$\int_{\Omega} ((\underline{u} \cdot \nabla)\underline{u}) \cdot \underline{v}$
dw_div	$\int_{\Omega} q\ \nabla \cdot \underline{u}$
dw_div_grad	$\int_{\Omega} \nu\ \nabla \underline{v} : \nabla \underline{u}$
dw_div_r	$\int_{\Omega} q\ \nabla \cdot \underline{w}$
dw_grad	$\int_{\Omega} p\ \nabla \cdot \underline{v}$
dw_gradDt	$\int_{\Omega} \frac{p-p_0}{\Delta t} \nabla \cdot \underline{v}$
dw_laplace	$c \int_{\Omega} \nabla s : \nabla r$
dw_lin_convect	$\int_{\Omega} ((\underline{b} \cdot \nabla)\underline{u}) \cdot \underline{v}$
dw_mass	$\int_{\Omega} \rho \underline{v} \cdot \frac{\underline{u}-\underline{u}_0}{\Delta t}$
dw_mass_scalar	$\int_{\Omega} qp$
dw_mass_scalar_fine_coarse	$\int_{\Omega} q_h p_H$
dw_mass_scalar_r	$\int_{\Omega} qr$
dw_mass_scalar_variable	$\int_{\Omega} cqp$
dw_mass_vector	$\int_{\Omega} \rho\ \underline{v} \cdot \underline{u}$
dw_point_lspring	$\underline{f}^i = -k\underline{u}^i \quad \forall$ FE node i in region
dw_sdcc	$\int_{\Omega} D_{ijkl}\ e_{ij}(\underline{v}) e_{kl}(\underline{u})$ with $D_{ijkl} = \mu(\delta_{ik}\delta_{jl} + \delta_{il}\delta_{jk}) + \lambda\ \delta_{ij}\delta_{kl}$
dw_st_grad_div	$\gamma \int_{\Omega} (\nabla \cdot \underline{u}) \cdot (\nabla \cdot \underline{v})$
dw_st_pspg_c	$\sum_{K \in \mathcal{T}_h} \int_{T_K} \tau_K\ ((\underline{b} \cdot \nabla)\underline{u}) \cdot \nabla q$
dw_st_pspg_p	$\sum_{K \in \mathcal{T}_h} \int_{T_K} \tau_K\ \nabla p \cdot \nabla q$
dw_st_supg_c	$\sum_{K \in \mathcal{T}_h} \int_{T_K} \delta_K\ ((\underline{b} \cdot \nabla)\underline{u}) \cdot ((\underline{b} \cdot \nabla)\underline{v})$
dw_st_supg_p	$\sum_{K \in \mathcal{T}_h} \int_{T_K} \delta_K\ \nabla p \cdot ((\underline{b} \cdot \nabla)\underline{v})$
dw_surface_ltr	$\int_{\Gamma} \underline{v} \cdot \underline{\underline{\sigma}} \cdot \underline{n}$, where, depending on dimension of 'material' argument, $\underline{\underline{\sigma}} \cdot \underline{n}$ is $\bar{p}\underline{\underline{I}} \cdot \underline{n}$ for given scalar pressure, $\underline{f}$ for traction vector, and itself for a stress tensor
dw_volume_integrate	$\int_{\Omega} q$
dw_volume_lvf	$\int_{\Omega} \underline{v} \cdot \underline{f}$
dw_volume_wdot	$\int_{\Omega} yqp$, $\int_{\Omega} y\underline{v} \cdot \underline{u}$
dw_volume_wdot_r	$\int_{\Omega} yqr$, $\int_{\Omega} y\underline{v} \cdot \underline{w}$

2 Terms in termsMass

2.1 dw_mass

Class: MassTerm
Description: Inertial forces term (constant density).
Definition:

$$\int_\Omega \rho \underline{v} \cdot \frac{\underline{u} - \underline{u}_0}{\Delta t}$$

Arguments:

material.rho	ρ
ts.dt	Δt
parameter	$\underline{u}_0$

Syntax: `dw_mass.<i>.<r>( <ts>, <material>, <virtual>, <state>, <parameter> )`

2.2 dw_mass_scalar

Class: MassScalarTerm
Description: Scalar field mass matrix/rezidual.
Definition:

$$\int_\Omega q p$$

Syntax: `dw_mass_scalar.<i>.<r>( <virtual>, <state> )`

2.3 dw_mass_scalar_fine_coarse

Class: MassScalarFineCoarseTerm
Description: Scalar field mass matrix/rezidual for coarse to fine grid interpolation. Field p_H belong to the coarse grid, test field q_h to the fine grid.
Definition:

$$\int_\Omega q_h p_H$$

Syntax: `dw_mass_scalar_fine_coarse.<i>.<r>( <virtual>, <state>, <iemaps>, <pbase> )`

2.4 dw_mass_scalar_r

Class: MassScalarRTerm
Description: Scalar field mass rezidual — r is assumed to be known.
Definition:

$$\int_\Omega q r$$

Syntax: `dw_mass_scalar_r.<i>.<r>( <virtual>, <parameter> )`

2.5 dw_mass_vector

Class: MassVectorTerm
Description: Vector field mass matrix/rezidual.
Definition:

$$\int_{\Omega} \rho \, \underline{v} \cdot \underline{u}$$

Syntax: dw_mass_vector.<i>.<r>(<material>, <virtual>, <state>)

3 Terms in termsBasic

3.1 d_surface_dot

Class: DotProductSurfaceTerm
Description: Surface $L^2(\Gamma)$ dot product for both scalar and vector fields.
Definition:

$$\int_{\Gamma} pr , \int_{\Gamma} \underline{u} \cdot \underline{w}$$

Syntax: d_surface_dot.<i>.<r>(<parameter_1>, <parameter_2>)

3.2 d_surface_integrate

Class: IntegrateSurfaceTerm
Definition:

$$\int_{\Gamma} y, \text{ for vectors: } \int_{\Gamma} \underline{y} \cdot \underline{n}$$

Syntax: d_surface_integrate.<i>.<r>(<parameter>)

3.3 d_volume

Class: VolumeTerm
Description: Volume of a domain. Uses approximation of the parameter variable.
Definition:

$$\int_{\Omega} 1$$

Syntax: d_volume.<i>.<r>(<parameter>)

3.4 d_volume_dot

Class: DotProductVolumeTerm
Description: Volume $L^2(\Omega)$ dot product for both scalar and vector fields.
Definition:

$$\int_{\Omega} pr , \int_{\Omega} \underline{u} \cdot \underline{w}$$

Syntax: d_volume_dot.<i>.<r>(<parameter_1>, <parameter_2>)

3.5 d_volume_integrate

Class: IntegrateVolumeTerm
Definition:

$$\int_\Omega y$$

Syntax: `d_volume_integrate.<i>.<r>( <parameter> )`

3.6 d_volume_wdot

Class: WDotProductVolumeTerm
Description: Volume $L^2(\Omega)$ weighted dot product for both scalar and vector fields.
Definition:

$$\int_\Omega ypr \,,\, \int_\Omega y\underline{u} \cdot \underline{w}$$

Arguments:

material	weight function y

Syntax: `d_volume_wdot.<i>.<r>( <material>, <parameter_1>, <parameter_2> )`

3.7 di_volume_integrate_mat

Class: IntegrateVolumeMatTerm
Description: Integrate material parameter m over a domain. Uses approximation of y variable.
Definition:

$$\int_\Omega m$$

Arguments:

material	m (can have up to two dimensions)
parameter	y
shape	shape of material parameter
mode	'const' or 'vertex' or 'element_avg'

Syntax: `di_volume_integrate_mat.<i>.<r>( <material>, <parameter>, <shape>, <mode> )`

3.8 dw_volume_integrate

Class: IntegrateVolumeOperatorTerm
Definition:

$$\int_\Omega q$$

Syntax: `dw_volume_integrate.<i>.<r>( <virtual> )`

3.9 dw_volume_wdot

Class: WDotProductVolumeOperatorTerm
Description: Volume $L^2(\Omega)$ weighted dot product operator for scalar and vector (not implemented!) fields.
Definition:

$$\int_\Omega yqp, \int_\Omega y\underline{v} \cdot \underline{u}$$

Arguments:

material	weight function y

Syntax: `dw_volume_wdot.<i>.<r>( <material>, <virtual>, <state> )`

3.10 dw_volume_wdot_r

Class: WDotProductVolumeOperatorRTerm
Description: Volume $L^2(\Omega)$ weighted dot product operator for scalar and vector (not implemented!) fields (to use on a right-hand side).
Definition:

$$\int_\Omega yqr, \int_\Omega y\underline{v} \cdot \underline{w}$$

Arguments:

material	weight function y

Syntax: `dw_volume_wdot_r.<i>.<r>( <material>, <virtual>, <parameter> )`

4 Terms in termsLaplace

4.1 dw_laplace

Class: LaplaceTerm
Description: Laplace term (constant parameter).
Definition:

$$c \int_\Omega \nabla s : \nabla r$$

Syntax: `dw_laplace.<i>.<r>( <material>, <virtual>, <state> )`

5 Terms in termsNavierStokes

5.1 d_div

Class: DivIntegratedTerm
Description: Integrated divergence term (weak form).
Definition:

$$\int_\Omega \bar{p}\ \nabla \cdot \underline{w}$$

Syntax: `d_div.<i>.<r>( <parameter_1>, <parameter_2> )`

5.2 dq_grad

Class: GradQTerm
Description: Gradient term (weak form) in quadrature points.
Definition:

$$(\nabla p)|_{qp}$$

Syntax: `dq_grad.<i>.<r>( <state> )`

5.3 dq_lin_convect

Class: LinearConvectQTerm
Description: Linearized convective term evaluated in quadrature points.
Definition:

$$((\underline{b} \cdot \nabla)\underline{u})|_{qp}$$

Syntax: `dq_lin_convect.<i>.<r>( <parameter>, <state> )`

5.4 dw_convect

Class: ConvectTerm
Description: Nonlinear convective term.
Definition:

$$\int_{\Omega}((\underline{u} \cdot \nabla)\underline{u}) \cdot \underline{v}$$

Syntax: `dw_convect.<i>.<r>( <virtual>, <state> )`

5.5 dw_div

Class: DivTerm
Description: Divergence term (weak form).
Definition:

$$\int_{\Omega} q \ \nabla \cdot \underline{u}$$

Syntax: `dw_div.<i>.<r>( <virtual>, <state> )`

5.6 dw_div_grad

Class: DivGradTerm
Description: Diffusion term.
Definition:

$$\int_{\Omega} \nu \ \nabla \underline{v} : \nabla \underline{u}$$

Syntax: `dw_div_grad.<i>.<r>( <material>, <virtual>, <state> )`

5.7 dw_div_r

Class: DivRTerm
Description: Divergence term (weak form) with a known field (to use on a right-hand side).
Definition:

$$\int_\Omega q \; \nabla \cdot \underline{w}$$

Syntax: `dw_div_r.<i>.<r>( <virtual>, <parameter> )`

5.8 dw_grad

Class: GradTerm
Description: Gradient term (weak form).
Definition:

$$\int_\Omega p \; \nabla \cdot \underline{v}$$

Syntax: `dw_grad.<i>.<r>( <virtual>, <state> )`

5.9 dw_gradDt

Class: GradDtTerm
Description: Gradient term (weak form) with time-discretized $\dot{p}$.
Definition:

$$\int_\Omega \frac{p - p_0}{\Delta t} \nabla \cdot \underline{v}$$

Arguments:

ts.dt	Δt
parameter	p_0

Syntax: `dw_gradDt.<i>.<r>( <ts>, <virtual>, <state>, <parameter> )`

5.10 dw_lin_convect

Class: LinearConvectTerm
Description: Linearized convective term.
Definition:

$$\int_\Omega ((\underline{b} \cdot \nabla) \underline{u}) \cdot \underline{v}$$

Syntax: `dw_lin_convect.<i>.<r>( <virtual>, <parameter>, <state> )`

5.11 dw_st_grad_div

Class: GradDivStabilizationTerm
Description: Grad-div stabilization term (γ is a global stabilization parameter).
Definition:

$$\gamma \int_{\Omega} (\nabla \cdot \underline{u}) \cdot (\nabla \cdot \underline{v})$$

Syntax: `dw_st_grad_div.<i>.<r>( <material>, <virtual>, <state> )`

5.12 dw_st_pspg_c

Class: PSPGCStabilizationTerm
Description: PSPG stabilization term, convective part (τ is a local stabilization parameter).
Definition:

$$\sum_{K \in \mathcal{T}_h} \int_{T_K} \tau_K \ ((\underline{b} \cdot \nabla) \underline{u}) \cdot \nabla q$$

Syntax: `dw_st_pspg_c.<i>.<r>( <material>, <virtual>, <parameter>, <state> )`

5.13 dw_st_pspg_p

Class: PSPGPStabilizationTerm
Description: PSPG stabilization term, pressure part (τ is a local stabilization parameter), cf. Laplace term.
Definition:

$$\sum_{K \in \mathcal{T}_h} \int_{T_K} \tau_K \ \nabla p \cdot \nabla q$$

Syntax: `dw_st_pspg_p.<i>.<r>( <material>, <virtual>, <state> )`

5.14 dw_st_supg_c

Class: SUPGCStabilizationTerm
Description: SUPG stabilization term, convective part (δ is a local stabilization parameter).
Definition:

$$\sum_{K \in \mathcal{T}_h} \int_{T_K} \delta_K \ ((\underline{b} \cdot \nabla) \underline{u}) \cdot ((\underline{b} \cdot \nabla) \underline{v})$$

Syntax: `dw_st_supg_c.<i>.<r>( <material>, <virtual>, <parameter>, <state> )`

5.15 dw_st_supg_p

Class: SUPGPStabilizationTerm
Description: SUPG stabilization term, pressure part (δ is a local stabilization parameter).
Definition:

$$\sum_{K \in \mathcal{T}_h} \int_{T_K} \delta_K \ \nabla p \cdot ((\underline{b} \cdot \nabla) \underline{v})$$

Syntax: `dw_st_supg_p.<i>.<r>( <material>, <virtual>, <parameter>, <state> )`

6 Terms in termsPoint

6.1 dw_point_lspring

Class: LinearPointSpringTerm
Description: Linear springs constraining movement of FE nodes in a reagion; use as a relaxed Dirichlet boundary conditions.
Definition:

$$\underline{f}^i = -k \underline{u}^i \quad \forall \text{ FE node } i \text{ in region}$$

Syntax: `dw_point_lspring.<i>.<r>( <material>, <virtual>, <state> )`

7 Terms in termsVolume

7.1 dw_volume_lvf

Class: LinearVolumeForceTerm
Description: Linear volume forces (weak form).
Definition:

$$\int_{\Omega} \underline{v} \cdot \underline{f}$$

Syntax: `dw_volume_lvf.<i>.<r>( <material>, <virtual> )`

8 Terms in termsSurface

8.1 dw_surface_ltr

Class: LinearTractionTerm
Description: Linear traction forces (weak form).
Definition:

$\int_{\Gamma} \underline{v} \cdot \underline{\underline{\sigma}} \cdot \underline{n}$, where, depending on dimension of 'material' argument, $\underline{\underline{\sigma}} \cdot \underline{n}$ is $\bar{p} \underline{\underline{I}} \cdot \underline{n}$ for given scalar pressure, $\underline{f}$ for traction vector, and itself for a stress tensor

Syntax: `dw_surface_ltr.<i>.<r>( <material>, <virtual> )`

9 Terms in termsLinElasticity

9.1 de_sdcc_strain

Class: SDCCStrainTerm
Description: Cauchy strain tensor averaged in elements.
Definition: vector of

$$\forall K \in \mathcal{T}_h : \int_{T_K} \underline{\underline{e}}(\underline{w})$$

Syntax: `de_sdcc_strain.<i>.<r>( <parameter> )`

9.2 dw_sdcc

Class: SDCCTerm
Description: Homogeneous isotropic linear elasticity term.
Definition:

$$\int_\Omega D_{ijkl}\ e_{ij}(\underline{v}) e_{kl}(\underline{u}) \text{ with } D_{ijkl} = \mu(\delta_{ik}\delta_{jl} + \delta_{il}\delta_{jk}) + \lambda\ \delta_{ij}\delta_{kl}$$

Syntax: `dw_sdcc.<i>.<r>( <material>, <virtual>, <state> )`

10 Terms in termsSpecial

10.1 dw_mass_scalar_variable

Class: MassScalarVariableTerm
Description: Scalar field mass matrix/rezidual with coefficient c defined in nodes.
Definition:

$$\int_\Omega cqp$$

Syntax: `dw_mass_scalar_variable.<i>.<r>( <material>, <virtual>, <state> )`

11 Term caches in cachesBasic

11.1 cauchy_strain

Class: CauchyStrainDataCache

```
cache = term.getCache( 'cauchy_strain', <index> )
data = cache( <data name>, <ig>, <ih>, state )
```

11.2 div_vector

Class: DivVectorDataCache

```
cache = term.getCache( 'div_vector', <index> )
data = cache( <data name>, <ig>, <ih>, state )
```

11.3 grad_scalar

Class: GradScalarDataCache

```
cache = term.getCache( 'grad_scalar', <index> )
data = cache( <data name>, <ig>, <ih>, state )
```

11.4 mat_in_qp

Class: MatInQPDataCache

```
cache = term.getCache( 'mat_in_qp', <index> )
data = cache( <data name>, <ig>, <ih>, mat, ap, assumedShapes, modeIn )
```

11.5 state_in_surface_qp

Class: StateInSurfaceQPDataCache

```
cache = term.getCache( 'state_in_surface_qp', <index> )
data = cache( <data name>, <ig>, <ih>, state )
```

11.6 state_in_volume_qp

Class: StateInVolumeQPDataCache

```
cache = term.getCache( 'state_in_volume_qp', <index> )
data = cache( <data name>, <ig>, <ih>, state )
```

11.7 volume

Class: VolumeDataCache

```
cache = term.getCache( 'volume', <index> )
data = cache( <data name>, <ig>, <ih>, region, field )
```