AD FALCON API Manual

Void Ratio Affected Constant Permeability Model

Javad Ghorbani

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1 Void Ratio Affected Constant Permeability Model

1.1 Syntax

```
@Perm: VoidRatioAffectedConstant k_sat <k_sat> [e_ref <e_ref>]
```

This model extends the constant permeability approach by incorporating the effect of the void ratio. The reference intrinsic permeability, k_{sat}^{ref}, is adjusted by a void-ratio correction factor that depends on the current void ratio e relative to a reference void ratio e_{ref}.

$$k_c = \frac{e^3(1 + e_{ref})^2}{e_{ref}^3(1 + e)^2} \tag{1}$$

Key points:

- This model is **independent of saturation**: the multiplier is based on void ratio only.
- The correction factor k_c is a **multiplier** on the reference permeability and can be greater than 1 if the void ratio increases relative to e_{ref}.
- The correction is applied only when both $e_{ref} > 0$ and $e > 0$. Otherwise, the model falls back to the constant-water form $k_{rw} = 1$.

1.2 Water permeability multiplier

The water multiplier is:

$$k_{rw} = \max\{k_c,\ k_{min}\} \tag{2}$$

where k_{min} is a small **lower bound on the multiplier** used to avoid numerically-zero conductivities.

1.3 Gas permeability multiplier

For this specific model, the gas multiplier is defined as zero:

$$k_{rg} = 0.0 \tag{3}$$

This means the model is intended for cases where gas flow is not part of the physics (e.g. saturated or two-phase formulations without an explicit gas phase). If you need a nonzero gas permeability in fully coupled unsaturated analyses, use a saturation-dependent permeability model that defines $k_{rg}(S_e)$ (and may optionally apply the same void-ratio scaling).

Equation (1) uses the familiar Kozeny-Carman void-ratio dependence for permeability scaling, expressed here as a dimensionless multiplier relative to the reference state.

1.4 References

- Carman, P. C. (1937). *Fluid flow through granular beds*. Transactions of the Institution of Chemical Engineers, 15, 150-166.