



AD FALCON API Manual

Van Genuchten Permeability Model

Javad Ghorbani

March 26, 2026

Contents

1 Van Genuchten Permeability Model 3

1.1 Syntax 3

1.2 References 3



1 Van Genuchten Permeability Model

1.1 Syntax

```
@Perm: VanGenuchten m <m> k_sat <k_sat> [e_ref <e_ref>]
@Perm: VanGenuchtenKe m <m> k_sat <k_sat> [ke_ref <e_ref>] [k_min <k_min>]
```

The Van Genuchten permeability model uses a more complex relationship to capture the nonlinear variation of relative permeability with effective saturation, S_e . The relative permeability for water is given by:

$$k_{rw} = \sqrt{S_e} \left[1 - \left(1 - S_e^{1/m} \right)^m \right]^2 \quad (1)$$

and for gas by:

$$k_{rg} = (1 - S_e)^{1/3} \left[1 - \left(1 - S_e^{1/m} \right)^{2m} \right] \quad (2)$$

To account for the effects of void ratio, a correction factor is applied. This factor is computed as:

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

Therefore, the effective relative permeabilities become:

$$k_{rw}^{eff} = \max\{k_{rw} \times k_c, k_{min}\} \quad (4)$$

$$k_{rg}^{eff} = \max\{k_{rg} \times k_c, k_{min}\} \quad (5)$$

Equations (1)-(2) correspond to the Mualem-van Genuchten relative-permeability model (Mualem, 1976; van Genuchten, 1980). Equation (3) uses a Kozeny-Carman-type void-ratio multiplier.

1.2 References

- Mualem, Y. (1976). *A new model for predicting the hydraulic conductivity of unsaturated porous media*. Water Resources Research, 12(3), 513-522.
- van Genuchten, M. Th. (1980). *A closed-form equation for predicting the hydraulic conductivity of unsaturated soils*. Soil Science Society of America Journal, 44(5), 892-898. <https://doi.org/10.2136/sssaj1980.03615995004400050002x>
- Carman, P. C. (1937). *Fluid flow through granular beds*. Transactions of the Institution of Chemical Engineers, 15, 150-166.