

Pulse Neutron Neutron Thermal Decay Logging (PNN)

Neutron count in time interval $\tau = [\tau_1, \tau_2]$

Neutron Porosity

$$(1) \quad N_{near}[\tau] = \int_{\tau_1}^{\tau_2} N_{near}(t) dt$$

$$(2) \quad N_{far}[\tau] = \int_{\tau_1}^{\tau_2} N_{far}(t) dt$$

$$(3) \quad N2F = \frac{N_{near}[\tau]}{N_{far}[\tau]}$$

Diffusion Correction

$$(4) \quad \phi_T = N2F[\tau] + \Delta_{\tau}(\phi_N)$$

Neutron Sigma

$$(5) \quad N_{near}(t) = N_{near}(0) \exp(-t \Sigma_{near})$$

$$(6) \quad N_{far}(t) = N_{far}(0) \exp(-t \Sigma_{far})$$

Diffusion Correction

$$(7) \quad \Sigma_{near} = \Sigma_{frm} + \Delta_{near}(\phi)$$

$$(8) \quad \Sigma_{far} = \Sigma_{frm} + \Delta_{far}(\phi)$$

Neutron Saturation

$$(9) \quad \Sigma_{frm} = (1 - \phi) \Sigma_m + \phi (\Sigma_w s_w + \Sigma_o s_o + \Sigma_g s_g)$$

$$(10) \quad \delta \Sigma_{frm} \approx +/- 1.5c.u.$$

$$(11) \quad \Sigma_m = \sum_k \Sigma_k$$

$$(12) \quad \Sigma_o \approx 18 \quad 11 < \Sigma_o < 21$$

$$(13) \quad \Sigma_w = 21 + 0.05 * Sal[ppk]$$

$$(14) \quad \Sigma_g \approx 3$$

$$(15) \quad \Sigma_{sh} \approx 40 \text{ c. u.}$$

$$(16) \quad \Sigma_{ls} \approx 7 \text{ c. u.}$$

In case of two-component sandstone-shale model:

$$(17) \quad \Sigma_m = (1 - V_{sh}) \Sigma_{snd} + V_{sh} \Sigma_{sh}$$

In case of two-component limestone-shale model:

$$(18) \quad \Sigma_m = (1 - V_{sh}) \Sigma_{lms} + V_{sh} \Sigma_{sh}$$

TSCN, TSCF, NPHI, SIGMA

References

SPE162074 – [Memory Pulsed Neutron-Neutron Logging](#)