Neutron Porosity

Part of rock volume containing the hydrogen atoms.

The neutron porosity is usually abbreviated **NPHI** or **PHIN** on log panels and denoted as ϕ_n in equations.

The key measurement is compensated neutron log N_{log} (log name **CNL**) from Compensated Neutron Tool.

The key model parameters are:

N_m	rock matrix CNL
N_{sh}	shale CNL
N_f	pore-saturating fluid CNL
N_{mf}	mud filtrate CNL
$\{N_w,\ N_o,\ N_g\}$	formation water, oil, gas CNL
s_{xo}	a fraction of pore volume invaded by mud filtrate
$\{s_w,\ s_o,\ s_g\}$	original water, oil, gas reservoir saturations $s_w + s_o + s_g = 1$

The values of N_m and N_{sh} are calibrated for each lithofacies individually and can be assessed as vertical axis cut-off on N_{log} cross-plot against the lab core porosity ϕ_{air} and shaliness V_{sh}.

The model also accounts for saturating rock fluids with fluid CNL value N_f.

In overbalance drilling across permeable rocks the saturating fluid is usually mud filtrate.

In underbalance drilling the saturating fluid is identified from resistivity logs.

The **total neutron porosity** ϕ_n equation is:

(1) $$\phi_n = \frac{N_{log} - N_m}{N_f - N_m}$$

The **effective neutron porosity** ϕ_{en} equation is:

(2) $$\phi_{en} = \phi_n - \frac{N_{sh} - N_m}{N_f - N_m} \cdot V_{sh}$$

The fluid density N_f is calculated in-situ using the following equation:

(3) $$N_f = s_{xo} N_{mf} + (1 - s_{xo})(s_w N_w + s_o N_o + s_g N_g)$$

The matrix CNL is calculated from the following equation:

(4) $$N_m = \sum_i V_{m,i} N_{m,i}$$

where

$V_{m,i}$ – volume share of the *i*-th matrix component,

$N_{m,i}$ – density of the *i*-th matrix component,

$\sum_i V_{mi} = 1$.