

DrNuc Examples

DrNuc® is the Nuclear Petrophysical Calculator. It is a scientific app that is used in the oil and mineral mining industries. The app calculates 6 important nuclear parameters used by geologists, log analysts, petrophysicists and scientists in the oil industry to study and evaluate oil reservoirs. The petrophysical parameters are:

- Bulk density (ρ_{b})
- Electron density (ρ_{e})
- Photoelectric factor (PEF)
- Density porosity (DPHI)
- Hydrogen index (HI)
- Neutron capture cross section (σ)

The first 4 parameters are derived from or related to the nuclear litho-density measurement used in oil exploration and in the drilling of new wells. The 5th parameter, HI, is a key factor in interpreting neutron porosity measurements in new wells. And the 6th parameter (σ) is critical for evaluating nuclear logs in producing wells.

There are 6 calculators in the DrNuc app:

1. **Lithology Calculator** – Designed for good for clean limestone, sandstone or dolomite formations with water, oil, gas and/or CO₂.
2. **Clay Calculator** – Designed for sandstone formations with the clays illite, kaolinite and/or smectite.
3. **Mineralogy Calculator** - Designed for examining the petrophysical properties of pure minerals (over 100 in the app's database).
4. **Saline Water Calculator** – Determines the petrophysical properties of saline water as a function of salinity, temperature and pressure.
5. **Weight Percents Calculator** - designed for chemical or elemental assays of rock or fluid samples.
6. **SuperNuc Calculator** - The SuperNuc can do everything that the other calculators can do and more. It's designed for real-life situations where the rock is a complex mixture of minerals and the formation fluids are complex hydrocarbons.

The inputs and outputs have been quite literally smashed onto an iPhone screen. While the interface is atypical for an app, it's been designed to allow the user to enter specific values and to see all of the input parameters at one time. Values are typically typed, vs. using a slider or stepper in many apps, so that precise environmental conditions can be studied. The DrNuc app calculates important values for making important decisions. Bad data is worse than no data.

Important results can be saved by the user and emailed to themselves or to others. No data is stored on the iPhone. The DrNuc app only collects user data if they contact the DrNuc team by email. And you control what you send. The DrNuc app does not harvest any user information, and is suitable for all ages of scientists and future scientists.

The app is green, well the user inputs are green. Finding oil and gas more efficiently will reduce carbon emissions. I use gas in my automobile, heat my house with natural gas, buy food stored in plastic containers, buy everyday items with plastic components, and use other products that contain products obtained from oil. I am not apologetic about my use of oil and gas. The DrNuc app benefits all.

The 6 examples that follow show the power of the DrNuc app.

Example 1: 20 pu Sandstone, Fresh water

This problem can be handled by the Lithology Calculator, the Clay Calculator or the SuperNuc Calculator. Shown is a screen capture from the Lithology Calculator.

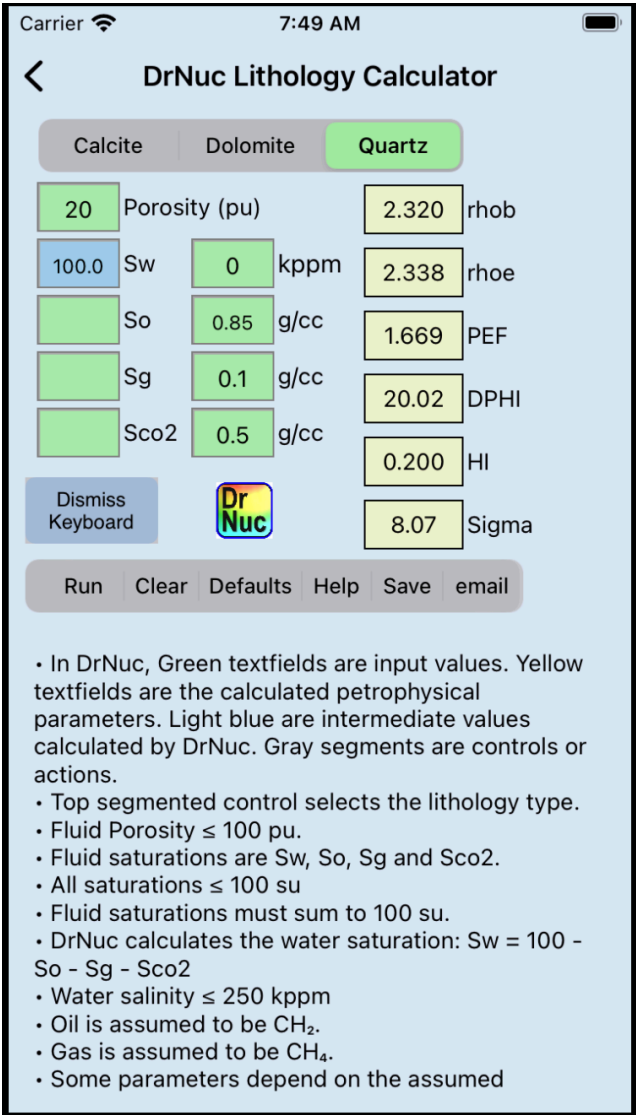
In this case, there are only 4 input values:

- Quartz matrix
- 20 pu porosity
- Sw=100 (water saturation)
- 0 kppm water salinity

Because the water saturation is 100 s.u. (100%), the oil, gas and CO₂ values are not needed.

By selecting the “Quartz” control, the calculator uses 2.65 g/cc SiO₂ in the calculations. The user doesn’t even need to supply that data.

The calculator has a short help guide on the page and a longer help guide on a separate page. The results can be saved and emailed to oneself or others.



Example 2:

25 pu Sandstone with 20% Kaolinite. Pore fluids are 70% saline water with salinity 125 kppm, and 30% oil, composition CH₂ and density of 0.85 g/cc.

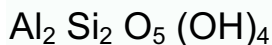
This problem can be handled by the Clay Calculator or the SuperNuc Calculator. Shown is a screen capture from the Clay Calculator.

In this case, there are 8 input values:

- 25 pu porosity
- 70% water saturation
- 125 kppm salinity
- 30% oil (the Clay Calculator assumes CH₂)
- oil density 0.85 g/cc
- matrix density 2.65 g/cc
- 80% SiO₂ (by weight)
- 20% Kaolinite (by weight)

The calculator determines the density of the saline water. The Clay Calculator is based on CH₂ for oil and CH₄ for gas.

The calculator is using the following formula for kaolinite:



If the assumptions used in this calculator don't meet the user's needs, the SuperNuc Calculator can be used because it allows the user to enter any chemical formula for the formation rock and hydrocarbons.

The screenshot shows the DrNuc Clay Calculator app interface. The title is "DrNuc Clay Calculator". The interface displays input and output values for various parameters. Input values are in green textfields, and output values are in yellow textfields. Light blue textfields represent intermediate values. Gray segments represent controls or actions.

Parameter	Value	Color
Porosity (pu)	25	Green
Sw	70.0	Light Blue
So	30	Green
Sg	0.1	Green
matrix density (g/cc)	2.65	Green
SiO ₂ (%)	80.0	Light Blue
Illite (%)		Green
Kaolinite (%)	20	Green
Smectite (%)		Green
rhob	2.242	Yellow
rhoe	2.268	Yellow
PEF	1.606	Yellow
DPHI	24.73	Yellow
HI	0.305	Yellow
Sigma	18.50	Yellow

Controls: Dismiss Keyboard, DrNuc logo, Run, Clear, Defaults, Help, Save, email.

This calculator models a Sandstone formation with 3 common clays. Fluid pore volume can contain water, oil and gas.

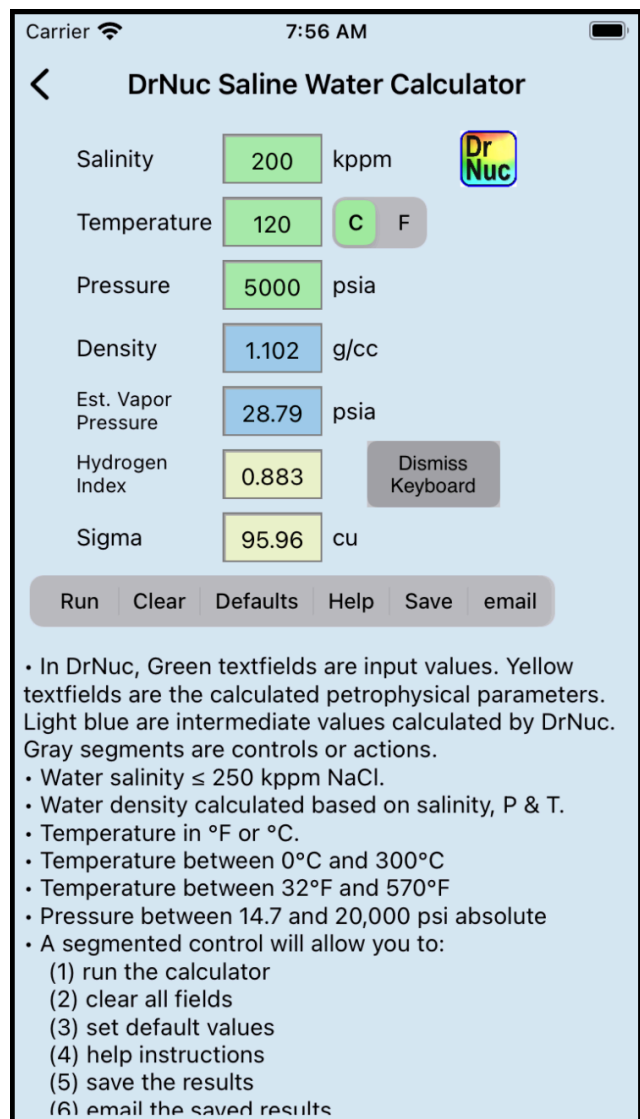
- In DrNuc, Green textfields are input values. Yellow textfields are the calculated petrophysical parameters. Light blue are intermediate values calculated by DrNuc. Gray segments are controls or actions.
- Fluid Porosity ≤ 100 pu
- Fluid saturations are Sw, So and Sg.
- All saturations ≤ 100 su
- Sw + So + Sg must equal 100
- DrNuc calculates the water saturation: Sw = 100 - So - Sg

Example 3. Properties of 200 kppm saline water at 120°C and 5000 psi(a).

This problem can be easily handled by the Saline Water Calculator. In this case, there are only 4 input values needed:

- 200 kppm water salinity
- 120 degrees
- °C temperature scale
- 5000 psia

The calculator first checks to verify that the vapor pressure is below the specified pressure. The calculator then calculates the water density as a function of salinity, temperature and pressure. Finally, it calculates the hydrogen index (HI) and neutron capture cross section (cu).



The screenshot shows the DrNuc Saline Water Calculator app interface. The title bar at the top reads "Carrier" with a signal strength icon, "7:56 AM", and a battery icon. Below the title bar is a back arrow and the app name "DrNuc Saline Water Calculator". The main interface consists of several rows of input and output fields. The input fields are: Salinity (200 kppm), Temperature (120 °C), and Pressure (5000 psia). The output fields are: Density (1.102 g/cc), Est. Vapor Pressure (28.79 psia), Hydrogen Index (0.883), and Sigma (95.96 cu). A "Dismiss Keyboard" button is located to the right of the Hydrogen Index field. At the bottom of the interface is a segmented control with six options: Run, Clear, Defaults, Help, Save, and email. Below the segmented control is a list of instructions for using the app.

- In DrNuc, Green textfields are input values. Yellow textfields are the calculated petrophysical parameters. Light blue are intermediate values calculated by DrNuc. Gray segments are controls or actions.
- Water salinity \leq 250 kppm NaCl.
- Water density calculated based on salinity, P & T.
- Temperature in °F or °C.
- Temperature between 0°C and 300°C
- Temperature between 32°F and 570°F
- Pressure between 14.7 and 20,000 psi absolute
- A segmented control will allow you to:
 - (1) run the calculator
 - (2) clear all fields
 - (3) set default values
 - (4) help instructions
 - (5) save the results
 - (6) email the saved results

Example 4. Properties of the Mineral Siderite.

DrNuc has a library of over 100 common minerals. The petrophysical properties of the minerals can be determined using the Mineralogy Calculator.

In this example, the user clicks the ► icon to open up a list of the minerals in the database. Common ones are listed first, then a complete listing is provided in alphabetical order. Once a mineral has been selected, the petrophysical parameters are computed (as shown).

The screenshot shows the DrNuc Mineralogy Calculator app interface. At the top, the status bar displays 'Carrier', signal strength, and the time '7:55 AM'. The app title is 'DrNuc Mineralogy Calculator'. The main display shows the mineral 'Siderite' in a green textfield, with a right-pointing arrow icon to its right. Below this, a yellow textfield contains '3.960' and is labeled 'mineral density (g/cc)'. To the right of this is the 'Dr Nuc' logo. Below that, a yellow textfield contains 'FeCO3' and is labeled 'chemical formula'. Further down, a list of parameters is shown in yellow textfields: '3.960 rhob', '3.828 rhoe', '14.69 PEF', '0.000 HI', and '52.78 Sigma'. To the right of these is a box titled 'Atomic Composition (atom numbers)' containing the following data: 'Z = 6 C # = 1', 'Z = 8 O # = 3', and 'Z = 26 Fe # = 1'. At the bottom, there is a segmented control with buttons for 'Run', 'Clear', 'Default', 'Help', 'Save', and 'email'. Below the app interface, there are four bullet points providing instructions and details about the app's functionality.

- Green textfield is the Mineral. Yellow textfields are calculated parameters. Gray segments are controls or actions.
- Selecting the Green text field or selecting the ► symbol will open a mineral library.
- Most popular minerals are listed first. Then all of the minerals are listed alphabetically.
- The segmented control will allow you to:
 - (1) run (calculator runs automatically)
 - (2) clear all fields
 - (3) set default mineral (SiO2)
 - (4) help instructions

Example 5. Weight Percents Calculator

This calculator is designed for a chemical assay of a rock sample. It allows for mixing up to 8 elements, chemicals or minerals. The user can use a mineral from the library, or can enter the chemical formula appropriate for their conditions.

The example shown is for 10 pu Sandstone with 250 kppm saline water. Of course, the bulk density and weight percents had to be calculated by hand. The Saline Water Calculator was used to determine the density of 250 kppm saline water. (This case would be even easier to do with the Lithology, Clay or SuperNuc calculators).

More typical uses of this calculator will be entering the elemental weight percents determined from one of the available elemental analysis techniques.

If the assay has more than 8 elements, the calculator can be run twice to obtain the desired parameters.

Carrier 7:58 AM

DrNuc Weight Percents Calculator

2.504 density (g/cc) Dismiss Keyboard Dr Nuc

95.25... (%) SiO2

3.56 (%) H2O

1.186 (%) NaCl

(%)

(%)

(%)

(%)

(%)

2.504 rhob 2.509 rhoe 1.781 PEF

8.85 DPHI 0.089 HI 16.37 Sigma

Run Clear Defaults Help Save email

- This calculator is designed for elemental assays of rock samples.
- In DrNuc, Green textfields are input values. Yellow textfields are the calculated petrophysical parameters. Light blue are intermediate values calculated by DrNuc. Gray segments are controls or actions.
- The matrix is a mix of up to 8 minerals/elements/materials.
- DrNuc will calculate the weight percent of the 1st mineral to achieve 100%.

Example 6. SuperNuc is really super. The calculator will be able to handle just about any case you will encounter.

Formation:

- 18 pu
- 2.67 g/cc
- 80% SiO₂, 10% Kaolinite, 10% Al₂O₃

Fluids:

- 50% water, 100 kppm at 110°C and 4000 psia.
- 40% oil, 0.82 g/cc, CH_{2.1} (downhole properties)
- 10% gas, 0.1 g/cc, CH_{4.2} (downhole properties)

The SuperNuc Calculator allows the user to define the composition of the rock and hydrocarbons. The user can use a mineral from the library, or can enter the chemical formula appropriate for their conditions.

