PETROLEUMSOFT

USER MANUAL

1. System Configuration

- Hard Disk – 500 GB or above
- Processor –i3 or above
- 4 GB RAM or above

2. Software Requirements

MS Office 2007 & above

3. Matrix Acid Stimulation

PetroleumSoft's Reaction model module predicts the Acid Placement, Acid Penetration, Improvement in Skin and Production Profile after acid stimulation. The model also shows the impact of Diverter Viscosity, Pump Rate, Acid Volume, Acid Concentration and Diverter fluid used. The reaction model helps in successful stimulation planning and the diagnosis of matrix-acid treatments to achieve effective acid coverage in each zone.

4. Graphical User Interface

The graphical user interface of the stimulation input section has mainly five popup windows where the user has to put the relevant data with the proper unit selection. The names of these are User id and Password, Homepage, Project Information, First Input screen for data inputs and Output Screen for Graph Analysis.

5. Home Page

Go to www.stimulationhub.com/stimopti

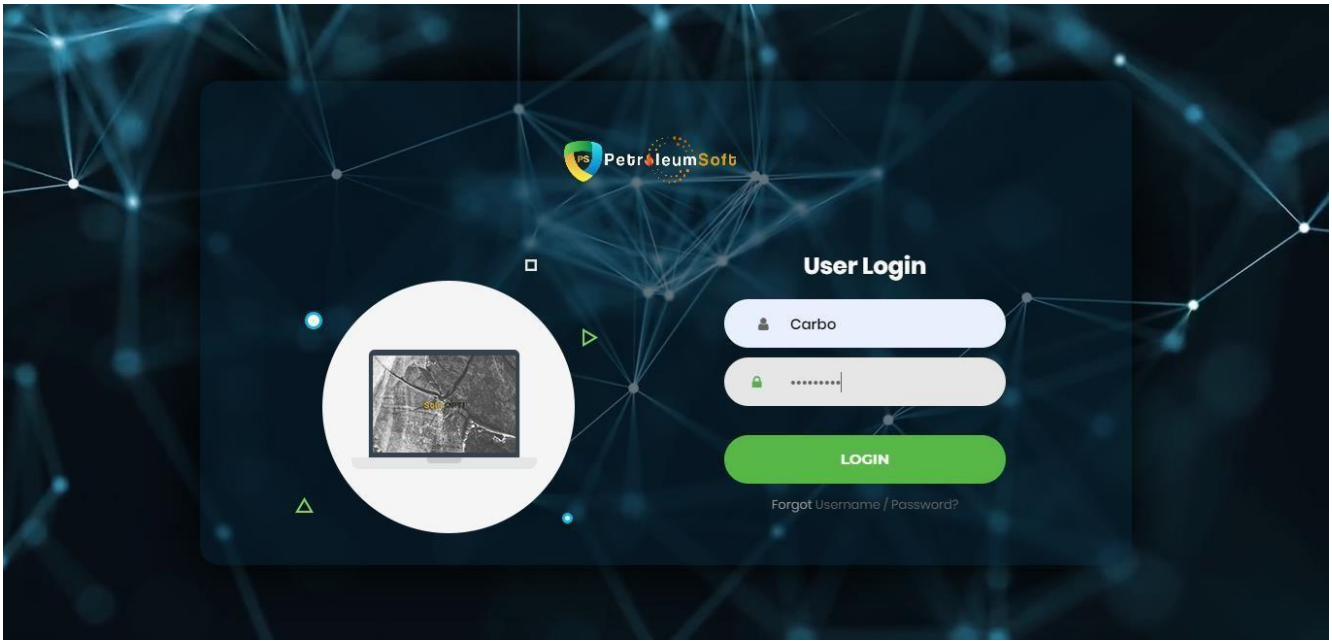
On opening the website, you will see the Home Page of website. On the bottom of the webpage, you will find "**Click Here to Begin**" button.

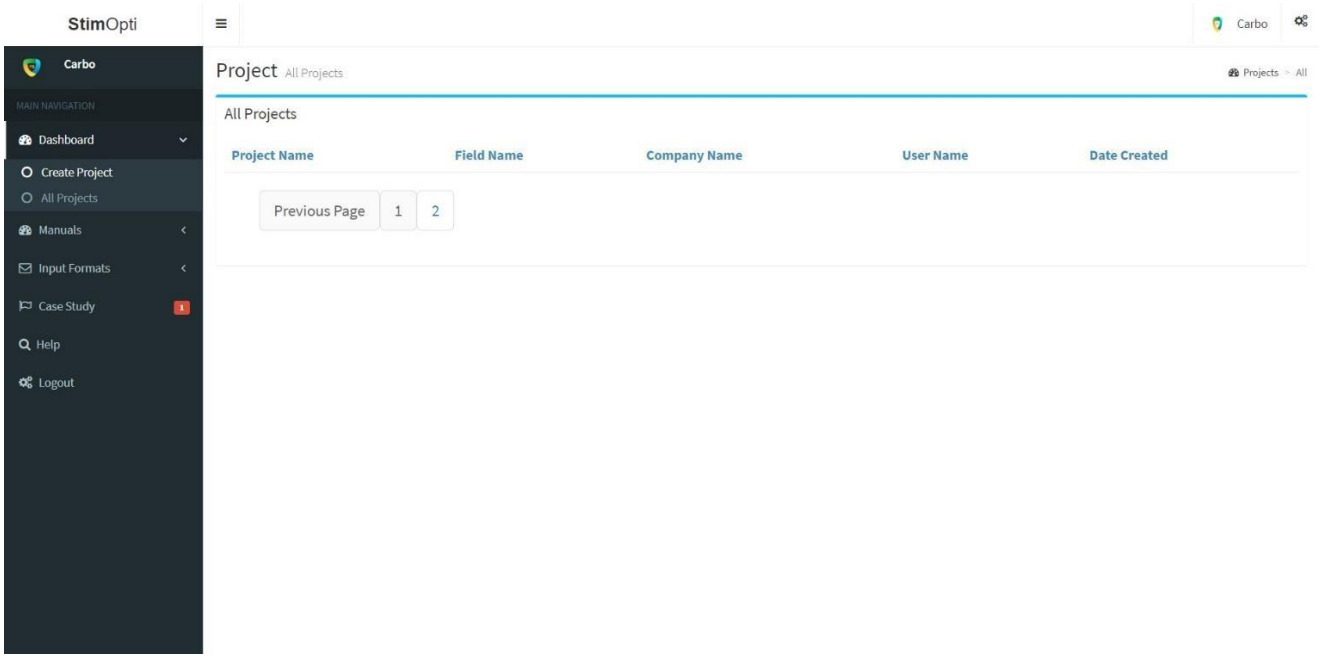
6. Login Page

Username and Password Window

On clicking that Login button, you will arrive at the Login page. The user will have to enter the Username and Password provided by PetroleumSoft.

Press the "**LOGIN**" button after entering the details.



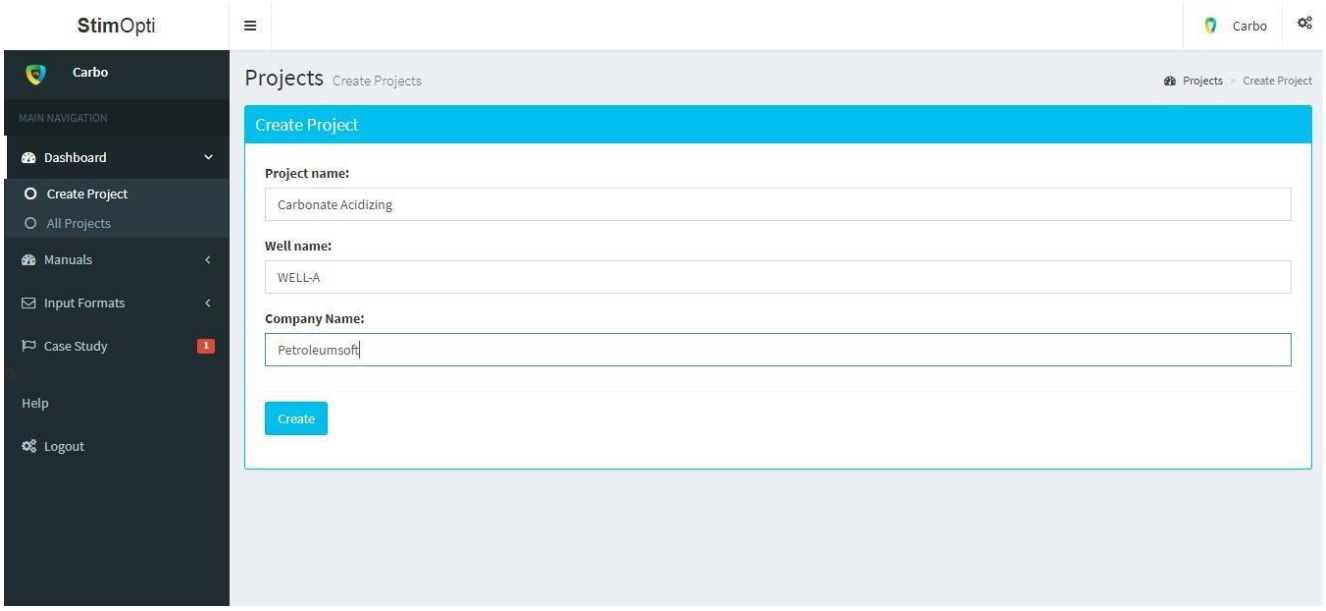


7. Create New Project

To create a new project,

- Click on **Create Project** option on Menu list on Left side of the screen
- Enter the Project name, Well name and Company name.
- Click on the **Create** button.

The user can view all the previously created projects in their Login, by clicking on **All Projects** Button.

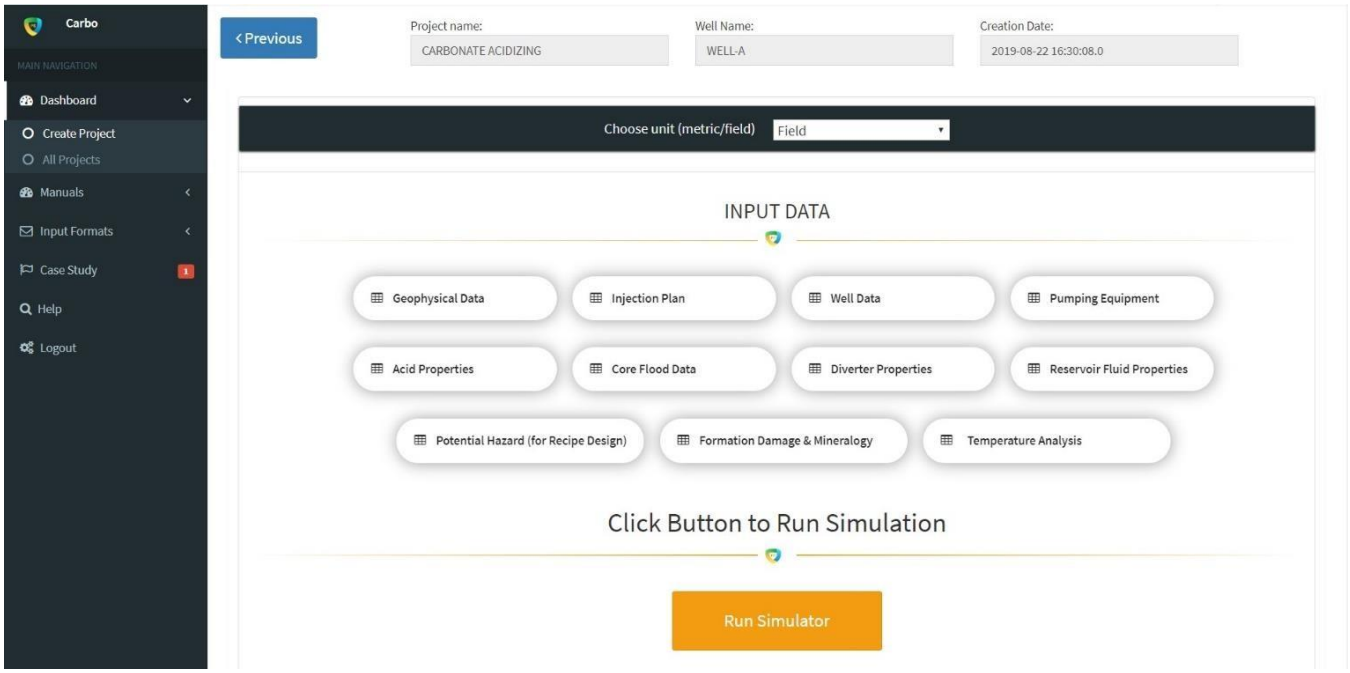


8. Input Data Page

After Clicking on the create button, a new window will open called as First Input Option Screen which contains 11 Input Options required to make the model for the simulation and each of the options are explained later.

Before data input in the module,

- Select the desired unit among metric or field from **Choose Unit (Metric/Field)** drop down option.

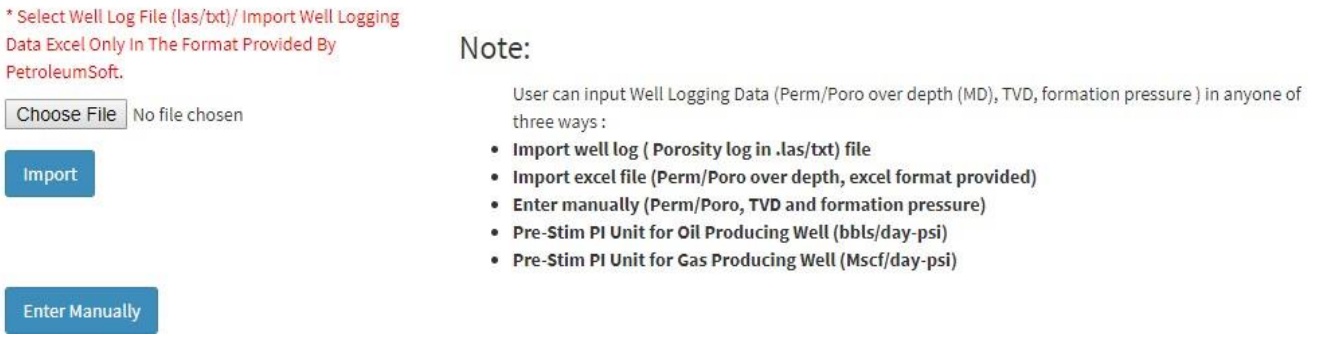


*Note: There is facility of importing the LAS file/ Excel File for **Geophysical Data and Injection Plan** table which is given to the user for easy import of the large field Data. Otherwise the user can input the data manually also.

9. Geophysical Data Input

9.1. Import LAS file/ Excel File or Manually

The Input LAS/Excel file consists of a table of Geophysical Data. Each input table is discussed below in detail. User can also insert Geophysical Data manually after clicking "Enter Manually" button.



9.2. LAS File/ Excel File Import of Geophysical Well Data

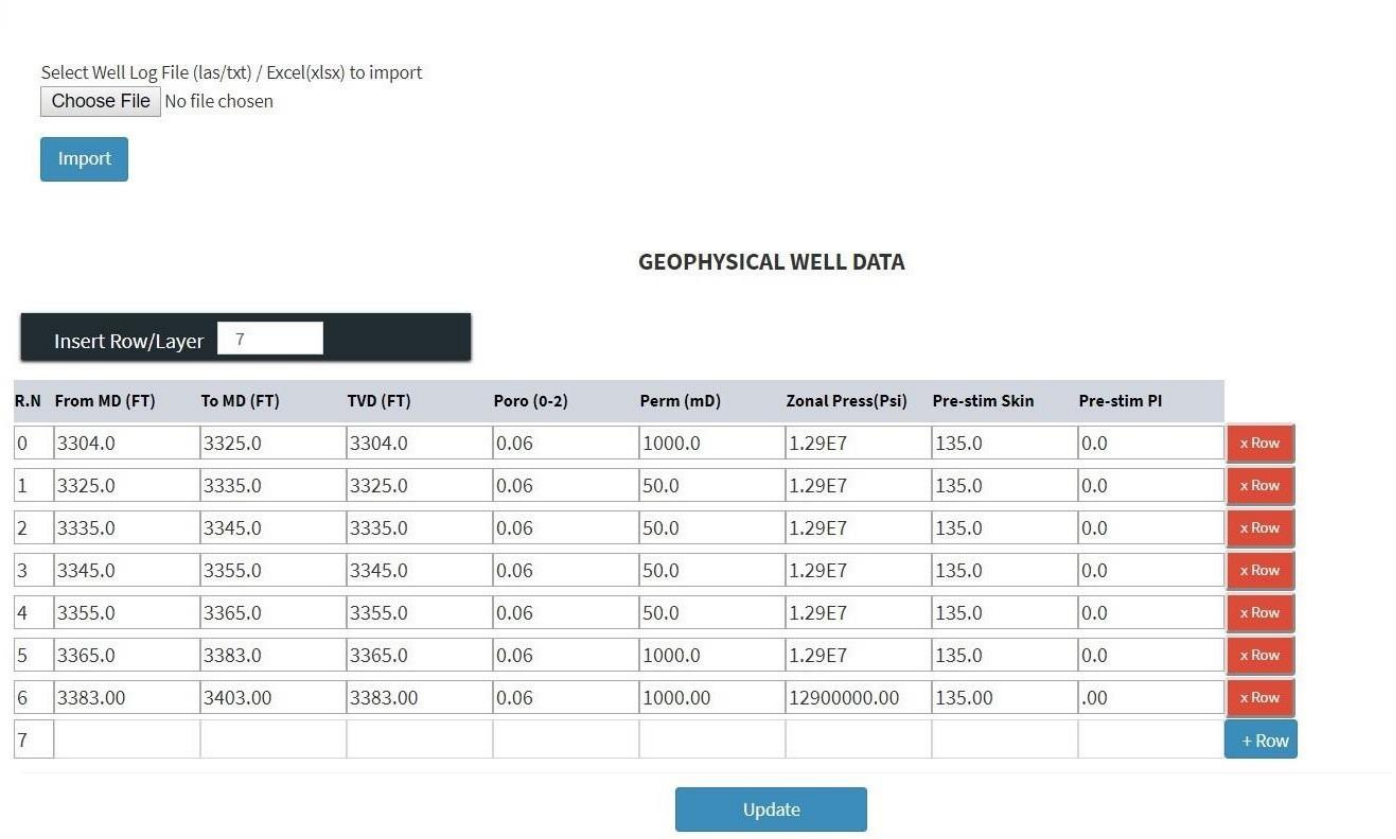
GEOPHYSICAL WELL DATA

From MD (FT)	To MD (FT)	TVD (FT)	Poro (0-1)	Perm (mD)	Zonal Press(Psi)	Pre-stim Skin	Pre-stim PI
3304.0	3325.0	3304.0	0.06	1000.0	1.29E7	135.0	0.0
3325.0	3335.0	3325.0	0.06	50.0	1.29E7	135.0	0.0
3335.0	3345.0	3335.0	0.06	50.0	1.29E7	135.0	0.0
3345.0	3355.0	3345.0	0.06	50.0	1.29E7	135.0	0.0
3355.0	3365.0	3355.0	0.06	50.0	1.29E7	135.0	0.0
3365.0	3383.0	3365.0	0.06	1000.0	1.29E7	135.0	0.0
3383.00	3403.00	3383.00	0.06	1000.00	12900000.00	135.00	.00

EDIT

9.3. Manually Enter Geophysical Well Data

The Geophysical Data table defines the number of layers that need to be stimulated and their reservoir properties. In a single formation, the reservoir can be segmented into multiple layers or zones. The user will enter the top and bottom depth of each layer. Parameters such as Layer Permeability, Porosity of each layer, Zonal Pressure at that layer, pre-stimulated skin (damaged skin) and the reservoir fluid in place in that layer are important in understanding the reservoir formation. The user will have to enter the values for all the parameters, for a successful simulation.



R.N	From MD (FT)	To MD (FT)	TVD (FT)	Poro (0-2)	Perm (mD)	Zonal Press(Psi)	Pre-stim Skin	Pre-stim PI	
0	3304.0	3325.0	3304.0	0.06	1000.0	1.29E7	135.0	0.0	x Row
1	3325.0	3335.0	3325.0	0.06	50.0	1.29E7	135.0	0.0	x Row
2	3335.0	3345.0	3335.0	0.06	50.0	1.29E7	135.0	0.0	x Row
3	3345.0	3355.0	3345.0	0.06	50.0	1.29E7	135.0	0.0	x Row
4	3355.0	3365.0	3355.0	0.06	50.0	1.29E7	135.0	0.0	x Row
5	3365.0	3383.0	3365.0	0.06	1000.0	1.29E7	135.0	0.0	x Row
6	3383.00	3403.00	3383.00	0.06	1000.00	12900000.00	135.00	.00	x Row
7									+ Row

9.4. From Measured Depth (MD)

Measured Depth is the length of the borehole. Entire reservoir depth can be segmented into small thin zones (to calculate injection fluid placement per foot or per few feet). This value represents the top depth value of each sub-zones.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

9.5. To Measured Depth (MD)

This is the bottom level value for Measured Depth for each layer.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

9.6. True Vertical Depth (TVD)

TVD is the measurement from the surface to the bottom of the borehole (or anywhere along its length) in a straight perpendicular line. Here, TVD is equal to the depth of the top layer.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

9.7. Permeability

Permeability is a characteristic that allows oil and gas to flow through the rock.

For Metric Units

Unit: MilliDarcy (mD)
Range: 0.01-100 mD

For Field Units

Unit: MilliDarcy (mD)
Range: 0.01-100 mD

9.8. Porosity

Porosity consists of tiny spaces in the rock that holds oil or gas.

Unit: – Dimensionless (Same for **Metric** & **Field** units)
Range: 0 – 1

9.9. Zonal Pressure

Zonal pressure is a measurement of the fluid pressure in a porous reservoir.

For Metric Units

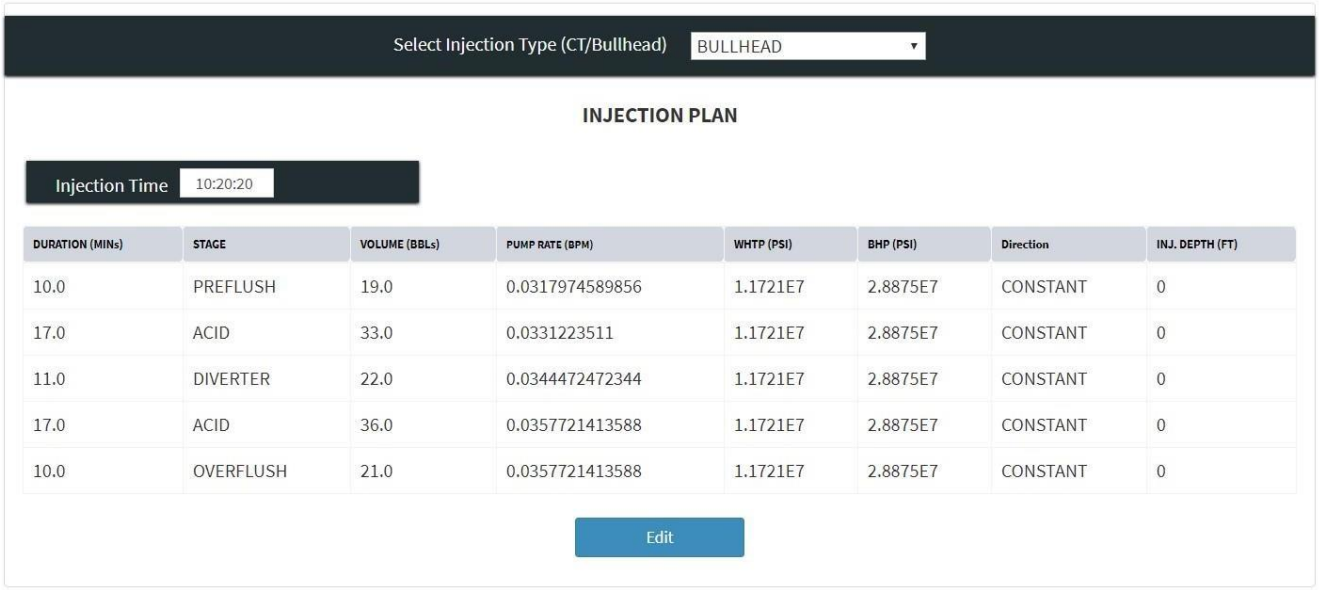
Unit: Pascal (Pa)
Range: Greater than Zero

For Field Units

Unit: Pounds per Square Inch (psi)
Range: Greater than Zero

10. Injection Plan

- Select from **Select Injection Type** as “BULLHEAD” or “CT”
- Fill in various datapoints such as Duration, Stage Name, Volume of fluid injected (Volume), Pump Rate of fluid Injected (Pump Rate), Well Head Treatment Pressure (WHTP), Bottom Hole Pressure (BHP), Direction, Injection Depth (Inj. Depth).



10.1. Start Time

It is the start time of an injection stage. The user should follow the time format in the Excel File.

Unit: – (HH:MM:SS)
Range: – (00:00:00 – 23:59:59)

10.2. Duration

It will show you the duration of particular stage that how long it takes during the injection time.

Unit: Minutes
Range: (0 – 60)

10.3. Stage

The stage column will allow the user to define the type of injection stage they need to set. The different stages in Carbonate Acidizing include:

Pre-flush: - Fluid injected prior to the acid solution pumped into a well in an acid-stimulation treatment.

Acid: - Acid solution injection into the well for a stimulation treatment.

Diverter: - A chemical agent used in stimulation treatments to ensure uniform injection over the area which is to be treated. The user can make alternate stages between acid and diverter injection to allow acid uniform injection.

Over-flush: - A specially prepared fluid used to displace matrix acid treatments away from the wellbore at the conclusion of a stimulation treatment.

10.4. Volume

It is the volume of fluid injected into the well for a stimulation treatment.

For Metric Units

Unit: cubic meter (m^3)
Range: Greater than Zero

For Field Units

Unit: Barrel (bbl)
Range: Greater than Zero

10.5. Pump Rate

The injection rate at which the fluid needs to be pumped for a stimulation treatment.

For Metric Units

Unit: Cubic meter per second (m^3/s)
Range: Greater than Zero

For Field Units

Unit: Barrels per minute (bpm)
Range: Greater than Zero

10.6. Well Head Treatment Pressure

The well head treatment pressure that needs to be maintained for acid injection.

For Metric Units

Unit: Pascal (Pa)
Range: Greater than Zero

For Field Units

Unit: Pounds per Square Inch (psi)
Range: Greater than Zero

10.7. Injection Depth

The depth at which the fluid is injected.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

10.8. Bottom Hole pressure

The bottom hole pressure is equal to the pressure drop in the tubing plus the wellhead pressure.

For Metric Units

Unit: Pascal (Pa)
Range: Greater than Zero

For Field Units

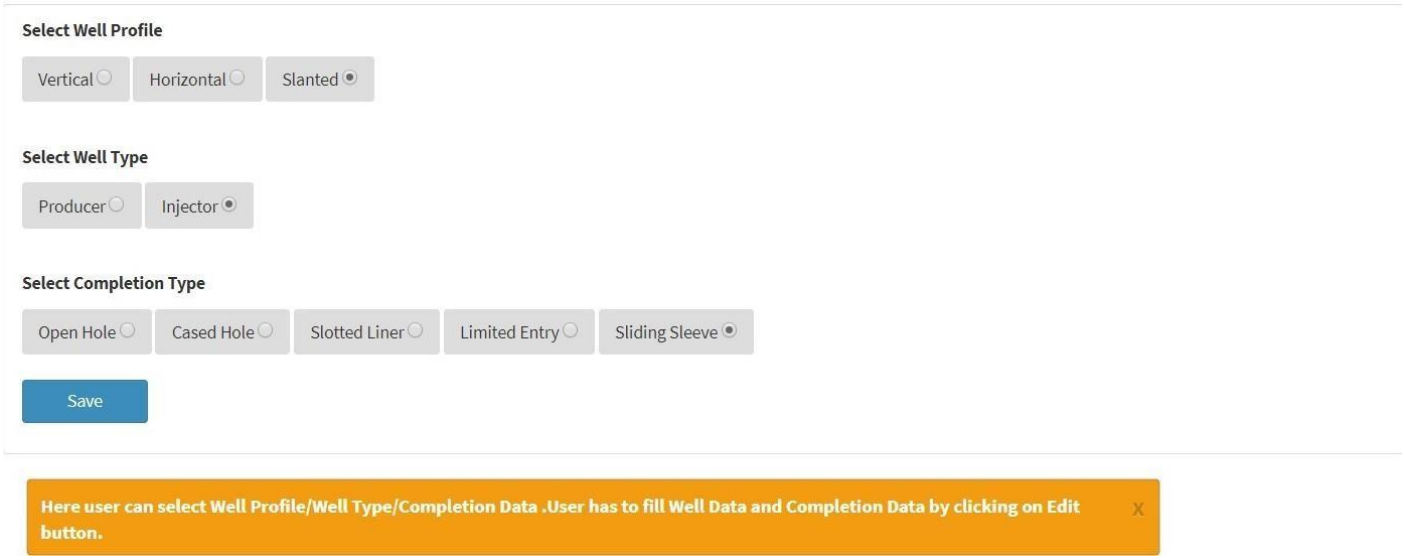
Unit: Pounds per Square Inch (psi)
Range: Greater than Zero

11. Well and Completion Data

Well Properties are important in understanding the nature of the well. The parameters in the well properties table are used to understand the design of the well.

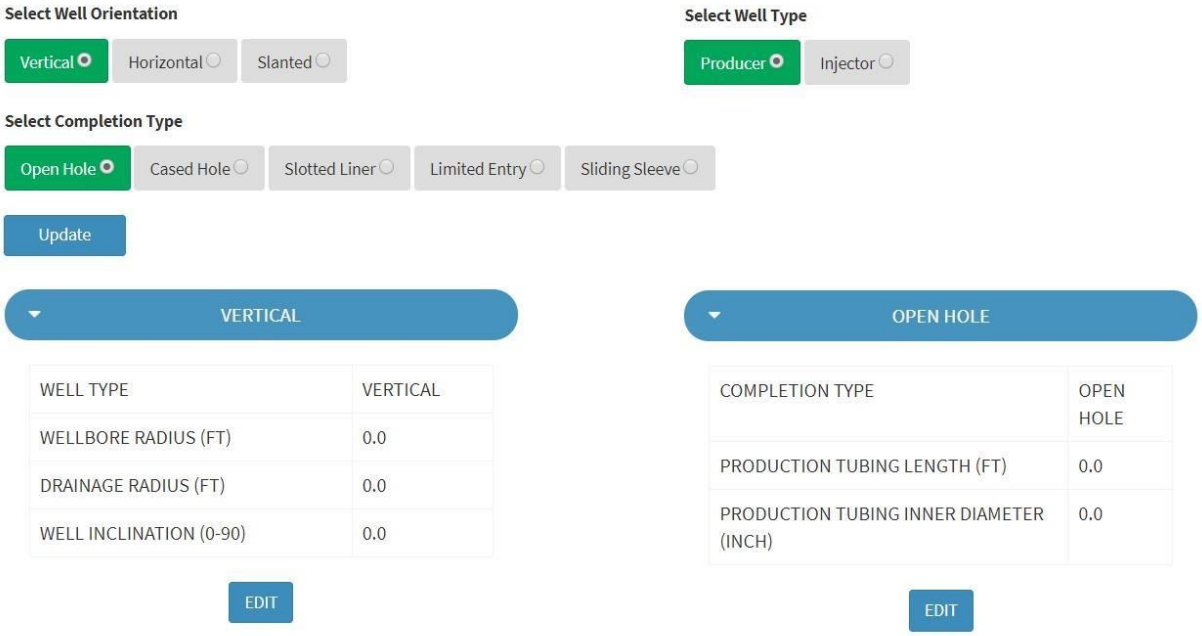
The User must

- Select Well Profile as **Vertical**, **Horizontal** or **Slanted**.
- Select Well type as **Producer** or **Injector**.
- Select Completion type as **Open hole**, **Cased Hole**, **Slotted**, **Limited Entry** and **Sliding Sleeve**.

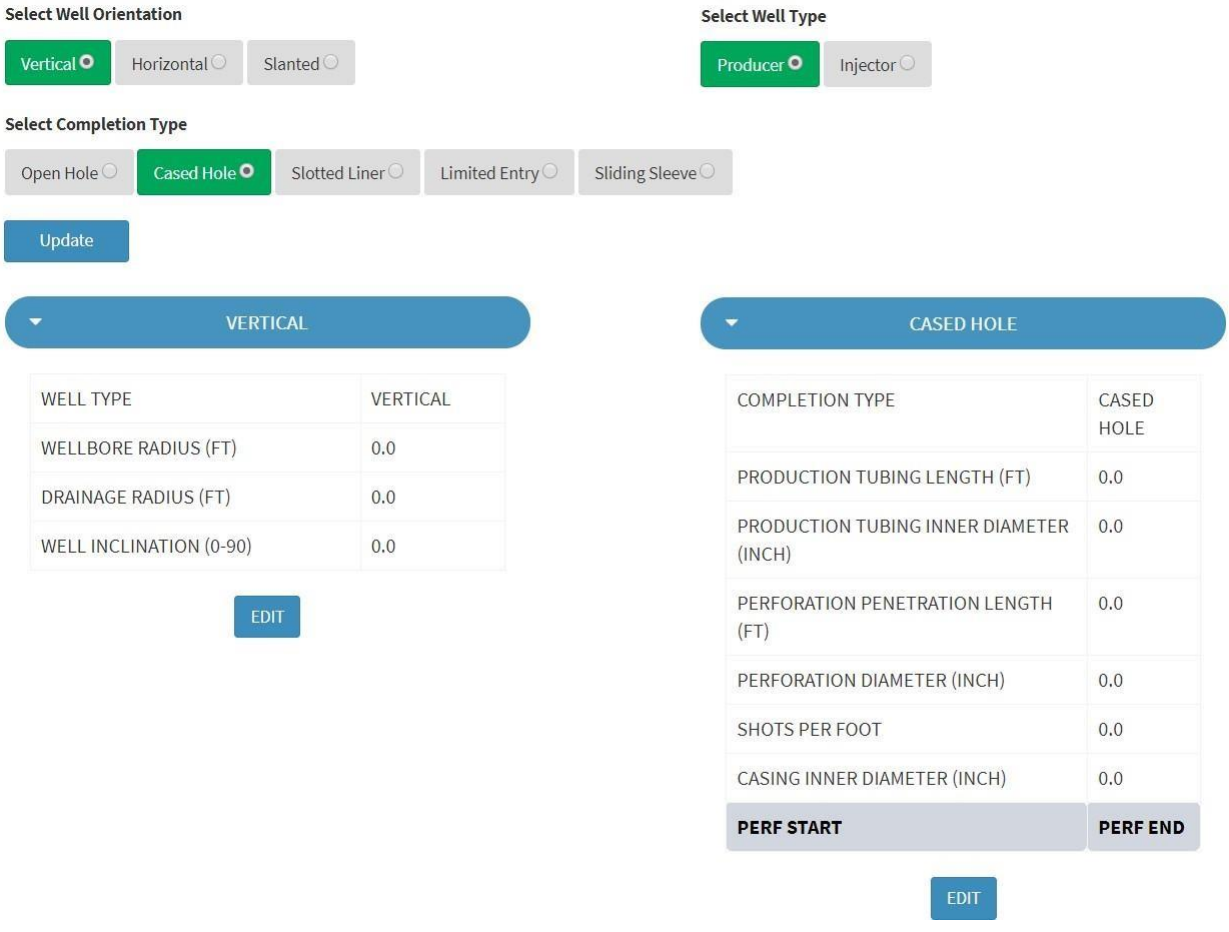


12. Well properties

For Vertical and Open Hole



For Vertical and Cased Hole



For Vertical and Slotted Liner

Select Completion Type

Open Hole ○ | Cased Hole ○ | Slotted Liner ◉ | Limited Entry ○ | Sliding Sleeve ○

Update

VERTICAL

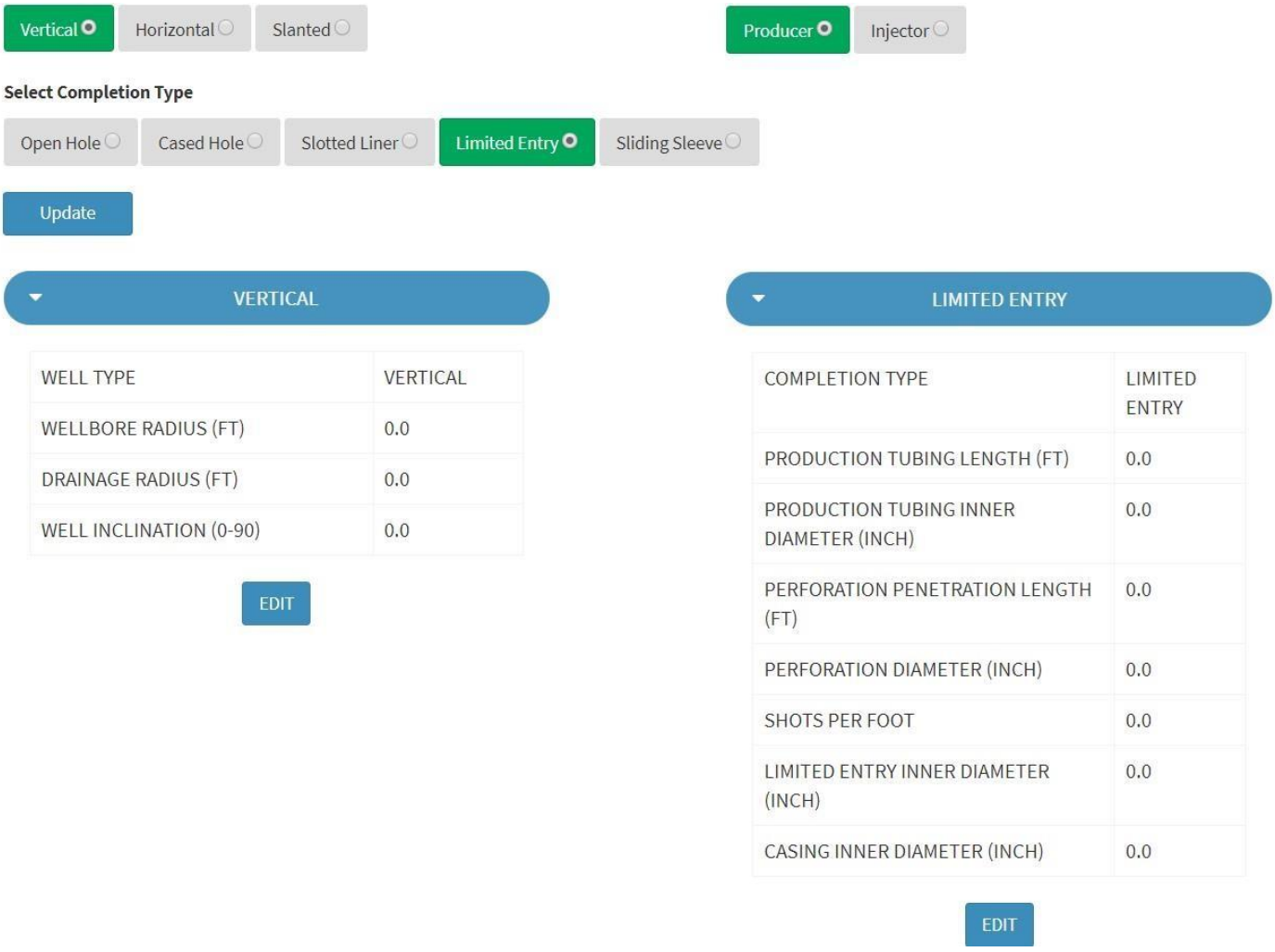
WELL TYPE	VERTICAL
WELLBORE RADIUS (FT)	0.0
DRAINAGE RADIUS (FT)	0.0
WELL INCLINATION (0-90)	0.0

EDIT

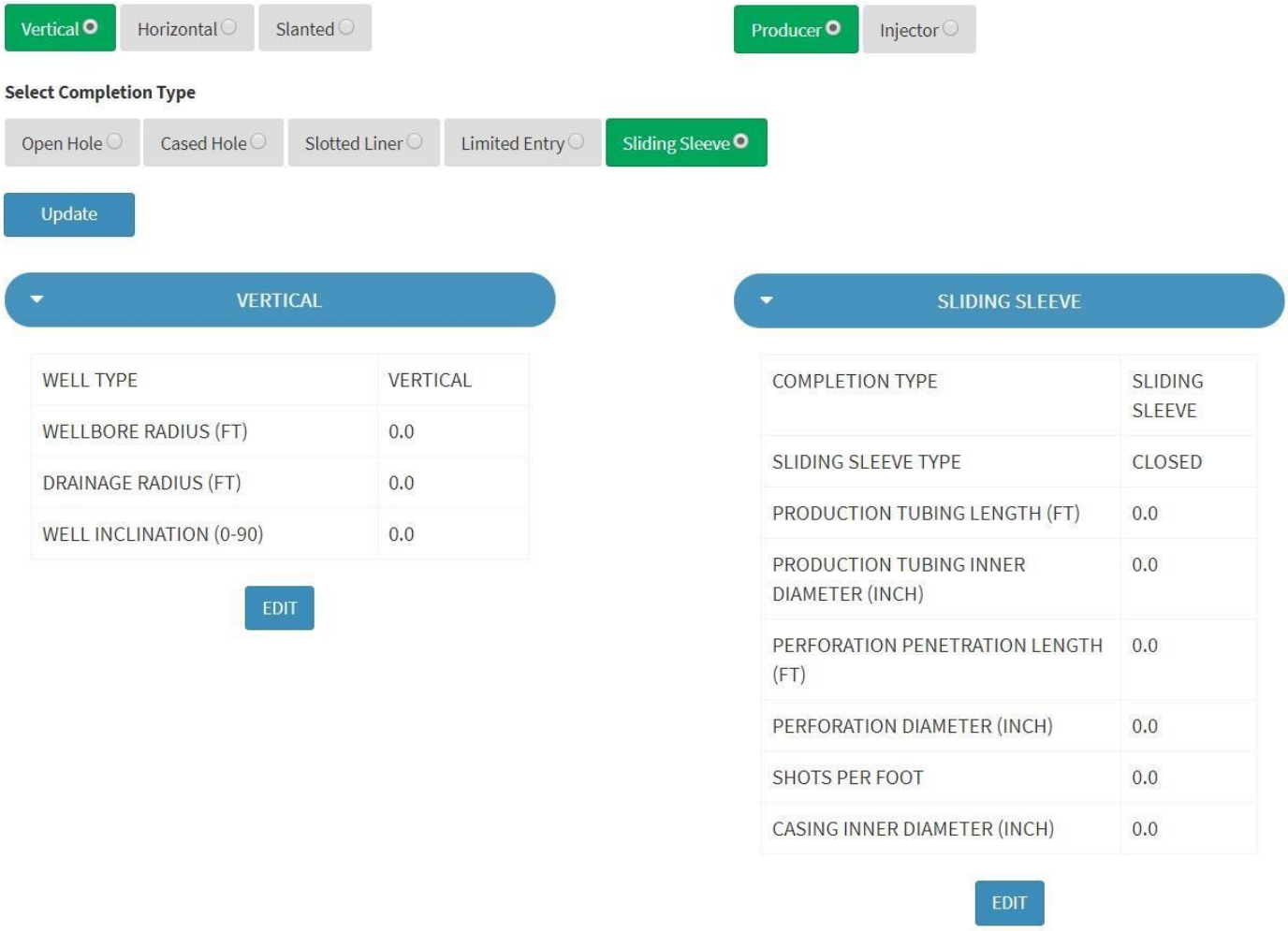
SLOTTED LINER

COMPLETION TYPE	SLOTTED LINER
PRODUCTION TUBING LENGTH (FT)	0.0
PRODUCTION TUBING INNER DIAMETER (INCH)	0.0
PERFORATION PENETRATION LENGTH (FT)	0.0
PERFORATION DIAMETER (INCH)	0.0
SHOTS PER FOOT	0.0
CASING INNER DIAMETER (INCH)	0.0
SLOT TYPE	OPEN
WIDTH OF SINGLE SLOT (INCH)	0.0
LINER INNER DIAMETER (INCH)	0.0
LENGTH OF SINGLE SLOT (INCH)	0.0
NO OF SLOT PER SLOT UNIT	2.0

For Vertical and Limited Entry



For Vertical and Sliding Sleeve



12.1. Wellbore Radius

In pressure transient analysis the wellbore is assumed to be cylindrical and has a specific radius called the wellbore radius.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.2. Drainage Radius

The calculated maximum radius of a formation in which pressure has been affected during the flow period of a transient well test.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.3. Well Inclination

The deviation from vertical, irrespective of compass direction, expressed in degrees.

Unit: Degree
Range: (0 – 90) Degree

12.4. Production Tubing Diameter

It is the diameter of the tubing from which production would take place.

For Metric Units

Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units

Unit: Inch (in)
Range: Greater than Zero

12.5. Completion Type

Type: - Open hole Completion
A well completion that has no casing or liner set across the reservoir formation, allowing the produced fluids to flow directly into the wellbore

Type: - Cased Hole Completion
A completion configuration in which a production casing string is set across the reservoir interval and perforated to allow communication between the formation and wellbore.

Type: - Slotted Liner Completion
Slotted liners can be selected as an alternative to the pre-holed liner, sometimes as a personal preference or from established practice on a field. It can also be selected to provide a low-cost control of sand/solids production.

Type: - Limited Entry
The limited entry technique (**LET**) is a technology for efficient simultaneous treatment of multiple zones in a low-permeable reservoir.

Type: - Sliding Sleeve
Sliding sleeves are assembled to and form part of the tubing string; they are used to establish communication between the tubing string and the casing annulus for single- or multiple tubing-string completions.

12.6. Perforation Height

The height of perforations or perforated interval is that portion of the net pay (h) that is open to flow into the wellbore either through partial penetration of the wellbore or incomplete perforation.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.7. Perforation Length

It is the length of perforation that has penetrated in the formation.

For Metric Units

Unit: Meter(m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.8. Perforation Diameter

The diameter of the perforation created in the formation.

For Metric Units

Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units

Unit: Inch (in)
Range: Greater than Zero

12.9. Shots per Foot

It's the number of Shots of perforation done in the length of one feet
Unit: No unit
Range: Depends on the number of Perforations done.

12.10. Number of perforations

The number of perforations in the well.

Unit: – Dimensionless
Range: – **(0 – 20)**

12.11. Well Type

Vertical Well: -A vertical well is a well that is not turned horizontally at depth and which allows access to oil and gas reserves located directly beneath the surface access point.

Horizontal Well: -A horizontal well is an oil or gas well that is dug at an angle of at least eighty degrees to a vertical bore.

12.12. Length horizontal reach of well

Length from which the well turns horizontal till the end of the well.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.13. Distance of reservoir bottom to horizontal

The distance between the bottom of the reservoir to the horizontal wellbore.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.14. Horizontal Well Diameter

The diameter of the horizontal wellbore.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.15. Casing Inner Diameter

It's the diameter of casing measured.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.16. Limited Entry Inner Diameter

It's the diameter for the limited entry space.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.17. Sliding Sleeve

Type: - **Open/Closed**

12.18. Sliding sleeve zone start depth

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.19. Sliding Sleeve zone end depth

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

12.20. Slot Type

Type: - **Open/ Plugged**

12.21. Width of single slot

For Metric Units

Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units

Unit: Inch (in)
Range: Greater than Zero

12.22. Length of single slot

For Metric Units

Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units

Unit: Inch (in)
Range: Greater than Zero

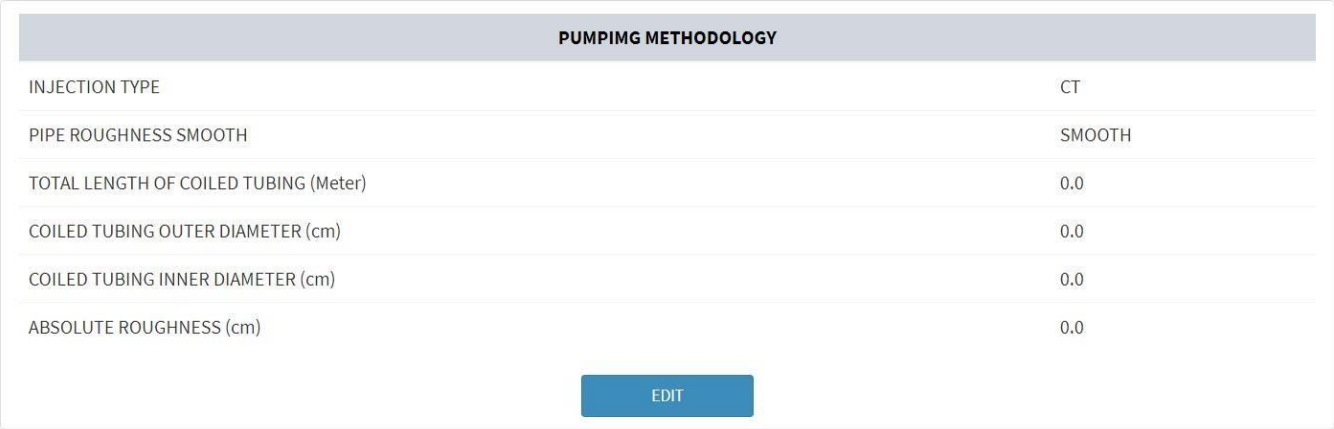
12.23. Open area of single slot

Unit: - Percentage (%)

12.24. No. of Slot per Slot unit

It's the number of slots present in unit slot
Unit: -No unit

13. Pumping Equipment



13.1. Injection Type

Type:

13.2. Pipe

Type: - Smooth/Rough.

13.3. Coiled tubing outer diameter

The outer diameter of the coiled tubing.

For Metric Units
Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units
Unit: Inch (in)
Range: Greater than Zero

13.4. Coiled tubing inner diameter

The inner diameter of the coiled tubing.

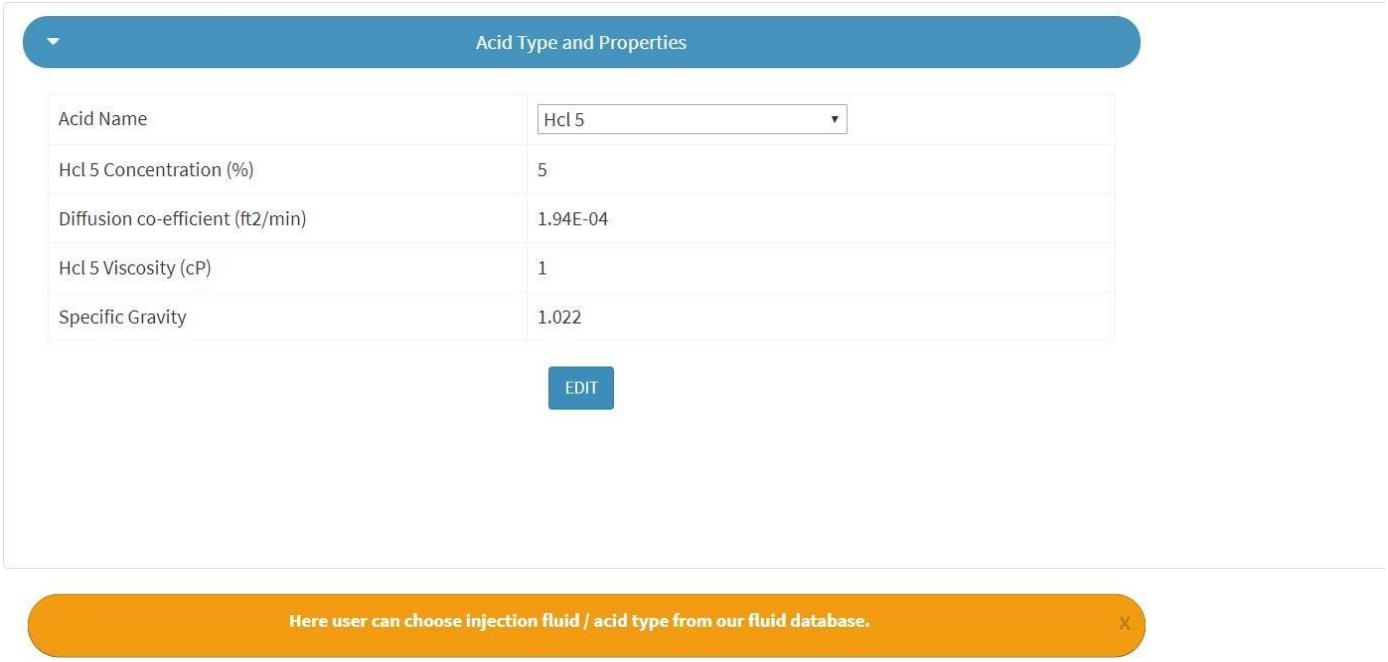
For Metric Units
Unit: Centimetre (cm)
Range: Greater than Zero

For Field Units
Unit: Inch (in)
Range: Greater than Zero

13.5. Absolute Roughness

Its an input for CT/ Bullhead type of Tubing.
Unit: No unit
Range: 0-1

14. Acid Type and Properties



14.1. Acid Name

Name: - HCL/Acetic Acid/ Mud Acid/ Alcoholic Acid/ Emulsified Acid

14.2. Acid Concentration

It's the measure of the amount of available **acid** ions dissolved in a solvent. Various Concentrations of the acid can be selected from the list provided by Petroleum**Soft.**

Default Data: 5/7.5/10/15/28

14.3. Acid Viscosity

Acid Viscosity is the measure or degree of the thickness of a fluid.
Unit: Centipoise (cP)
Range: Greater than Zero
Default Data: 1.2

14.4. Specific Gravity

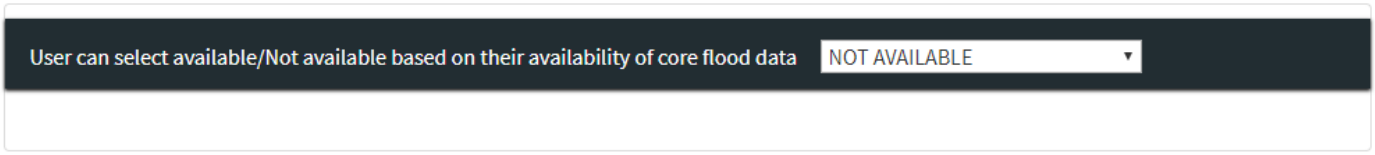
Specific gravity is the ratio of the density of a substance to the density of a reference substance
Range: - 1.0- 2.0
Default Data: 1.072

14.5. Diffusion Coefficient.

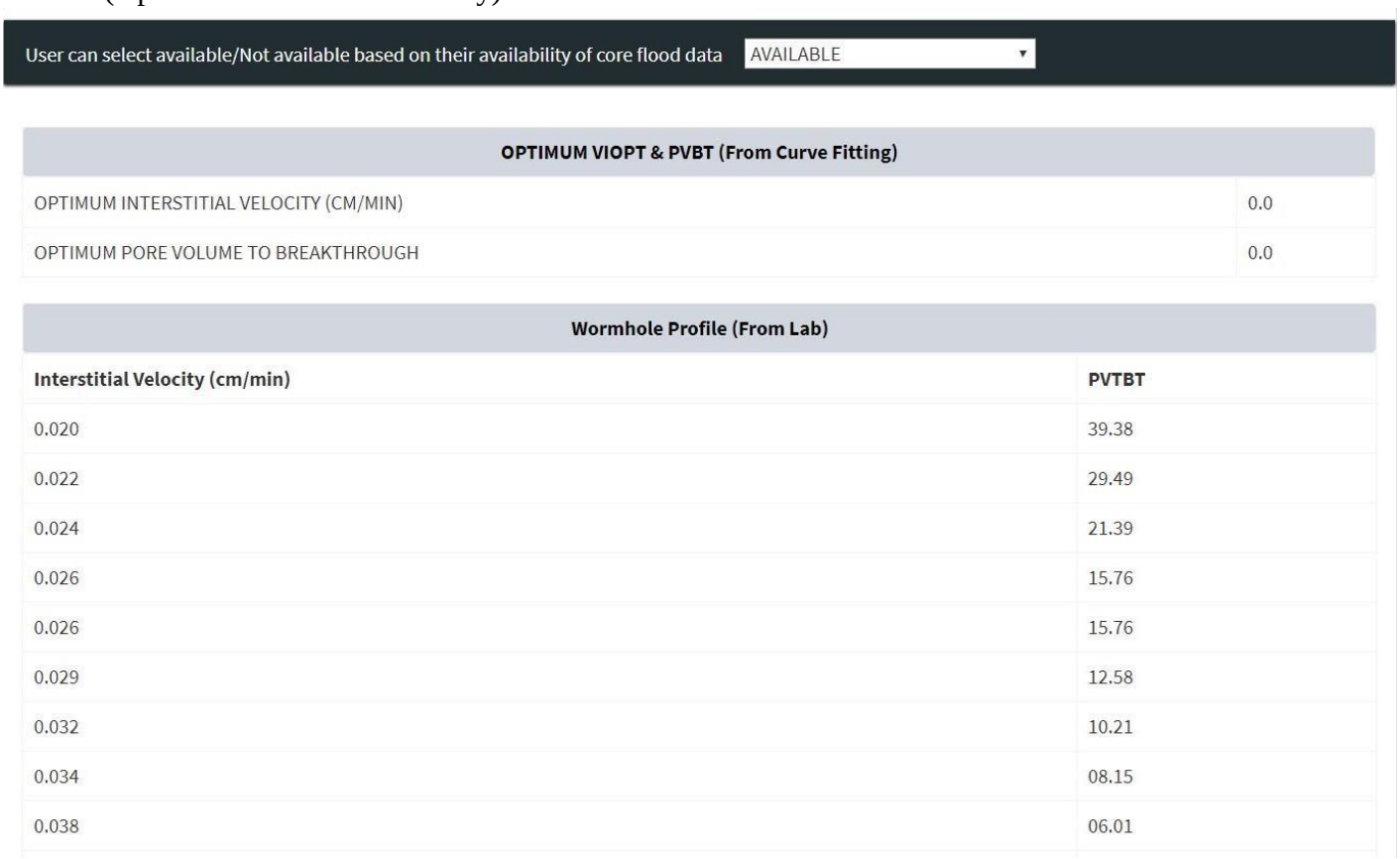
Diffusion Coefficient defined quantity of a substance that in diffusing from one region to another passes through each unit of cross section per unit of time when the volume-concentration gradient is unity.
Unit: Feet squared per Minute (Ft^2/min)
Default Data: 2.24E-04

15. Core Flood data

If Core Flood Data is **NOT AVAILABLE** then user can leave the tab by clicking on **CLOSE** button



If Core Flood Data is **AVAILABLE** then user can input optimum PVBT(Pore Volume Break Through) and VIOPT (Optimum Interstitial Velocity).



OPTIMUM VIOPT & PVBT (From Curve Fitting)	
OPTIMUM INTERSTITIAL VELOCITY (CM/MIN)	0.0
OPTIMUM PORE VOLUME TO BREAKTHROUGH	0.0

Wormhole Profile (From Lab)	
Interstitial Velocity (cm/min)	**PVTBT**
0.020	39.38
0.022	29.49
0.024	21.39
0.026	15.76
0.026	15.76
0.029	12.58
0.032	10.21
0.034	08.15
0.038	06.01

15.1. Worm Hole- Optimum VIOPT and PVBT

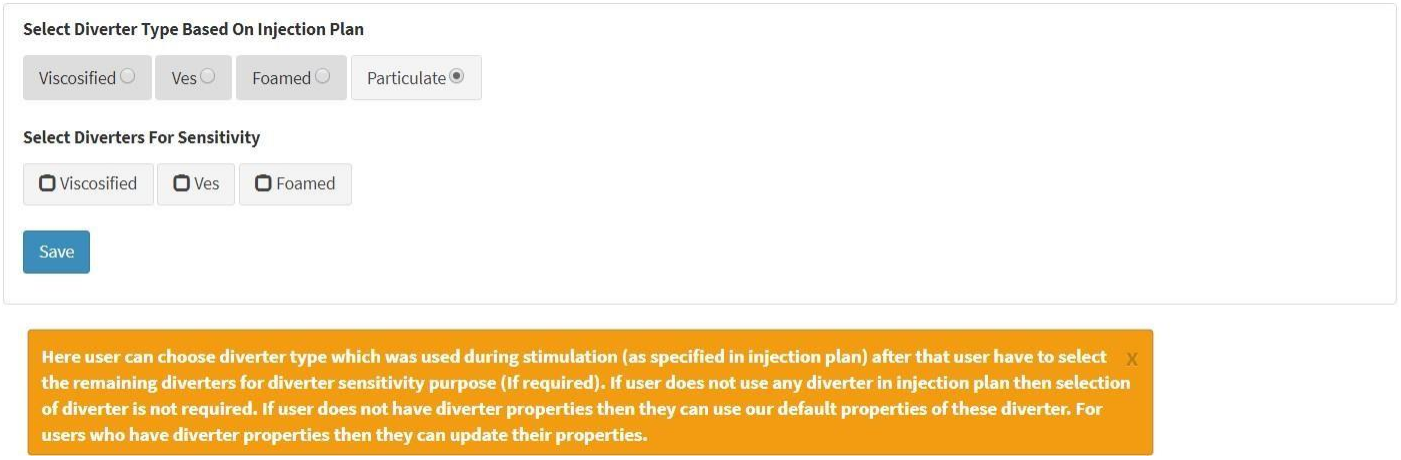
Obtained from Laboratory Test.

15.2. Optimum Interstitial Velocity

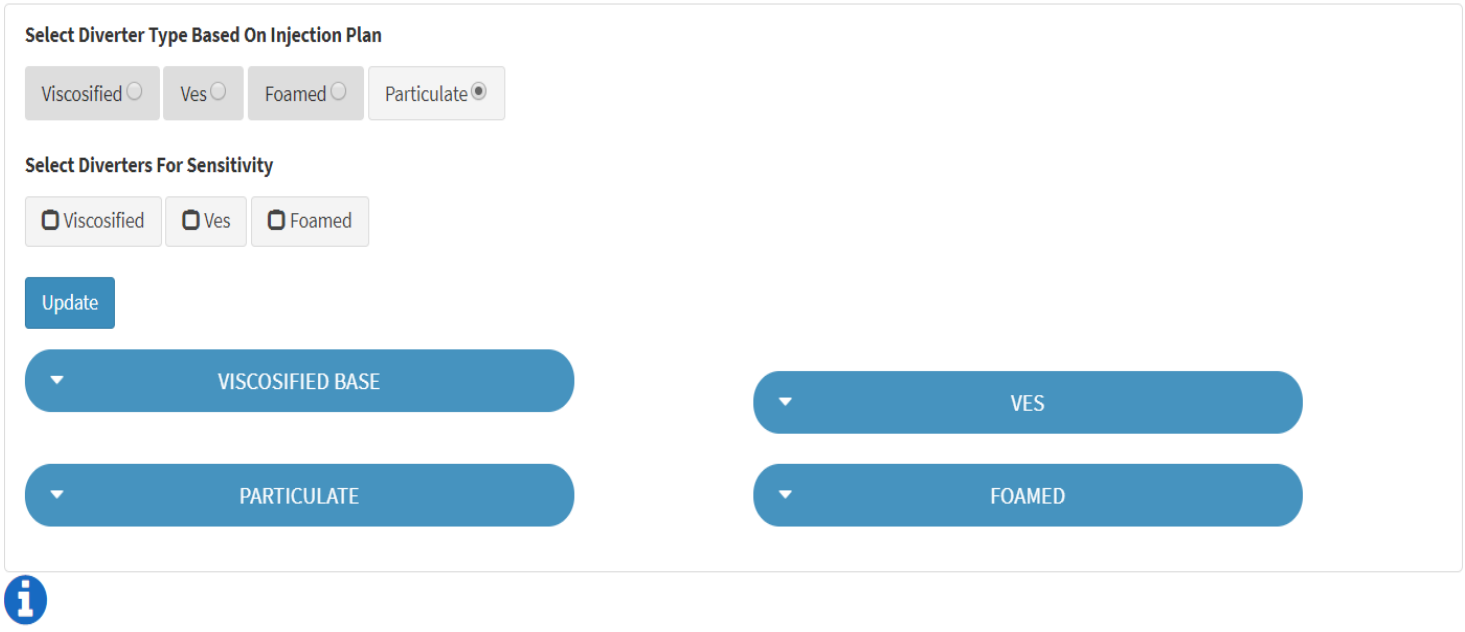
Unit: - (cm/min)

16. Diverter Properties

Select any one Diverter from Select Diverter Type Based on Injection Plan option and save it by clicking on Save Button.



Here user can choose diverter type which was used during stimulation (as specified in injection plan) after that user have to select the remaining diverters for diverter sensitivity purpose (If required). If user does not use any diverter in injection plan then selection of diverter is not required. If user does not have diverter properties then they can use our default properties of these diverter. For users who have diverter properties then they can update their properties.



16.1. Diverter Type

- Select Diverter Type Based on Injection Plan

Type: - **Viscosified Type**, **Foam Type**, **Particulate Type**, **VES**.

- Select Diverters for Sensitivity

Type: - **Viscosified**, **VES**, **Foamed**.

16.2. K (For Diverter)

Consistency index (LB-Sn/FT^2)
Default Data: 10000

16.3. N (For Diverter)

Flow behaviour index indicated the degree of the non –Newtonian characteristics of the fluids.
Default Data: 0.02

16.4. Viscosified Viscosity

It's the more viscous viscosity or the increase in viscosity
Unit: No unit
Default Data: 1.0

16.5. Viscosified Concentration

It's the increase in the concentration of the viscosity.
Unit: Percentage (%)
Default Data: 15

16.6. Diverter Fluid Density

It's the density of the Fluid Diverter which is a Physical or Chemical Substance used to for blocking or diverting the substances injected inside the well.

For Metric Units
Unit: Kilogram per cubic meter (Kg/m3)
Range: Greater than Zero
Default Data: 550

For Field Units
Unit: Gram per cubic meter (g/m3)
Range: Greater than Zero
Default Data: 0.55

16.7. Maximum viscosity (VES)

Unit: - Centipoise (cP)
Range: - 300 cP
Default Data: 300

16.8. Calcium concentration at maximum viscosity

Unit: - Percentage (%)
Range: - 20%
Default Data: 20

16.9. VES Concentration

It's the concentration of the Viscosified Emulsion which used as a diverter.
Unit: Percentage %
Default Data: 15

16.10. VES pH

It's the pH of Viscosified Emulsion.
Unit: No unit
Default Data: 2.0

16.11. SDVA Concentration

SDVA- Self Diverting Acid based on Viscoelastic Surfactant. SDVA Concentration is the concentration of the ions of SDVA in the solvent.
Unit: No Unit
Range: Greater than Zero
Default Data: 6.0

16.12. Foam Quality

Foam quality is the ratio of gas volume to foam volume over a given pressure and temperature.
Unit: Percentage (%)
Default Data: 80

16.13. Foamed Viscosity

It's the Viscosity of Foam Concentrates.
Unit: No Unit.
Default Data: 1.0

16.14. Foamed Concentration

It's the concentration of Foam used in Diverter.
Unit: Percentage (%)
Default Data: 15

16.15. Connate Water Saturation

Connate water saturation is the amount of the water which adsorbs on the surface of the grains of the rock or on the walls of the porous pore channels divided by the pore volume.
Unit: No Unit
Default Data: 0.2

16.16. Gas Saturation

The gas saturation is the fraction of the pore space occupied by gas.
Unit: No Unit
Default Data: 0.1

16.17. Cake Porosity

Unit: - No Unit
Range: - 0.01 and above
Default Data: 0.15

16.18. Diverter Agent

It's the Chemical or Physical agent used to block or divert a substance injected inside the well. The User has the option of Choosing from the diverter provided by PetroleumSoft. The various diverter option provided are **Benzoic Acid**/ **Polymer**/ **Rock Salt**/ **Wax Beads**/ **Naphthalene Flakes**.

16.19. Particulate Grain size

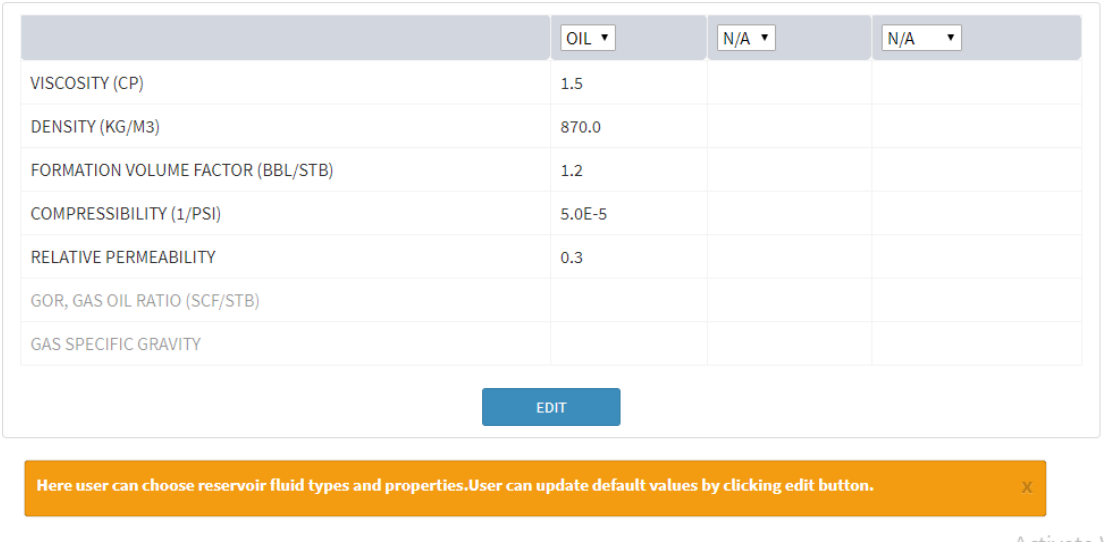
It's the Grain size of solid and liquid particles. Its input is in Micron.
Default Data: 50

16.20. Particulate Viscosity

Particulate is combination of solid and liquid diverter agents' particles. Particulate Viscosity is the Viscosity of the Particulate.
Unit: No Unit.
Range: Greater than zero
Default Data: 1.0

17. Reservoir Fluid Properties

If user has only Oil as fluid in the reservoir then the user can change Gas and Water as N/A.



17.1. Reservoir fluid

Type: - Oil/Water/Gas.

Reservoir fluids are the fluids mixture contained within the petroleum reservoir which technically are placed in the reservoir rock.

17.2. Flow types

Type: - Radial transient flow.

Fluid Flow is a part of fluid mechanics and deals with fluid dynamics. Fluids such as gases and liquids in motion are called as fluid flow. The motion of a fluid subjected to unbalanced forces. This motion continues as long as unbalanced forces are applied.

Type: - Multiphase flow.

In addition to oil, almost all oil wells produce a certain amount of water, gas, and sometimes sand. These wells are called multiphase-oil wells. The TPR equation for single-phase flow is not valid for

Multiphase oil wells. For the analysis of TPR of multiphase oil wells rigorously, a multiphase flow model is required. Multiphase flow is much more complicated than single phase flow because of the variation of flow regime (or flow pattern). Fluid distribution changes greatly in different flow regimes, which significantly affects pressure gradient in the tubing.

17.3. Reservoir oil density

‘‘Density of oil’’ is defined as the mass of oil per unit volume, or lbm=ft3 in U.S. Field unit. It is widely used in hydraulics calculations and performance calculations.

Unit: Kilogram per cubic meter (Kg/m^3)

Range: - Less than water density
Default Data: 870

17.4. Reservoir oil viscosity

‘‘Viscosity" is an empirical parameter used for describing the resistance to flow of fluid. The viscosity of the oil is of interest in well-inflow and hydraulics calculations in oil production engineering. Oil viscosity is a measure of the resistance to flow exerted by the oil and is given in units of centipoises. Higher values indicate greater resistance to flow. For oil, the viscosity decreases with increasing temperature and pressure (up to the bubble point).

Unit: Centipoise (cP)
Range: 0-2 cP
Default Data: 1.5

17.5. Reservoir gas density

Gas density is defined to be the mass of gas divided by the volume confining the gas. There is a related state variable called the specific volume which is the reciprocal of the density.

Unit: Kilogram per cubic meter (Kg/m^3)
Range: - Less than water density
Default Data: 106

17.6. Reservoir gas viscosity

The gas viscosity generally increases with pressure. The increase of temperature decreases the liquid viscosity, whereas it increases the gas viscosity at low and moderate pressures. At high pressure, the gas viscosity behaviour approaches that of liquid.

Gas viscosity is a measure of the resistance to flow exerted by the gas and is given in units of centipoises. Higher values indicate more resistance to flow. For gas, the viscosity increases with increasing temperature and pressure. As pressure decreases, gas viscosity decreases. The molecules are simply further apart at lower pressure and move past each other more easily.

Unit: Centipoise **cP**
Range: (1 – 5) cP
Default Data: 0.019

17.7. Reservoir water density

The density of water is the weight of the water per its unit volume, which depends on the temperature of the water.

Unit: Kilogram per cubic meter (Kg/m^3)

Range: Around 1000 kg/m^3
Default Data: 1000

17.8. Reservoir water viscosity

Water viscosity is a measure of the resistance to flow exerted by the water. Viscosity is one of the main physical properties that affect the mobility and flow of formation water in the porous media. Higher values indicate more resistance to flow. For water, the viscosity decreases with increasing temperature and increases with increasing pressure. Water viscosity is a very weak function of pressure. Water at room temperature is approximately equal to 1 cP. In a reservoir, it is typically between 0.5 to 1 cP. This is due to the higher temperature, salinity, and the solution gas content of the water. Thus, an accurate measure or estimate of formation water viscosity is necessary to interpret or predict fluids production from the reservoir

Unit: Centipoise cP
Range: (0.5 – 1) cP
Default Data: 1.0

17.9. Oil Compressibility

Oil compressibility is a measure of change in volume as a result of change in prevailing pressure. It is defined as the rate of change in the volume of crude oil per unit change in pressure divided by the volume of oil.

For Metric Units

Unit: Pascal Inverse (1/Pa)
Range: Greater than zero
Default Data: 0.034

For Field Units

Unit: Pound per Square inch Inverse 1/PSI
Range: Greater than zero
Default Data: 5.0E-5

17.10. Gas Compressibility

The compressibility of a substance is the change in volume per unit volume per unit change in pressure.

For Metric Units

Unit: Pascal Inverse (1/Pa)
Range: Greater than zero
Default Data: 0.00034

For Field Units

Unit: Pound per Square inch Inverse 1/PSI
Range: Greater than zero
Default Data: 500E-6

17.11. Oil formation volume factor

‘‘Formation volume factor of oil" is defined as the volume occupied in the reservoir at the prevailing pressure and temperature by volume of oil in the stock tank, plus its dissolved gas.

Oil formation volume factor (FVF) is defined as the ratio of the volume of oil and dissolved gas at reservoir (in-situ) conditions to the volume of oil at stock tank (surface) conditions. Since most Measurements of oil and gas production are made at the surface, and the fluid flow takes place in the formation, volume factors are needed to convert measured surface volumes to reservoir conditions.

For Metric Units

Unit: m^3/m^3
Range: 5-10
Default Data: 5.614

For Field Units

Unit: BBL/STB
Range: Greater Than 1 BBL/STB
Default Data: 1.2

17.12. Gas formation volume factor

The gas formation volume factor is the gas volume at reservoir conditions divided by gas volume at standard conditions. It is used to convert surface measured volumes to reservoir conditions. Defined below, it is a function of the fluid composition and the pressure/temperature ratio between the reservoir (in-situ) and standard conditions (14.65 psi and 519.67 °R or 60 °F).

For Metric Units

Unit: m^3/m^3
Range:
Default Data: 0.00011

For Field Units

Unit: BBL/STB
Range: Around 1 BBL/STB
Default Data: 0.000695

17.13. Water formation volume factor

Water formation volume factor is defined as the ratio of the volume of water at reservoir (in-situ) conditions to that at stock tank (surface) conditions. This factor is used to convert the flow rate of water (at stock tank conditions) to reservoir conditions.

For Metric Units

Unit: m^3/m^3
Range: 2-5
Default Data: 2.28

For Field Units

Unit: BBL/STB
Range: Around 1 BBL/STB
Default Data: 1.0

17.14. Specific Gravity of Gas

The specific gravity is defined as the ratio of the gas density to that of the air. Both densities are measured or expressed at the same pressure and temperature. Commonly, the standard pressure P_{sc} and standard temperature T_{sc} are used in defining the gas specific gravity.

Gas gravity is the molar mass (molecular weight) of the natural gas divided by the molar mass of air (28.94 kg/kmol). It ranges from 0.55 for dry sweet gas to approximately 1.5 for wet sour gas. Petroleum gases typically have a gravity of about 0.65.

Unit: Dimensionless
Range: (0 -2)
Default Data: 0.71

17.15. Relative permeability of Oil

Relative permeability of oil (K_{ro}), is the ratio of effective permeability of oil to absolute permeability. Relative permeability can be expressed as a number between 0 and 1.0 or as a percent.

Unit: Dimensionless
Range: (0 – 1)
Default Data: 0.3

17.16. Relative Permeability of water

Relative permeability of water (K_{rw}) is the ratio of effective permeability of water to absolute permeability. Relative permeability can be expressed as a number between 0 and 1.0 or as a percent.

Unit: Dimensionless
Range: (0 – 1)
Default Data: 0.3

17.17. Relative permeability of gas

Relative permeability of gas (K_{rg}), is the ratio of effective permeability of gas to absolute permeability. Relative permeability can be expressed as a number between 0 and 1.0 or as a percent.

Unit: Dimensionless
Range: (0 – 1)
Default Data: 0.4

17.18. GOR (gas oil ratio)

‘‘Solution GOR’’ is defined as the amount of gas (in standard condition) that will dissolve in unit volume of oil when both are taken down to the reservoir at the prevailing pressure and temperature.

The solution gas-oil ratio is the amount of gas dissolved in the oil at any pressure. It increases approximately linearly with pressure and is a function of the oil and gas composition. A heavy oil contains less dissolved gas than a light oil. In general, the solution gas-oil ratio varies from 0 (dead oil) to approximately 2000 scf/bbl (very light oil). The solution gas-oil ratio increases with pressure until the bubble point pressure is reached, after which it is a constant, and the oil is said to be undersaturated.

For Metric Units

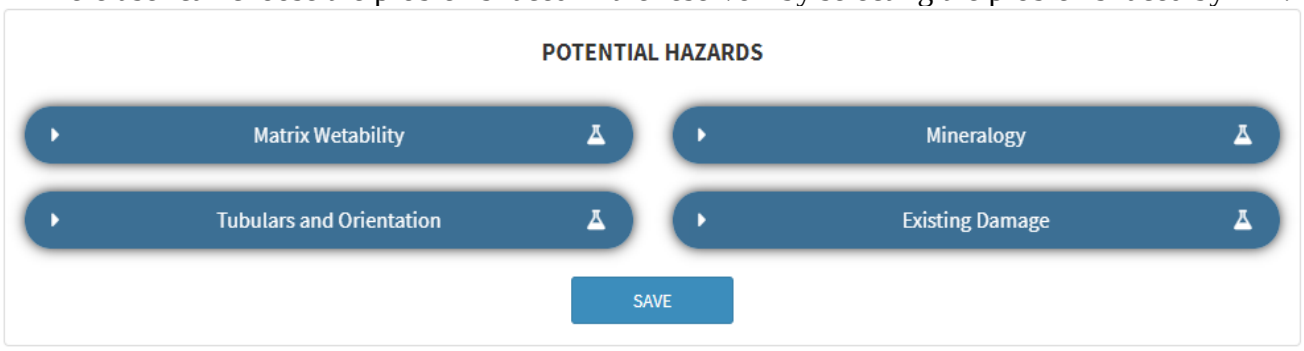
Unit: Sm^3/Sm^3
Range: 0-1
Default Data: 17.81

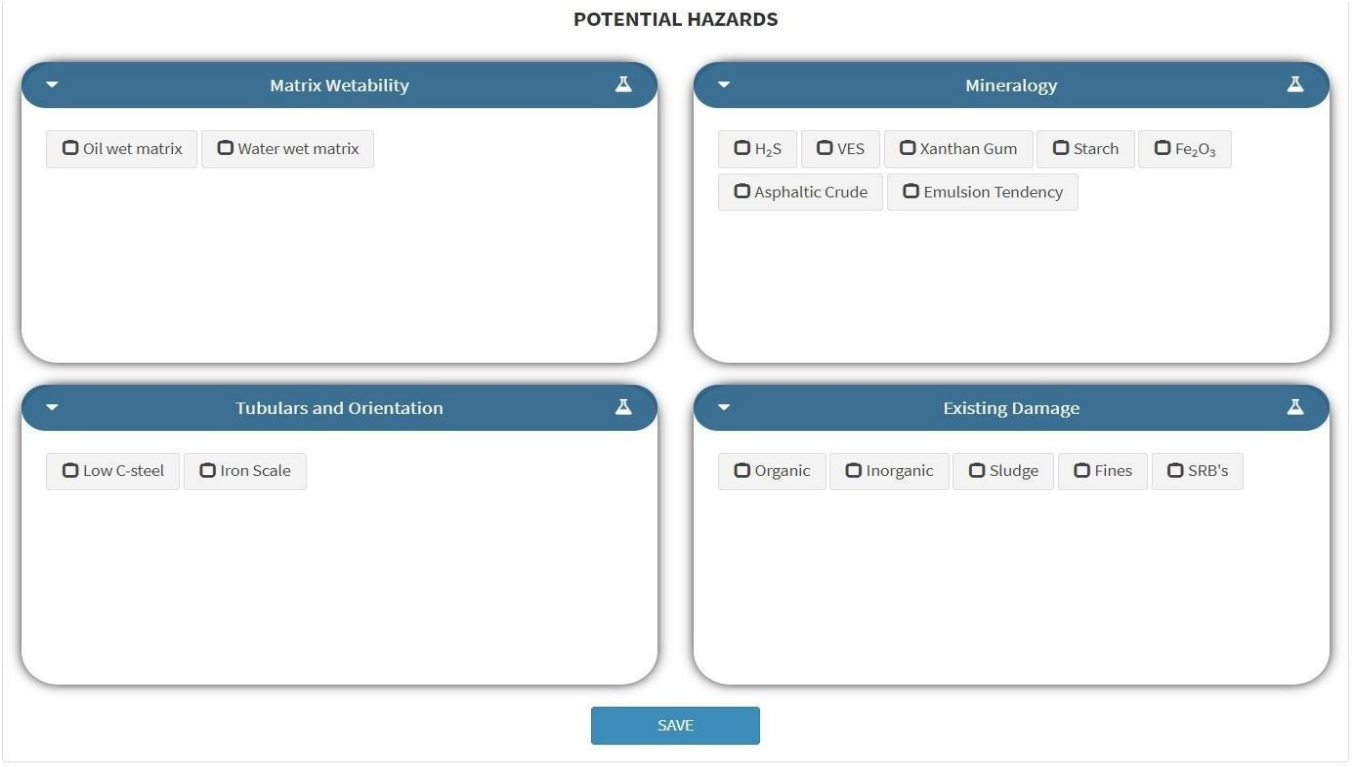
For Field Units

Unit: SCF/STB
Range: 0-10000 SCF/STB
Default Data: 100

18. Potential Hazards (For recipe Design).

Here user can choose the problems faced in the reservoir by selecting the problems faced by him.





18.1. Matrix Wettability

- Select from **Oil wet Matrix** and **Water wet Matrix** according the suitable formation orMatrix Present.

18.2. Mineralogy

This selected based on the Mineralogy of the formation. PetroleumSoft provides various types of selection of formation to the user

- Various options are: **H_2S**, **VES**, **Xantham Gum**, **Starch**, **Fe_2O_3**, **Asphaltic Crude** and **Emulsion Tendency.**

18.3. Tubular and Orientation

It's the description of the orientation or placement of the Tubing and the direction or angle of the well bore. The User is provided with two options to select from and the user will also be able to select both.

- Select from **Low C-Steel** or **Iron Scale**.

18.4. Existing Damage

The User will be able to provide information about existing formation damage to the module developed by PetroleumSoft so that Module can provide the correct recommended job design.

- Select from **Organic**, **Inorganic**, **Sludge**, **Fines** and **SRB's**

19. Formation Damage & Mineralogy

Formation Damage and Mineralogy	
MINERAL TYPE	CALCITE
DAMAGE RADIUS (Meter)	0.0
CALCITE CONCENTRATION (%)	100
Rock Properties	
FRACTURE GRADIENT (Pa/Meter)	0.0
FORMATION TEMPERATURE (°C)	0.0
ROCK DENSITY (KG/CM3)	0.0
LEAK-OFF CO-EFFICIENT (M/SEC^1/2)	0.0025

EDIT

Here user can input Formation Damage Data , Rock Properties . x

19.1. Mineral Type

The User gets the only option of choosing Calcite from the bar provided. PetroleumSoft is working and will soon be able to provide for more mineral type.

19.2. Damage Radius

The calculated maximum radius in a formation in which damage has occurred during the flow period.

For Metric Units

Unit: Meter (m)
Range: Greater than Zero

For Field Units

Unit: Feet (Ft)
Range: Greater than Zero

19.3. Calcite Concentration

This the percentage of the concentration of the calcite present in the formation.

Unit: Percentage (%)
Range: Near to 100%

19.4. Formation temperature

The temperature of the reservoir at the wellbore.

For Metric Units

Unit: Celsius (C)
Range: Depends on the Well Type

For Field Units

Unit: Fahrenheit (F)
Range: Depends on the Well Type

19.5. Fracture gradient

The factor used to determine formation fracturing pressure as a function of well depth in the unit of psi/ft.

For Metric Units

Unit: Pascal/ Meter (Pa/m)
Range: Greater than 0.00001

For Field Units

Unit: Psi/Ft
Range: Greater than 0.00001

19.6. Rock density

Density is defined as the mass of a substance per unit volume and is highly variable in crustal rocks. Rock density is a physical characteristic the is governed by the chemical composition and pore spaces of a specific rock or rock type.

For Metric Units

Unit: Kilogram per Cubic Centimetre (Kg/cm3)
Range: Greater than 0.0001

For Field Units

Unit: Gram Per Cubic Centimetre G/cm3
Range: Greater than 0.0001

19.7. Leak-Off Co-efficient

It describes the leak off of the medium

For Metric Units

Unit: Meter per square second (M/sec^1/2)
Range: Greater than 0.0001

For Field Units

Unit: Feet per square minute (Ft/min^1/2)
Range: Greater than 0.0001

20. Temperature Analysis

If the user has DTS (Distributed Temperature Sensing) data, then fill the data otherwise, leave this Temperature Analysis Input Tab.

DTS DATA	
Depth (Ft)	**Temperature (F)**
13550	100
13570	98
13590	98
13610	99
13630	97
13650	97
13670	98
13690	97
13710	103
13730	102.0
13750	102.5
13770	103.5
13790	108
13810	107

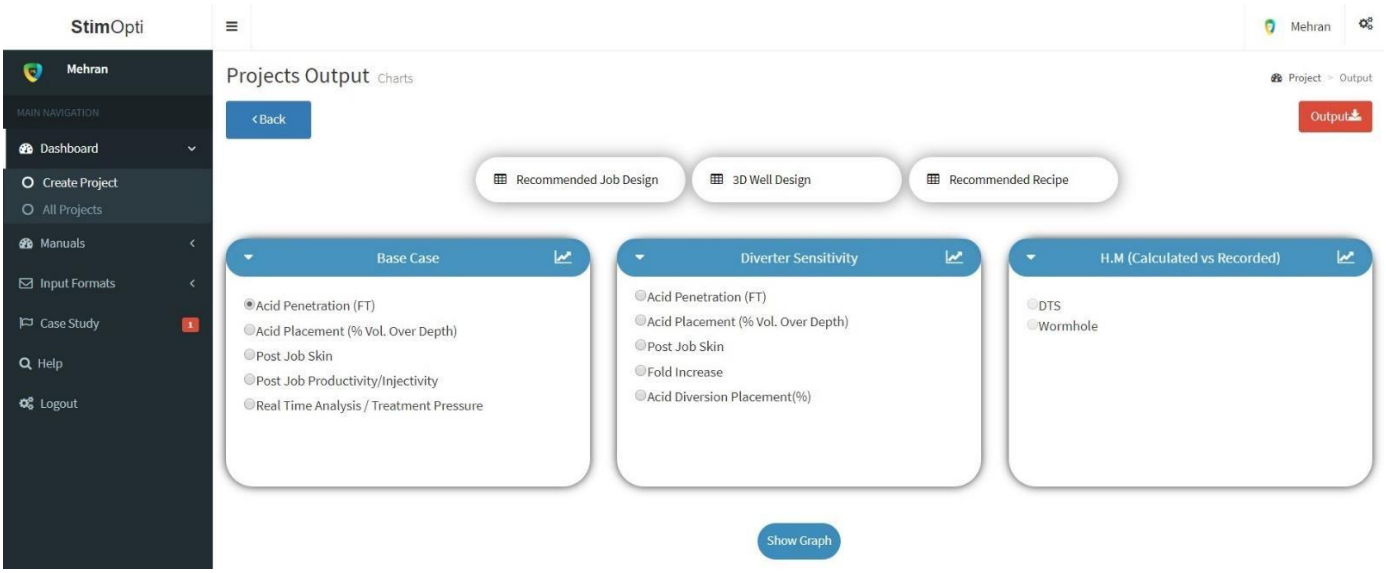
21. Run Simulation

After filling all the data user will have to click on the Run Simulation button to proceed**.** Now wait for few minutes to see the output page.

22. Output Page

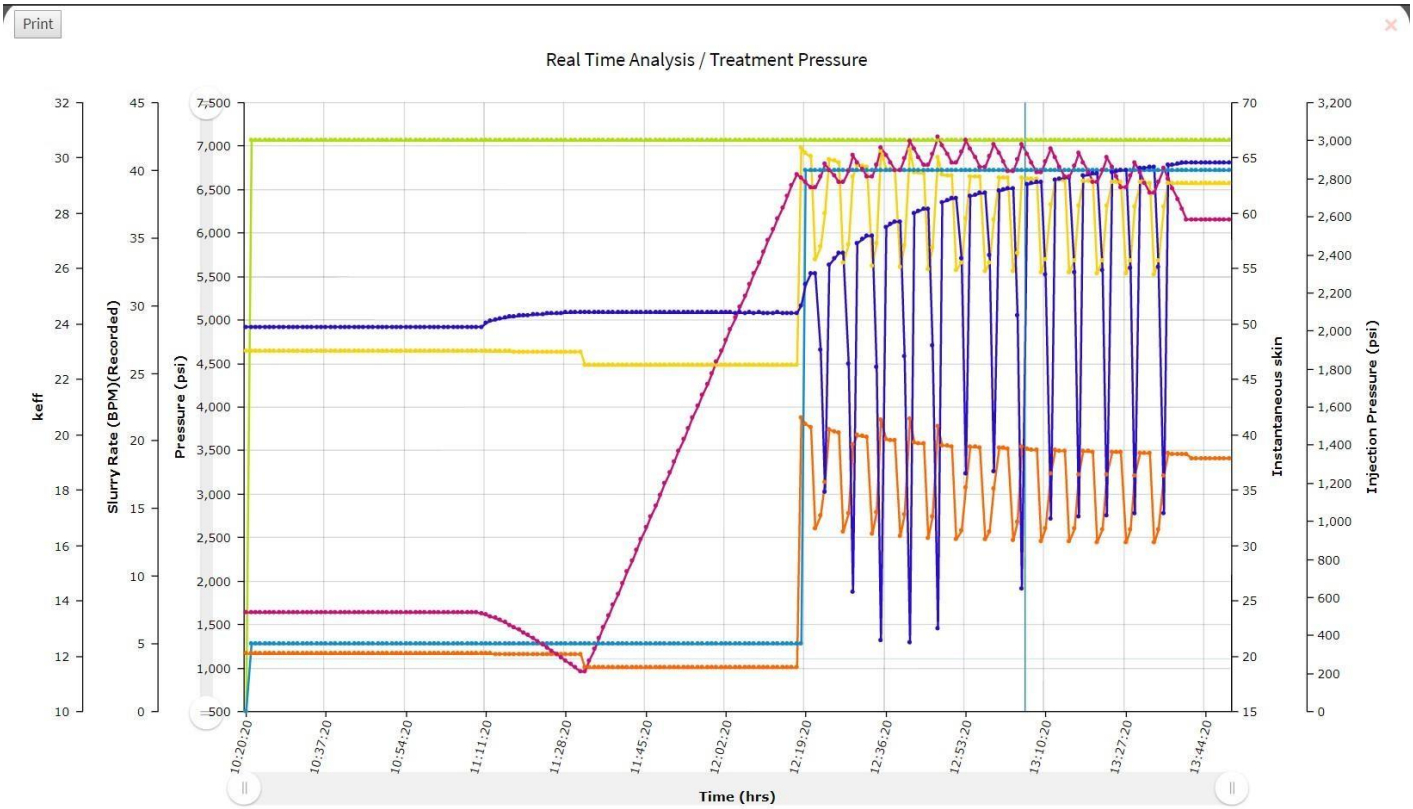
After successfully running the simulation, the user will be taken to the output page. On screen, the user will be shown Base Case Results, Diverter Sensitivity Results, the Recommended Job Design result and the Recommended Recipe

The user will check on the box next to the result and click the Show Graph button. Example:
If user selects **Real Time Analysis/Temperature Pressure** then to see the graph, after selection user must click on **Show Graph** button.



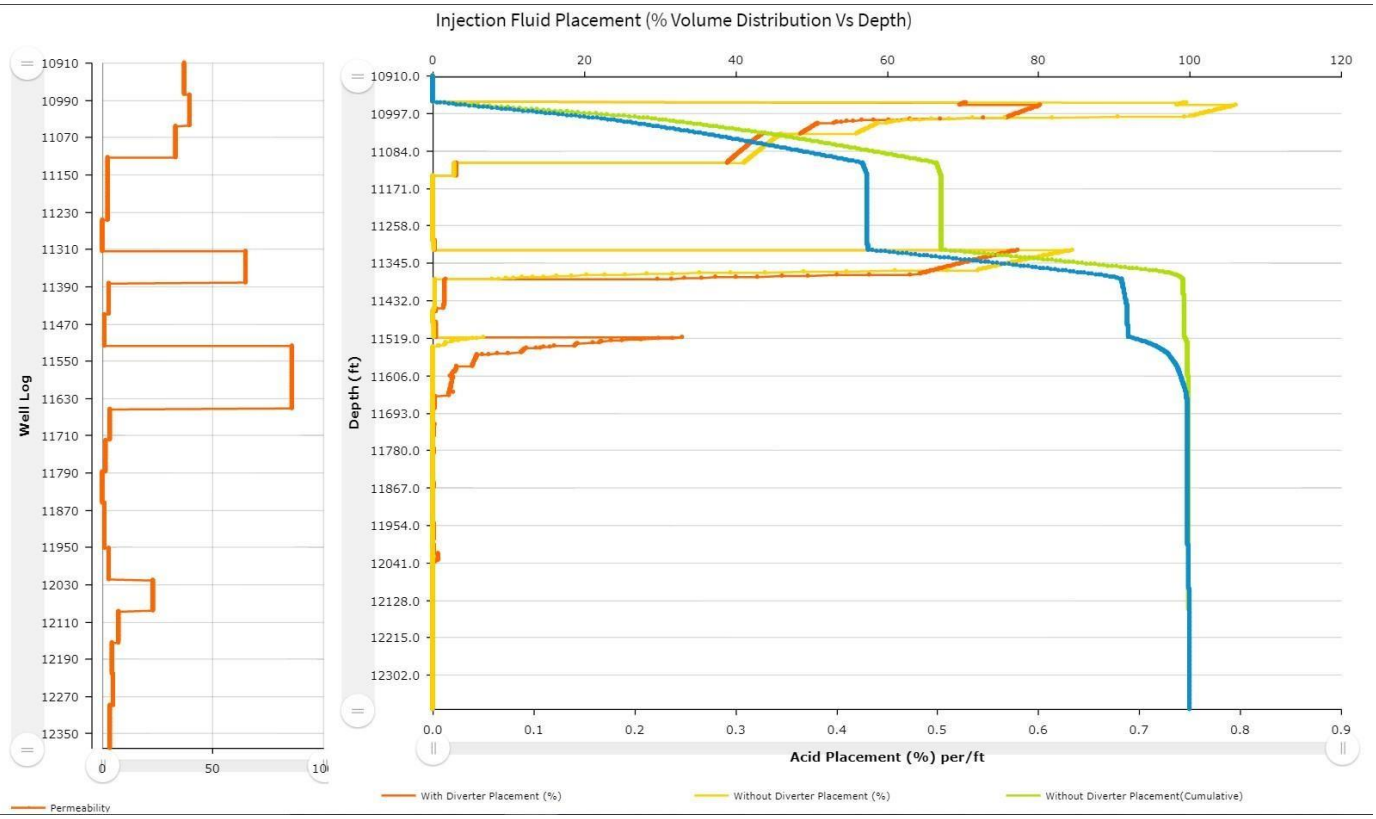
23. Analysis Result

23.1. Real time Analysis/ Treatment Pressure



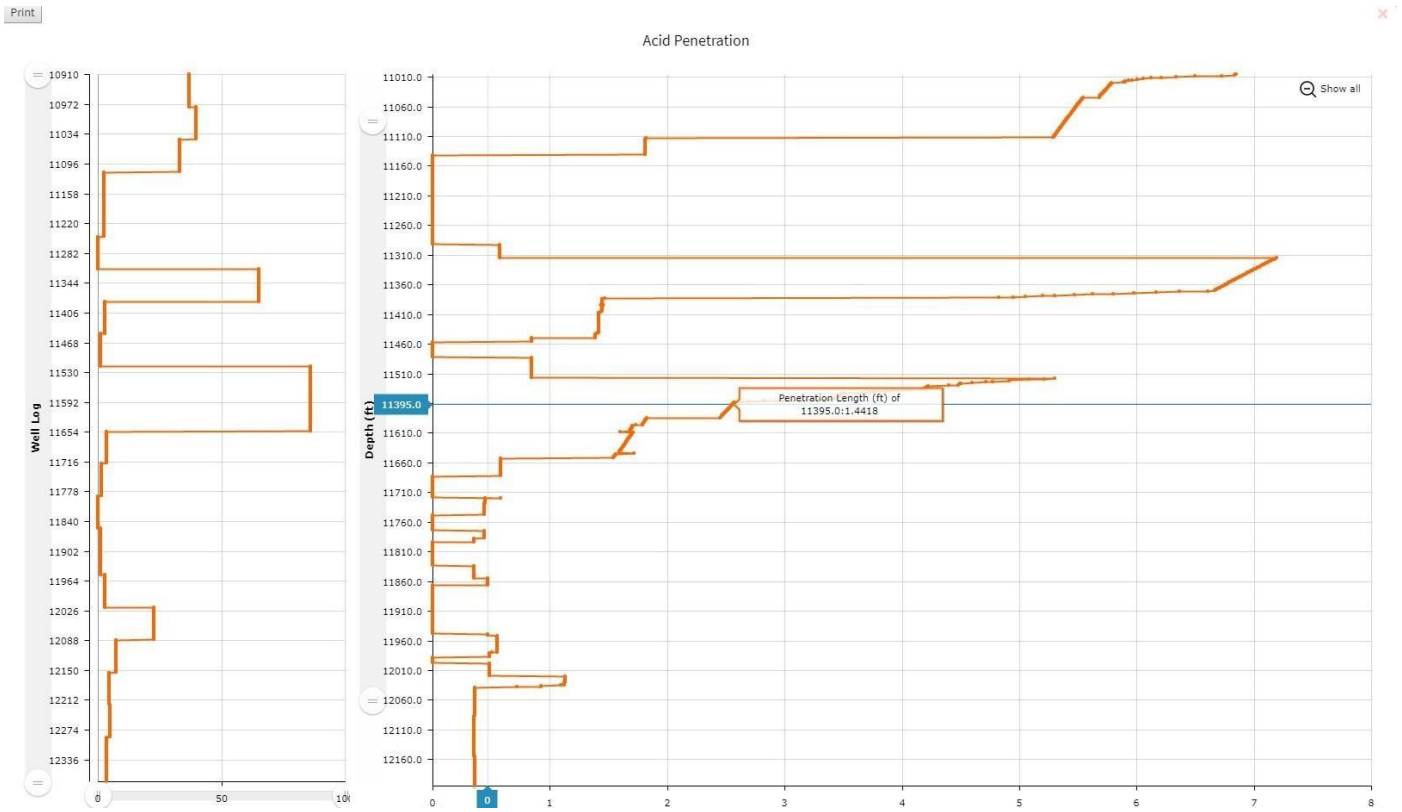
In above showing plot, y-axis shows the time interval (hours) and the left x-axis shows the pressure interval (psi), Slurry Rate (BPM) and Effective Permeability and on the right x-axis shows the Instantaneous Skin and also the Injection Pressure (psi) in the Real time Analysis/ Treatment pressure result.

23.2. Acid Placement



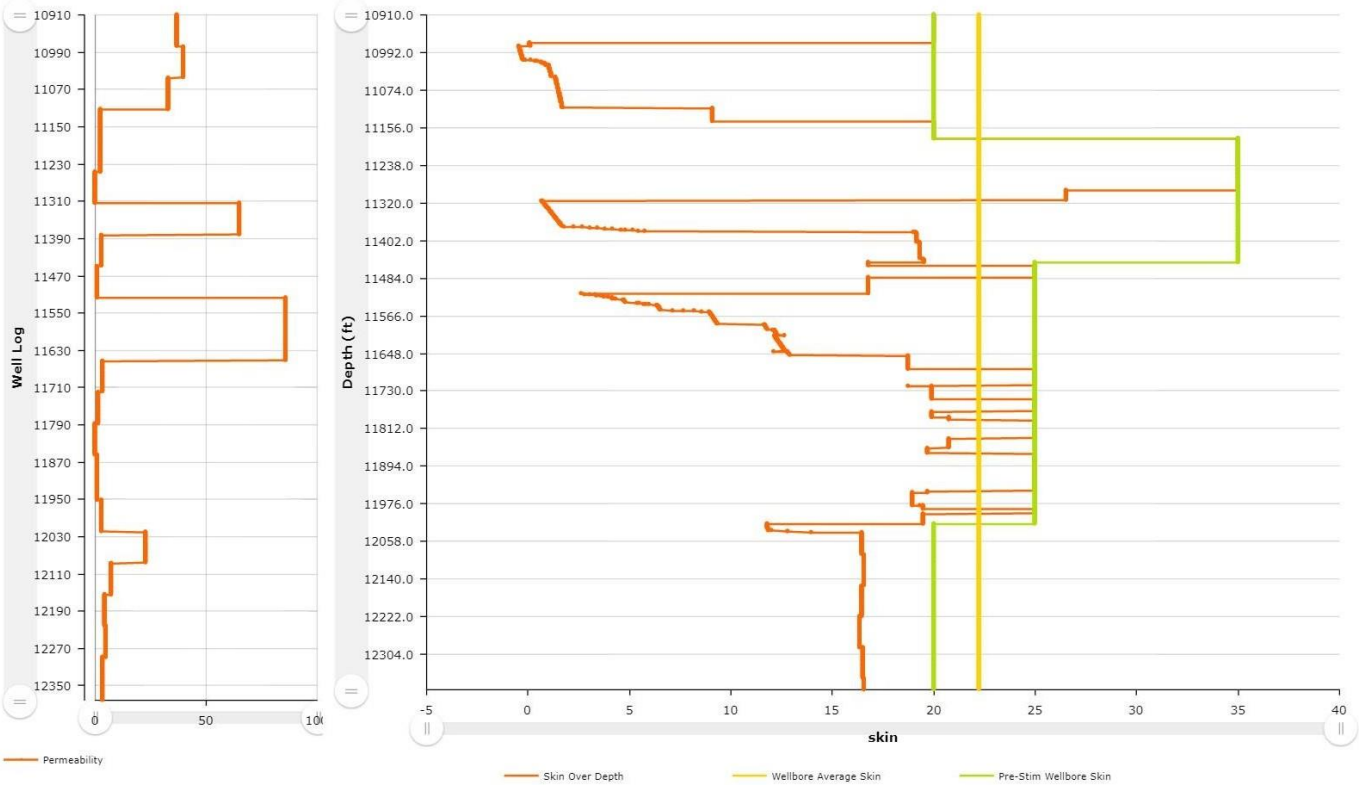
In above showing plot, y-axis shows the Depth (Ft) and the x-axis shows the Volume (%) in Placement analysis result.

23.3. Acid Penetration



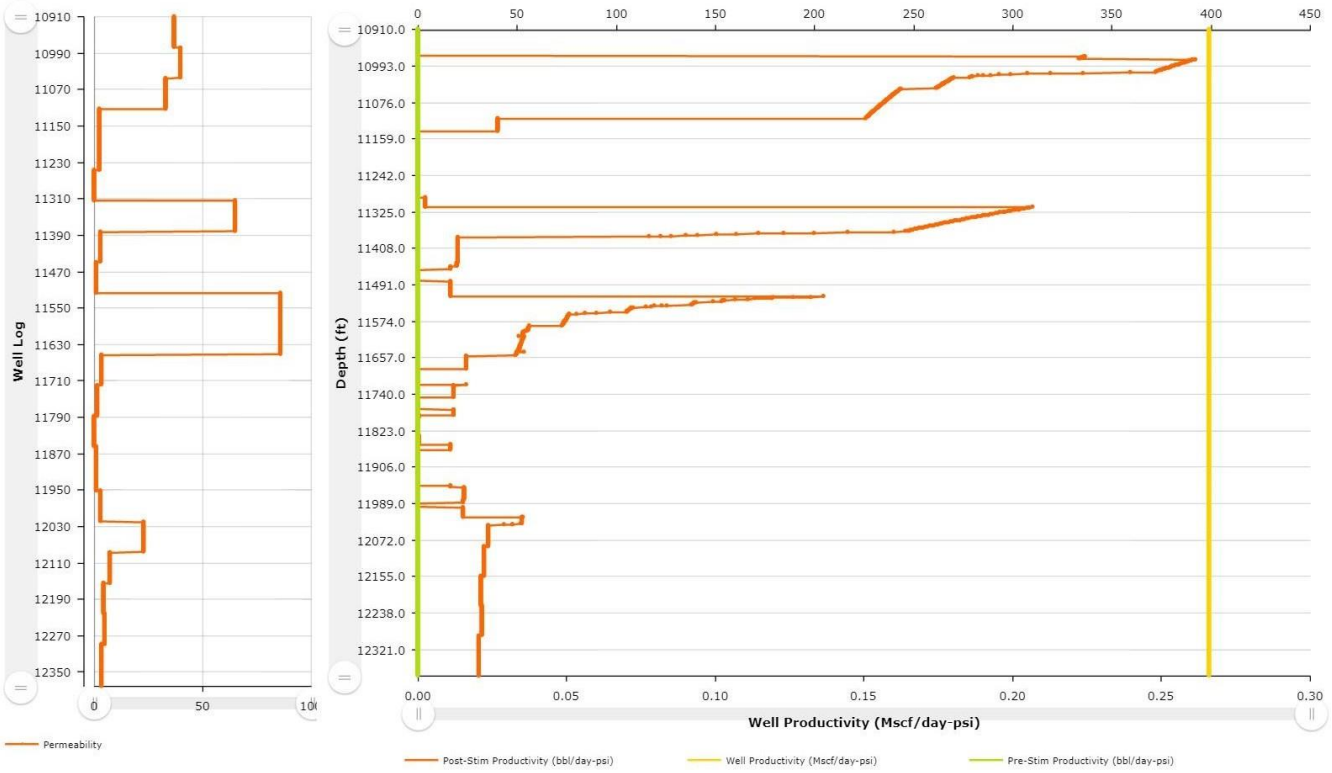
In above showing plot, y-axis shows the Depth (Ft) and the x-axis shows the Penetration Length (Ft)in Penetration analysis result.

23.4. Post Job Stimulated Skin



In above showing plot y-axis shows the Depth (Ft) and the x-axis shows the Skin in Post Stimulated Skin analysis result.

23.5. Productive Index



In above showing plot y-axis shows the Depth (Ft) and the x-axis shows the Productive Index (Mscf/day-psi) in Productivity Index analysis result.

23.6. Recommended Job Design Table

Print

PROPOSED DESIGN TABLE						
SERIAL NO.	**STAGE**	**PUMPRATE (BPM)**	**VISCOSITY (CP)**	**CONCENTRATION (%)**	**VOLUME (BBL)**	**DESCRIPTION OF OPERATION**
1	PREFLUSH	5.0	1.0	1.0	250.0	SEA WATER
2	ACID	18.70	1.0	28	2893	HCL 28
3	OVERFLUSH	18.70	1.0	1.0	4119	POST-FLUSH FLUID
4	TUBING DISPLACEMENT	18.70	1.0	1.0	560	SEA WATER
5	SHUT-IN					

18.70

PRESSURE AND RATE ASSUMPTION TABLE			
SERIAL NO.	**INJECTION RATE**	**MAX SURFACE INJECTION PRESSURE**	**RECOMMENDED ACID VOLUME PER FT**
1	18.70bpm	4421 psi	02.05 bbl/ft

23.7. Recommended Recipe

Print

PRE-FLUSH			
ADDITIVE NAME	**RANGE(%)**	**ACID NAME**	**RANGE(%)**
		WEAK ACID	3.0 < HCL < 7.5
SURFACTANT	0.1 < SURFACTANT < 0.5		
CORROSION INHIBITOR	0.5 < CORROSION INHIBITOR < 2.5		

MAIN-PILL			
ADDITIVE NAME	**RANGE(%)**	**ACID NAME**	**RANGE(%)**
SURFACTANT	0.1 < SURFACTANT < 0.5	HCL	7.0 < HCL < 28.0
CORROSION INHIBITOR	0.5 < CORROSION INHIBITOR < 2.5		

OVER-FLUSH			
ADDITIVE NAME	**RANGE(%)**	**ACID NAME**	**RANGE(%)**
		WEAK ACID	3.0 < HCL < 7.5
SURFACTANT	0.1 < SURFACTANT < 0.5		
SOAKING TIME (MIN)	60		

*** This is basic recipe design (developed based on formation temperature, mineralogy, potential hazard (if selected) and depth etc.) which field engineer need to blend along other specific needs of additive in their well & reservoir**