PE3025: Reservoir Engineering, Semester 1, 2016

Assignment #1 - Critical Review Report:

Relevance, Use and Abuse of Material Balance Equations and Decline Curve Analysis in

Reserves Engineering Studies: A Critical Review

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Volumetric Estimate

The method of reservoir estimations depends over reservoirs data which are volumetric and may be divided in to deterministic & stochastic estimate. The major problems in the volumetric estimates of resources reserves are that in the transfers of data received at a smaller scale core analyses, lithofacis data and well log, etc, into a much bigger scale (i.e. data 'up-scaling' for inter-well spaces).

Deterministic Method

The principles of a deterministic methods to resources / reserves estimate is to 'up-scale' the info produced from the well and gets the support from seismic surveys, into the inter well space by utilizing the interpolation techniques. The important parameter utilized for the volumetric estimates within these approaches are as follows:

• The reservoir's gross isopache maps that mean the bulk thicknesses of the reservoir rocks formations

• The reservoir's net isopache maps, that mean the cumulative thicknesses of the permeable rocks unit only. The Net to Gross ratio (N / G) is one of the main parameters which indicates the productive portions of the reservoirs.

The reservoir's rock porosity (as a volume based weight average) :-

$\varphi=\sum i\varphi iAihi/\sum i\ Aihi$

where φ is the local porosity, Ai is a sub area and hi is a sub thickness (of permeable rocks).

The permeable and net thickness product (khN) is important for the estimating the well production capacity.

$$\overline{(kh_N)} = h_N \frac{\sum_i k_i h_i}{\sum_i h_i} = \frac{N}{G} \sum_i k_i h_i,$$

where ki is the local permeability (other symbols as above).

• Volumetric based average saturation of water, gas and oil. For example water saturation:

$$\overline{S_w} = \frac{\sum_i S_{wi} \overline{\phi_i} \overline{A_i} \overline{h_i}}{\sum_i \overline{\phi_i} \overline{A_i} \overline{h_i}}.$$

Plotting the parameter as contour map (isopaches, isoprosity, isopermeablity, etc.) provide the critical info on the variations and distributions in the reservoirs and make it feasible to estimate the reservoir's porous volumes and the fraction saturation with oil & gas (hydrocarbons volumes). The numerical values of hydrocarbons resources / reserves estimates the representative outcomes of the integrated map analyses.

Stochastic Method

The alternate approaches are the stochastic or probability based estimations of the resources / reserves, that take higher accounts of the estimation uncertainties. Stochastic reservoirs descriptions are usually dependent on the procedures of random numbers generators. These numerical techniques assume that the major reservoirs property (porous , permeable, N / G, etc.) possess the random or even normal, frequency distribution, with ranges of value which include the core and well logs data. The max. & min. value are provided for every reservoir's parameter and the random numbers generators then 'drown data', figuratively speaking, and then simulate the actual density distributions in the whole reservoirs.

As an standard practice, it is obligatory to do again the stochastic simulations using different 'seed (or the initial boundary value) so as to assess and quantify the exact variations in the given specified parameters. Every numerical realization bear the uncertainty of the reservoir's characterization, where the stochastic instead of the deterministic, are the estimate of resources / reserves. Various realizations guide to various volume related estimate, with various related probabilities. The cumulative frequency distribution of the estimate, which is utilized to assess Also, commonly we are specified as follows:

– the estimate with 90 % or more probabilities are the levels that are regarded as the proven estimated values.

– the estimate having 50 % or above

Probabilities are the levels regarded as proven+probable values

Performance Analyses

The method of performance analyses currently utilized are :--

• Analyses depending on Material Balance Equation (MBE)

• Reservoirs Simulation Model (RSM)

• Decline Curve Analyses (DCA)

"The objects of all of these methods are to get the best reservoir performance predictions depending on the availability of the data. The MBE methods are dependent on the data received from the previous reservoirs performances and PVT analyses, but involve a few assumptions on the reservoirs driving mechanisms so as to minimize the ranges of probable prediction from the data set. The methods are thereby adjusted in different manner compared to the reservoir which contains oil, gases or oil with the gas caps - - primary or even secondary.

The Reservoirs Simulation Models or RSM methods involve the numerical simulations techniques, with the match of the production and the reservoir previous performances or the log history. The discrepancies amongst the simulations result (predictions) and the availability of data is minimized with the help if the reservoir adjustment. The reservoir parameters take into account the most probable reservoir drive mechanisms (as per the history matches).

The DCA methods are used to predicting the future performances of the reservoirs by comparing the observed trends of the production declines with one or many of the standard mathematical models of the production rate time (hyperbolic, harmonic, exponential, etc.). If it works successfully then such performance analyses allow us in estimating both the reserve & the futuristic performance of the reservoir.

The following decline curves from productions well are mostly used in the DCA:

– Production rates v/s time.

– Production rates v/s cumulative oil productions.

– Water cut v/s cumulative oil productions

– Gas-oil ratio v/s cumulative productions

– Per cent oil productions vs. cumulative oil productions

– The p / z ratio v/s. cumulative gas production ratio

In the case of a subsystem to hydrazine, the reservoir (s) are typically pressurized at launch. Unfortunately, this method has the disadvantage that orbit, the pressure therein decreases and measuring the fuel consumption, which also reduces the performance of propellants. In addition, the volume of fuel that can be stored in these systems is limited by the pressurizing device and the pressurantes compositions used.currently available means to provide good fuel injection pressure to the thrusters during the entire lifetime of the powered device are either to arrange a pump between the (or the) reservoir (s) and propellants, or to have upstream of (or more) reservoir (s) a system where the pressurizing gas such as nitrogen or helium is stored under high pressure and injected into the (or the) reservoir (s) as and measuring the fuel consumption.

Thus, US-A-5026259 describes a miniaturized device for pressurizing a propulsion system. The described device uses a low-pressure fluid stored and conducts the high pressure fluid by means of pumps. A propane-isobutane mixture is used to maintain a pressure between 3 and 10 × 10 5 Pa (between 3 and 10 bar) in about an intermediate fuel tank. The squeezing and the fuel are separated by a movable piston in the reservoir.

The paper ‘A novel design warm Gas pressurization system’, Primex, 1998 article describes a pressurization system by hot gas. This system does not include a pre-pressurized gas, it includes a gas in liquid form consisting of a mixture -MMH hydrazine. The mixture is catalytically decomposed for pressurization. The disclosed device utilizes metallic sealing means for isolating the pressurizing liquid in a titanium container, a catalyst.

Unfortunately, none of these compositions, systems, methods and devices solves the aforementioned problems. It therefore appears a great need to develop new systems and compositions do not exhibit the aforementioned drawbacks and for feeding propellants at an optimum injection pressure throughout the life of the device powered to obtain better performance.

Presentation of the innovation

The present invention is specifically to provide such a composition, a method and apparatus which overcome the drawbacks and meet the above requirements. Pressurizing composition of a fuel tank of a fuel booster of the present invention is characterized in that it consists of a system partly in liquid form with a saturating vapor pressure of about 5 × 10 5 Pa to 35 × 10 5 Pa, for example about 5 x 10 5 Pa to 22 × 10 5 Pa, at a temperature of about 10 ° C to 50 ° C. According to the invention, said composition can be formed for example of a mixture selected from propane-nitrogen, propane-ethane, ammonia nitrogen and isobutane-difluoromethane, or a pure compound selected from difluoromethane and ammonia.

The inventors have considered a first characteristic point of operation which is the end of the emptying of the fuel tank. At the end of emptying, the net volume of a tank is completely occupied by the squeezing. A minimum temperature and the corresponding final pressure which is necessarily minimal, the squeezing of the composition sufficient to determine his physical condition, that is to say, the vaporization rate and the physicochemical properties, in particular the density of the vapor phase and optionally from the liquid phase.

For a given total mass of squeezing, tank volume is known, the balance sheet of writing material leads to the equation below :

x M w (l - W) x M w

‘R d (T MIN r '^ MMIINN) d (T MIN, P MIN)

With M p squeezing onboard mass; rate of mass vaporization ratio of the mass of squeezing to vapor on the total mass of squeezing; V R useful volume of the reservoir; LM No minimum specified temperature;

• MIN final minimum pressure; (MIN, PMIN) the density of the vapor of squeezing to T M ι N, P MI N; d (M IN, PMIN) density of the liquid squeezing T M ι N, P MIN –

The minimum temperature is always specified, that equation is used to calculate the minimum pressure, weight or composition of squeezing as appropriate.

The inventors have considered another characteristic point of operation which is the end of filling, the nominal temperature and the maximum temperature.

After filling in the nominal temperature and corresponding pressure, the mass of propellant on board occupies a volume that can be calculated, which allows to deduce the remaining space for squeezing the mixture, the properties (physical state, masses liquid and vapor densities) are accessible in these conditions. The writing of the material balance leads to the expression (II) below:

Moi

Mp + x (- '• NAME +' _ W MOM) = V (T N0M, N0M P) p ^ \ r ^ or NAME '-ε (OM r ‘NOMM c weight of onboard propellant;

Mo squeezing onboard mass;

W, NOUN rate of vaporization mass, defined as the mass of steam on the total mass of the squeezing;

VR useful volume of the reservoir;

TNOM specified nominal temperature;

PNOM pressure before emptying the nominal temperature; dp (r TMON PMON) density of the steam squeezing T MÛ, PM O N; d (MON ι PMON) density of the liquid squeezing T MO N, PMON of (PNOM) density 1 'propellant to TNOMC PNOM) •

The nominal temperature is always specified, that equation is used to access the nominal pressure, mass or composition of squeezing, as the case study. At the maximum temperature, the corresponding pressure must be such that the equation (II) is always verified.

The principle of calculating the maximum mass of propellant can be embedded based on the fact that the maximum volume of propellant is obtained if the squeezing is totally liquid at the maximum temperature. One then obtains the equation (III):

Me = MAX (v R - x C (I Λ, PMΠ) (III)

V R useful volume of the reservoir;

Mc MAX maximum mass of propellant that can be embedded;

TMAX specified maximum temperature; PMAX maximum pressure that can be observed in the tank; dp (^ PMAX TMAX) density of the liquid squeezing MftX T, P MAX; dc (T: MAX / t A j density of 1 'propellant.

Depending on the nature of the problem, different models have been developed to calculate the most important characteristics of a pressurization. Note that regardless of the model, the three temperatures, minimum, and maximum nominal • must be specified.

References

Schlumberger Educational Service (1994).: Modern Reservoir Testing. Schlumberger, SMP-7055, Houston,

Agarval, R.G. (1980). A new method to account for producing time effects when drawdown type curves are used to analyze pressure build-up and other test data. Paper SPE 9289,.

Amyx J.W., Jr. Bass, D.M., and Whiting R.L.(1960).. Petroleum Reservoir Engineering. McGraw-Hill, New York, Archer. J.S. and Wall, P.G. (1991.Petroleum Engineering: Principles and Practice. Graham & Trotman, London,