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ASPECTS REGARDING THE CALIBRATION OF THE VERTICAL LIFT PERFORMANCE CURVES

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Abstract: *In this paper we study how the calibration or non-calibration of the oil PVT properties and the two-phase flow correlations influences the vertical lift performance curve in the case of naturally flowing well. Several working scenarios regarding the calibration, respectively non-calibration of the oil PVT properties as well as the two-phase flow correlations were considered. This study shows a small influence of oil PVT properties (calibrated or non-calibrated) on the pressure traverse curves and consequently on vertical lift performance curves. On the other hand, the calibration of the two-phase flow correlations is very important; the results before calibration and after calibration being very different. Also, a practical aspect related by the number of measured data used in calibration process is shown.*

Key words: *two-phase flow correlations, oil PVT properties, calibration, pressure, vertical lift performance curve*

1. INTRODUCTION

The naturally flowing well is the simplest production system with the simplest down-hole and surface completion. The down-hole completion consists of the tubing string and the packer. The Christmas tree is installed at the surface and is connected with the separator through the flow-line(fig.1).

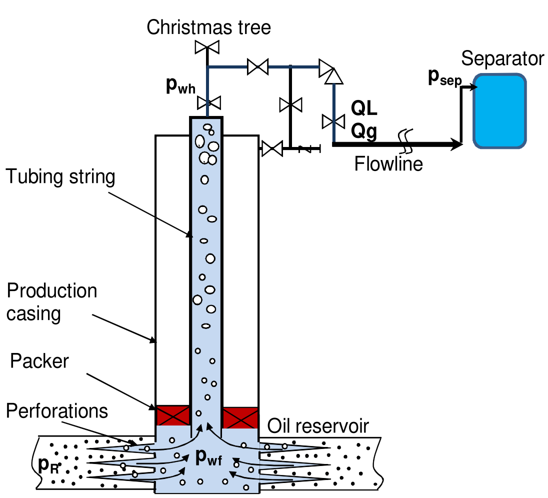

Fig. 1. Components of the production system for a naturally flowing well.

The packer avoids the reservoir fluids to flow through annular space between the production casing and tubing string, being installed at the lower part of the tubing string.

The fluids pass through the perforations of the production casing and then flow upwards through the tubing string to the surface at the Christmas tree. Thereafter, the fluid flows through flow-line to the separators.

In the case of a naturally flowing well, the oil reservoir has enough energy to lift the fluid through tubing string to the surface and to transport it to the separator.

The characteristic pressures of this production system are: reservoir pressure, p_R, bottom-hole pressure, p_{wf}, wellhead pressure, p_{wh} and separator pressure, p_{sep}.

The fluid flow through the production system shown in the figure 1 is generally biphasic because in the most cases the bubble point pressure is higher than the pressures mentioned above. As we show in figure 1, the two-phase flow through the production system has two components like the vertical flow through the tubing string and the horizontal flow through the flow-line. In our paper we refer only to the vertical two-phase flow.

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The two-phase flow through the tubing string shows many flow patterns like bubble, slug, foam and annular or mist. These are determined by the variation of the physical fluid properties, the slippage and the gas exit from solution. The variation of the fluid pressure along the tubing string or pressure traverse curve can be determine on the basis of the measured data or the predicted data with many two-phase flow correlations. These correlations depend on the oil PVT (Pressure Volume Temperature) properties, which in turn are strongly influenced by pressure and temperature. Therefore, it is necessary to select the appropriate correlations to predict the fluid PVT properties and the appropriate two-phase flow correlation in order to build the pressure traverse curves, respectively the Vertical Lift Performance curves.

In recent years, the good practice methods in the production engineering require the calibration of correlations to determine the fluid PVT properties as well as the two-phase flow correlations. In this case, these correlations are adapted to the specific data of a well so that the fluid and flow models are as close as possible to the real ones.

In our study we will build a calibrated fluid model which will be included into calibrated two-phase flow correlation. Beside this case, where the fluid PVT properties and the flow correlation are calibrated, we will study also the errors magnitude when the calibration is partial or missing.

This study is carried out because in the field practice the oil PVT properties can be incomplete or erroneous and an actual pressure flowing survey may be missing or has only two data points. In this situation, calibrating both the fluid PVT properties and the two-phase flow correlation is very difficult and we want to know the magnitude of the errors.

2. CALIBRATION OF FLUID PVT PROPERTIES

The fluid PVT properties can be measured or predicted with many correlations. The measured PVT data are provided by specialized laboratory which use the down-hole samples collected from the well. It is important to check the validity of PVT data and to identify the most representative PVT sample, because an invalid PVT data can lead to high uncertainty in many areas like field development study, reservoir simulation, production engineering and surface facility design [7].

Therefore, the quality and quantity of the measured PVT data are very important because these are used for the calibration of the correlations which describe the fluid model.

The PVT measured data set provided by laboratory corresponds to a pressure range and a temperature. To extrapolate them to different pressures and temperatures, we find in the literature many correlations that, however, lead to different results. Therefore, it would be better to determine which correlation best fits the measured data and to calibrate it.

The calibration of fluid PVT properties is based on regression in order to fit or match some existing correlation with measured data. Then, we can use the matched correlation to simulate the variation of fluid PVT properties on a wide range of pressures and temperatures, other than those measured.

Further we will predict the oil PVT properties like gas-oil ratio, formation volume factor, oil viscosity with several correlations, in order to compare these values with those measured. We consider the three fluid PVT properties mentioned above, because they have an important impact in the friction pressure drop and the hydrostatic pressure drop along the tubing string [8] and we will also use them in the next sections of the paper.

The standard correlations used to predict the three oil PVT properties are: Standing [12], Vasquez-Beggs [14], Lasater [9], Beal [2], Beggs [3]. From these, we will select the correlations that lead to minimal errors compared to the measured data and will match them by regression.

Figures 2, 3 and 4 show the variation of gas-oil ratio, R_s, formation volume factor, B_o and oil viscosity versus pressure at a temperature of 80°C. We observe from these figures the differences between the measured data, predicted values of oil PVT properties with different correlations and matched correlations.

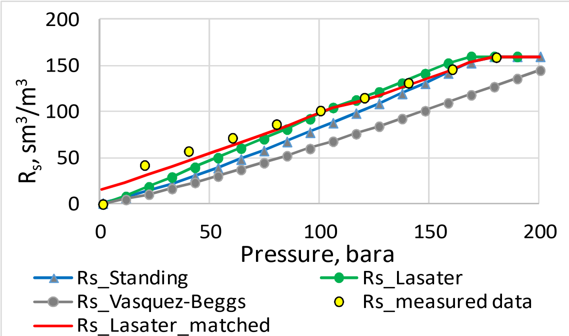

Fig. 2. Gas-oil ratio versus pressure at the temperature of 80°C.

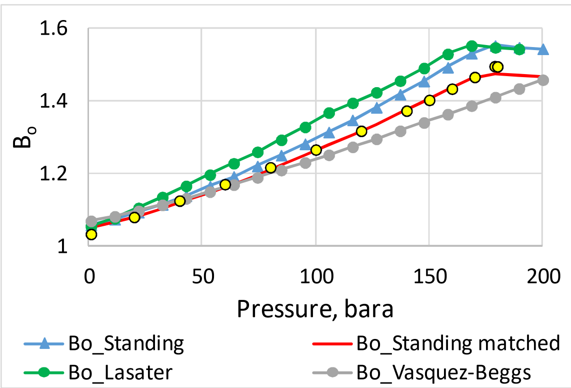

Fig. 3. Oil formation volume factor versus pressure at the temperature of 80°C.

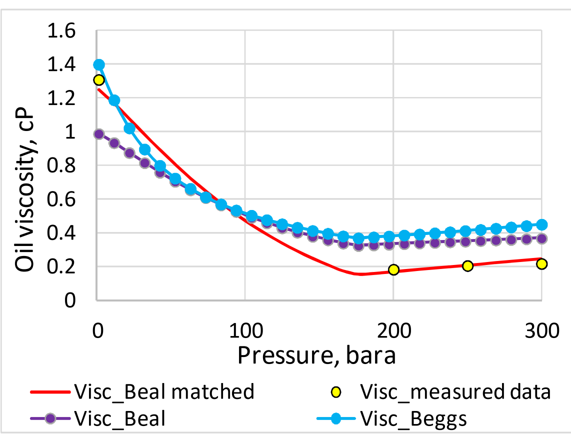

Fig. 4. Oil viscosity versus pressure at the temperature of 80°C.

To quantify the errors between measured data and predicted values of the fluid PVT properties with different correlations, we calculate the squared errors(SE), sum of squared errors(SSE), mean squared errors (MSE) and root mean squared errors(RMSE), whose equations are shown below:

$$SE = (x_i - x_{im})^2 \qquad (1)$$

$$SE = \sum(x_i - x_{im})^2 \qquad (2)$$

$$MSE = \frac{\sum(x_i - x_{im})^2}{n} \qquad (3)$$

$$RMSE = \sqrt{\frac{\sum(x_i - x_{im})^2}{n}} \qquad (4)$$

Where:
x_i is the predicted value;
x_{im} —measured value;
n —number of samples.

The calculated values of the errors are shown in tables 1 to 4.

Table 1

SSE, MSE, RMSE for gas oil ratio predicted with different correlations.

Correlation	SSE	MSE	RMSE
Standing	3571,237	357,124	18,898
Lasater	1478,547	147,855	12,160
Lasater matched	655,396	65,540	8,096
Vasquez-Beggs	11405,220	1140,522	33,772

Table 2

SSE, MSE, RMSE for oil formation volume factor predicted with different correlations.

Correlation	SSE	MSE	RMSE
Standing	0,014600	0,00146	0,03820
Standing matched	0,000944	0,00009	0,00971
Lasater	0,145800	0,01458	0,12070
Vasquez-Beggs	0,017400	0,00174	0,04170

Table 3

SSE, MSE, RMSE for oil viscosity predicted with different correlations.

Correlation	SSE	MSE	RMSE
Beal	0,07387	0,018468	0,135896
Beal matched	0,005098	0,001275	0,035702
Beggs	0,145129	0,036282	0,190479

Table 4

Squared errors for bubble point pressure predicted with different correlations.

Bubble point pressure	Value, bara	SE
Measured	181,00	
Standing	174,77	38,81
Lasater	164,33	277,89
Vasquez-Beggs	217,27	1315,50

From the figures 2 to 4 and the tables 1 to 4 we observe that the following correlations leads to minimal errors: the Lasater correlation[9] for gas-oil ratio, the Standing correlation[12] for oil formation volume factor, the Beal correlation[2] for oil viscosity and the Standing correlation[12] for bubble point pressure.

The correlations mentioned above are matched with the measured data which leads to smaller errors, as we see in tables 1 to 3.

3. CALIBRATION OF TWO-PHASE FLOW CORRELATIONS

The variation of the fluid flow pressure through the tubing string with respect to the depth or the pressure traverse curve is very important in the analysis and the optimization process of the production system.

The pressure traverse curve is built on the basis of the measured data (fluid flowing pressure versus depth) or using the two-phase flow correlations.

The two–phase flow correlations were developed by many researchers from 1950 years until now.

The most used or standard correlations are Duns and Ros[5], Hagedorn and Brown[6], Orkiszewski[11] and Beggs and Brill[4]. All these flow correlations are empirical. Beside these, we use in our study the flow correlation developed by Ansari et. al [1] which is mechanistic.

Recently, the researchers use the artificial intelligence to develop new methods to simulate the two-phase flow through tubing string and to determine the flowing bottom-hole pressure. For instance, Tariq et al. [13] propose a combination between particle swarm optimization and artificial neural network to determine the pressure traverse curves and bottom-hole pressure based on the surface measured data.

Also, Memon et al. [10] develop a method to predict the dynamic bottom-hole pressure based on radial basis neural network which use the data from reservoir simulation.

However, these methods are not implemented in the commercial software which are regular used in the petroleum industry and they are not used on a large scale.

In the most cases, the available measured data are the bottom hole flowing pressure, p_{wf} at a reference depth, H, the wellhead pressure, p_{wh}, the flow rate of liquid, Q_L and the flow rate of gas, Q_g. Here, it is necessary to use many two-phase flow correlations to build the pressure traverse curves. Then, we determine the bottom hole flowing pressures and compare them with the measured one, in order to select the appropriate two-phase flow correlation that leads to minimal errors.

To diminish the errors between the measured data and the predicted data, the two-phase flow correlation will be matched in this case with only two data points $((p_{wh}, 0); (p_{wf}, H))$.

When the data from the flowing pressure survey are available, we have many data points in order to match an appropriate two-phase flow correlation.

All two-phase flow correlations start to the total pressure gradient defined by the follow equation:

$$\left(\frac{\Delta p}{\Delta h}\right)_{\text{total}} = \left(\frac{\Delta p}{\Delta h}\right)_{\text{static}} + \left(\frac{\Delta p}{\Delta h}\right)_{\text{friction}} + \left(\frac{\Delta p}{\Delta h}\right)_{\text{acc}}. \qquad (5)$$

As we show in the equation (5), the total pressure gradient has three components such as:

- static gradient$(\Delta p/\Delta h)_{static}$;
- friction gradient $(\Delta p/\Delta h)_{friction}$;
- acceleration gradient$(\Delta p/\Delta h)_{acc}$.

Usually, for oil well the first two components of the total gradient are important. The acceleration gradient becomes significant when the gas flow rate is high, for example the gas-condensate wells.

The matching or calibration process of the two-phase flow correlations with the measured data can be performed with specialized software which calculates the adjusting parameters of the friction and static gradient as well as overall heat transfer coefficient [8].

The calculated values of the adjusting parameters for different flow correlations can vary in a large range.

However, we consider the two-phase flow correlation with the calculated parameters in range of (0,8-1,2)[8] to avoid the discrepancy between the real data (well completion data, measured PVT data and well testing data) and the predicted data with the calibrated two-phase flow correlation.

4. CALIBRATION OF VERTICAL LIFT PERFORMANCE CURVE

Vertical Lift Performance curve describe the fluid flow through tubing string and provide the values of bottom-hole flowing pressure necessary to produce different flow rates when the wellhead pressure is p_{wh}. This curve is used in nodal analysis together with the Inflow Performance Relationships (IPR) in order to establish the coordinates of the operating point(fig.5).

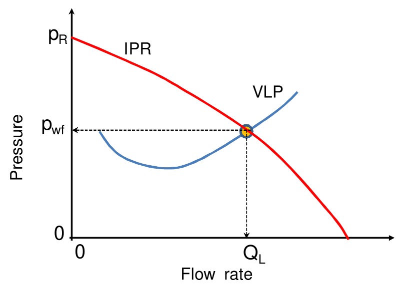

Fig. 5. Nodal analysis.

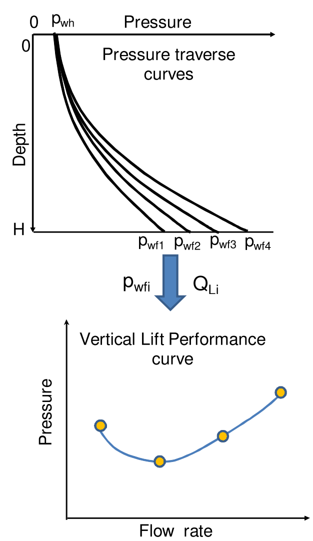

Fig. 6. Pressure traverse curves and VLP curve.

The Vertical Lift Performance (VLP) curve is built on the basis of the bottom-hole flowing pressures and corresponding flow rates resulted from the pressure traverse curves. These curves are built for a wellhead pressure and many values of the flow rate (fig.6). The calibration of VLP curve is based on both oil PVT properties calibration and two-phase flow correlation calibration.

5. RESULTS AND DISCUSSION

Our study highlights how the calibration of both oil PVT properties and two-phase flow correlation influences the errors magnitude between measured data and predicted data and the selection process of an appropriate two-phase flow correlation.

We investigate also how the pressure traverse curves and Vertical Lift Performance curves are influenced by the calibration or non calibration process and we determine the errors magnitude in different cases.

Thus we consider the following working scenarios in order to build the pressure traverse curves:

- Non-calibrated oil PVT properties and non-calibrated two-phase flow correlations;
- Calibrated oil PVT properties and non-calibrated two-phase flow correlations;
- Calibrated oil PVT properties and calibrated two-phase flow correlations.

The errors between measured data and predicted data are calculated with the equations (1) to (4) for each working scenario. To carry out our study, we consider a naturally flowing well with the characteristics data shown in the table 5. Also, data from the flowing pressure survey are shown in the table 6.

Table 5

Well characteristic data.

Parameter	**Units**	**Value**
Reservoir pressure, p_R	bara	164,000
Reservoir temperature, t_R	ºC	80,000
Wellhead temperature	ºC	28,940
Bottom hole flowing pressure, p_{wf}	bar	75,850
Gas liquid ratio, GLR	sm^3/m^3	159,200
Liquid flow rate, Q_L	m^3/d	39,400
Water cut, i	%	0,000
Casing length	m	1890,000
Tubing string length, m	m	1800,000
Angle of deviation	degree	0,000
Tubing inner diameter, d	m	0,0597
Casing inner diameter, D	m	0,162
Wellhead pressure, p_{wh}	bar	22,900
Oil density, ρ_o	kg/m^3	820,000
Relative density of gas, ρ_{rg}		0,875
Oil Viscosity, μ_o at 80ºC and p =1 bara	cP	1,310

Table 6

Data from the flowing pressure survey.

Depth	Pressure
m	bara
0	22,91
500	35,65
1000	48,15
1500	62,25
1800	72,75
1890	75,85

As we establish for the first working scenario, the oil PVT properties and the two-phase flow correlations are non- calibrated. Here, we use the correlations developed by Standing[12] and Beal[2] in order to predict the gas-oil ratio, formation volume factor and oil viscosity in respect with the pressure. To build the pressure traverse curves we use many two-phase flow correlations like Duns and Ros[5], Hagedorn and Brown[6], Orkiszewski[11], Beggs and Brill[4] and Ansari et.al[1].

The results of calculus are shown graphically in the figure 7 alongside of the available data from the flowing pressure survey.

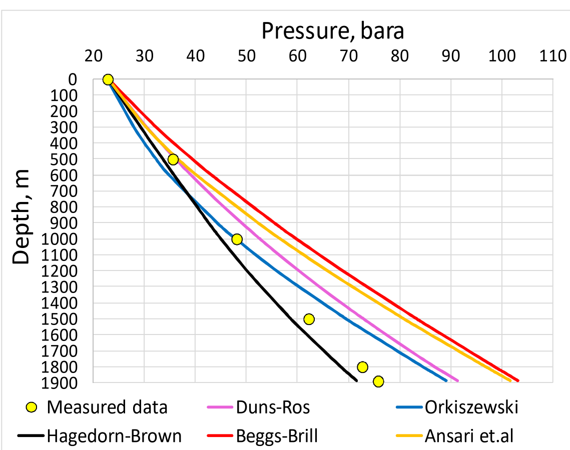

Fig. 7. Pressure traverse curves built with non –calibrated flow correlations and non-calibrated oil PVT properties (correlations of Standing, respectively Beal).

Table 7

SSE, MSE, RMSE for non-calibrated flow correlations and non-calibrated oil PVT properties.

Flow correlation	SSE	MSE	RMSE
Ansari et al	1646,901	274,484	16,568
Orkiszewski	374,432	62,405	7,900
Hagedorn -Brown	67,915	11,319	3,364
Beggs- Brill	1993,800	332,301	18,229
Duns- Ros	562,912	93,819	9,686

Table 8

Predicted bottom-hole flowing pressure with non-calibrated flow correlations and non calibrated oil PVT properties.

Flow correlation	Predicted p_{wf} bara	SE
Ansari et al	101,664	666,368
Orkiszewski	89,133	176,441
Hagedorn -Brown	71,482	19,0759
Beggs- Brill	103,83	747,076
Duns- Ros	91,32	239,321

In the table 7 are shown the values of the errors for each two-phase flow correlation and in the table 8 are shown the squared errors (SE) for bottom hole flowing pressure predicted with the two-phase flow correlations mentioned above.

The figure 7 and the table 7 show that the measured data are closed to the pressure traverse curve built with the Hagedorn and Brown correlation [6]. Also, the squared error for predicted bottom hole flowing pressure with this correlation is the smallest. The largest error in this case is provided by Beggs and Brill correlation [4].

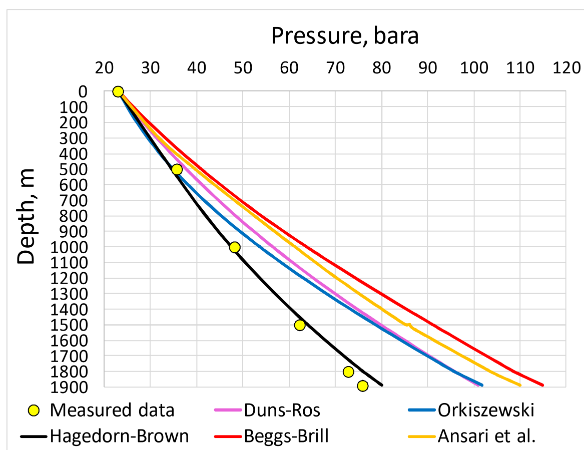

Fig. 8. Pressure traverse curves built with non–calibrated two-phase flow correlations and calibrated oil PVT properties.

In the second working scenario we considered the calibrated oil PVT correlations of Standing [12], respectively Beal [2] and the same non-calibrated two-phase flow correlations as in the first working scenario. The graphical results are shown in the figure 8.

If we compare the figure 8 with the figure 7 we observe that the calibration of the oil PVT properties has a small influence on the pressure traverse curves. Here, these curves move slightly to the right. Calculated values of the errors in this case are shown in tables 9 and 10.

Table 9

SSE, MSE, RMSE for non-calibrated flow correlations and calibrated oil PVT properties.

Flow correlation	SSE	MSE	RMSE
Ansari et al	2872,734	478,789	21,881
Orkiszewski	1479,000	246,500	15,700
Hagedorn -Brown	31,555	5,259	2,293
Beggs- Brill	3891,850	648,640	25,470
Duns- Ros	1456,650	242,775	15,581

Table 10

Predicted bottom-hole flowing pressure with non-calibrated two-phase flow correlations and calibrated oil PVT properties

Flow correlation	Predicted p_{wf} bara	SE
Ansari et al	110,073	1521,78
Orkiszewski	101,69	667,71
Hagedorn -Brown	80,00	17,22
Beggs- Brill	114,86	1521,78
Duns- Ros	100,87	625,50

Tables 9 and 10 show that the correlation of Hagedorn and Brown [6] leads to the smallest errors.

In both cases where oil PVT properties are calibrated or non-calibrated but the two-phase flow correlations are non-calibrated, the appropriate flow correlation seems to be that developed by Hagedorn and Brown [6] (tables 7 to 10) because the errors are the smallest for this flow correlation.

The third working scenario assumes that both the oil PVT properties and the two-phase flow correlations are calibrated.

In the first step we use all data from the flowing pressure survey to match the two-phase flow correlations and in the second step we consider only two data points $((p_{wh}, 0); (p_{wf}, H)$ in the matching process.

We use the same two-phase flow correlations as in the first and second working scenarios. These are matched with the data from flowing pressure survey from the table 6.

Also, for oil PVT properties we use the matched correlations of Standing [12], respectively Beal [2].

In the table 11 and 12 are shown the calculated errors for each calibrated two-phase flow correlation and the adjusting parameters of the static and friction gradient.

Table 11

SSE, MSE, RMSE for calibrated flow correlations and calibrated oil PVT properties.

Flow correlation	SSE	MSE	RMSE
Ansari	18,102	3,017	1,737
Orkiszewski	38,212	6,369	2,524
Hagedorn -Brown	13,346	2,224	1,491
Beggs- Brill	4,179	0,696	0,834
Duns- Ros	3,923	0,654	0,809

Table 12

Adjusting parameters for calibrated two-phase flow correlations.

Parameters	1	2
Ansari et al	1,9979	0,3304
Orkiszewski	0,7896	0,3719
Hagedorn -Brown	0,9538	1,0000
Beggs- Brill	0,6646	0,4194
Duns- Ros	0,7414	6,2612

Table 13 shows the values of the predicted bottom-hole pressure and squared errors in the case of calibrated two-phase flow correlation and oil PVT properties.

Table 13

Predicted bottom-hole flowing pressure with calibrated two-phase flow correlations and oil PVT.

Flow correlation	p_{wf} bara	SE
Ansari et al	77,430	2,497
Orkiszewski	77,67	3,312
Hagedorn -Brown	77,9	4,202
Beggs- Brill	76,54	0,476
Duns- Ros	76,4	0,303

From the tables 11, 12 and 13 we can see that the Duns and Ros correlation [5] leads to the smallest errors in this case, however the two adjusting parameters are out of range.

The only one flow correlation with parameters 1 and 2 in range is that developed by Hagedorn and Brown[6], which on the other hand leads to bigger errors (RMSE=1,491) in this case.

After the matching process, the pressure traverse curves are closed to the measured data as we see in the figure 9.

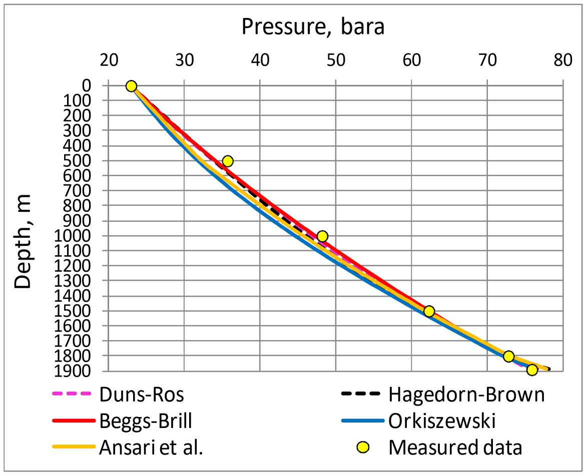

Fig. 9 Pressure traverse curves built with both the two-phase flow correlations and the oil PVT properties calibrated.

Further we considered only two available data points $(((p_{wh}, 0); (p_{wf}, H))$ and we use them to calibrate the two-phase flow correlations considering also the calibrated oil PVT properties. The errors in this case are shown in the table 14 to 16.

Table 14

SSE, MSE, RMSE for calibrated oil PVTand calibrated flow correlations based on two data points.

Flow correlation	SSE	MSE	RMSE
Ansari	27,092	4,515	2,125
Orkiszewski	51,198	8,533	2,921
Hagedorn -Brown	23,975	3,996	1,999
Beggs- Brill	5,450	0,908	0,953
Duns- Ros	6,540	1,090	1,044

Table 15

Adjusting parameters for calibrated two-phase flow correlations based on two data points.

Parameters	1	2
Ansari et al	1,4979	0,9890
Orkiszewski	0,7732	0,2000
Hagedorn -Brown	0,9301	1,0000
Beggs- Brill	0,6538	1,0000
Duns- Ros	0,7638	1,0000

Table 16

Predicted bottom-hole flowing pressure with calibrated oil PVT properties and calibrated two-phase flow correlations based on two data points.

Flow correlation	Predicted p_{wf} bara	SE
Ansari et al	75,93	0,0064
Orkiszewski	75,80	0.0025
Hagedorn -Brown	75,91	0,0036
Beggs- Brill	75,9	0,0025
Duns- Ros	75,87	0,0004

From the table 14 we observe that the errors are slightly bigger than in the case where many data points are available (see table 11). On the other hand the predicted bottom-hole flowing pressure is more closed to the measured data for all calibrated two-phase flow correlations.

Therefore, if only two data points are available (the common situation), the error level is not very high compared to where many measured data from pressure flowing survey are available.

From the tables 11,13,14 and 16 we observe that the three flow correlations developed by Hagedorn and Brown [6], respectively Duns and Ros [5], respectively Beggs and Brill [4] lead to smaller errors. Further we use these correlations to build the pressure traverse curves in order to determine the Vertical Lift Performance curves. We note that the flow correlations developed by Duns and Ros [5], respectively Beggs and Brill [4] have the adjusting parameters out of range, however they have the smallest errors.

The Vertical Lift Performance curves are built for the following two cases:

- non-calibrated oil PVT properties and non calibrated two-phase flow correlations;
- calibrated both the oil PVT properties and the two-phase flow correlations.

The graphical results for the two cases are shown in the figures 10 and 11.

Also, the calculated errors are presented in the tables 17 and 18.

Table 17

SE for predicted coordinates of the operating point in the case of non -calibrated oil PVT properties and non calibrated two-phase flow correlation.

Flow correlation	Squared errors	
	p_{wf}	Q_L
Hagedorn -Brown	11,156	0,04
Beggs- Brill	746,382	0,04
Duns- Ros	173,449	0,04

Table 18

SE for predicted coordinates of operating point in the case of calibrated oil PVT properties and calibrated two-phase flow correlation.

Flow correlation	Squared errors	
	p_{wf}	Q_L
Hagedorn -Brown	3,240	0,04

Beggs- Brill	0,348	0,04
Duns- Ros	0,084	0,04

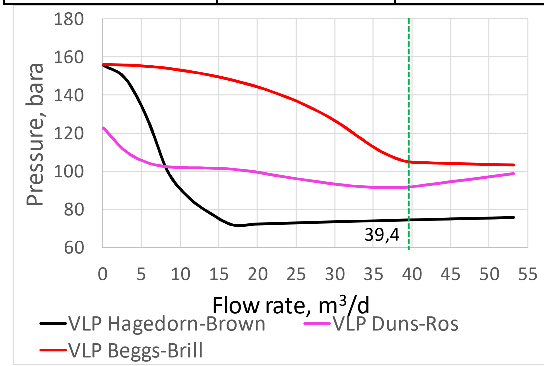

Fig.10 Vertical lift performance curves for non – calibrated oil PVT properties and non-calibrated two-phase flow correlations.

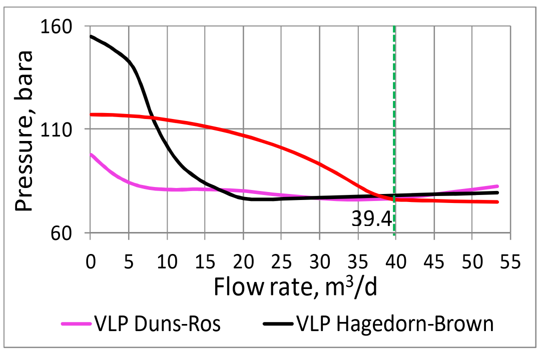

Fig.11 Vertical lift performance curves for calibrated oil PVT properties and calibrated two-phase flow correlations.

As we see in the figure 10 and table 17, the errors in the prediction of bottom-hole flowing pressure are big in the case of non-calibrated oil PVT properties and non-calibrated two-phase flow correlation. The smallest errors in this case are provided by the Hagedorn and Brown correlation [6] as we expected.

When both correlations (oil PVT properties and two-phase flow) are calibrated, all the three flow correlations match with small errors (table 18) the well test data:

$$Q_L = 39{,}4\frac{m^3}{d} \text{ and } p_{wf} = 75{,}85 \text{ bara}$$

Analyzing the level of errors and the values of parameters 1 and 2 necessary to match the flow correlation with measured data, Hagedorn and Brown correlation [6] seems to be the best.

The future work will be focused on the comparison of the standard two-phase flow correlations that will be calibrated with the modern methods which use the artificial intelligence.

6. CONCLUSION

Our work investigates the influence of the calibrated and non-calibrated oil PVT properties on the calibrated or non calibrated two-phase flow correlations used to build the pressure traverse curves and Vertical Lift Performance curves. Although the pressure traverse curves can be determined with many two-phase flow correlations, only one is appropriate to the measured data.

The calibrated or non- calibrated oil PVT properties have a slightly influence on the pressure traverse curves.

The calibrated two-phase flow correlations have an important impact on the pressure traverse curves and Vertical Lift Performance curve.

We used in our study the mechanistic and empirical two-phase flow correlations. It doesn't matter what type of correlation is if that calibrated correlation matches the measured data.

After calibration of the oil PVT properties and the two-phase flow correlations, the errors for some of these correlations are smaller. Therefore it is strongly recommended to calibrate both the oil PVT properties and the two-phase flow correlation.

The number of data points from pressure flowing survey has a slightly influence on the two-phase flow calibration.

The selection of the appropriate two-phase flow correlation takes into account the magnitude of the errors between the measured data and the predicted data and also the adjusting parameters that must have some values in order to maintain a concordance between the predicted data and the measured data.

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Aspecte privind calibrarea curbelor de comportare ale echipamentului.

Rezumat. În această lucrare am studiat modul în care calibrarea sau necalibrarea proprietăților PVT ale țiţeiului și a modelelor de ascensiune a fluidului bifazic prin ţevile de extracţie influențează curbele de comportare ale echipamentului în cazul unei sonde în erupţie naturală. Au fost luate în considerare mai multe scenarii de lucru în ceea ce privește calibrarea, respectiv necalibrarea proprietăților PVT ale ţiţeiului, precum și a modelelor de ascensiune a fluidului bifazic prin ţevile de extracţie. Acest studiu arată că proprietățile PVT ale ţiţeiului (calibrate sau necalibrate) au o influență mică asupra curbelor gradient și în consecinţă asupra curbelor de comportare a echipamentului. Pe de altă parte, calibrarea modelelor de ascensiune a fluidului bifazic prin ţevile de extracţie este foarte importantă; rezultatele înainte de calibrare și după calibrare fiind foarte diferite. De asemenea, este prezentat un aspect practic legat de numărul de date măsurate utilizate în procesul de calibrare.

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