

Reservoir Fluid Properties Estimation and Analysis of Haripur Gas Field, Bangladesh.

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Abstract

Haripur gas field is one of the most important gas fields in Bangladesh which lies in surma basin. The research work has been conducted on the gas field and here, it has been analysed the gas properties, water properties and rock properties. Pseudo critical properties, pseudo reduced properties, gas formation volume factor and gas expansion, gas compressibility and compressibility factor and gas viscosity has also been determined of the gas field. For this work it has been used the Petroleum Engineering Essentials (PE Essentials) software version 2017.4 software. The gas properties of Haripur gas field such as Pseudo critical temperature (T_c), pseudo critical pressure (P_c), compressibility factor (Z), compressibility, viscosity, gas expansion are 354.5 °R, 672.9 psia, 0.878, $36.205e-5$ 1/psi, 0.0184 and 175.2 scf/ft³ respectively. The estimated gas for the field is sweet and dry.

Keywords: Gas Properties, Water Properties, Rock Properties, Dry Gas, Habiganj Gas Field.

1.0 Introduction:

Haripur gas field is located in Sylhet district, about 22km from the Sylhet city. It was the first discovered hydrocarbon field in Bangladesh. On the basis of geological

survey, the Pakistan Petroleum Limited (PPL) started drilling activities in Haripur structure back in 1955. Sylhet structure is exposed on the surface with rocks of Dupi Tila age. Geology varies with traps that are

folded structures i.e. anticlines, often accompanied by faults. Sylhet anticline is an exposed structure with outcrops of Tipam Sandstone. The stratigraphic units encountered in this field are, from bottom upward, Bokabil Formation, Tipam Formation, Girujan Clay Formation and Dupitila Formation. Figure 2.1 shows the stratigraphic succession of the Haripur gas field. The lowest unit, the Bokabil Formation, consists of alternating sand and shale bed and about 950 meter of the units is drilled without reaching its base. The sandstone is fairly indurated and the shale is laminated. The top of Bokabil unit is marked by regional marker 'Upper Marine Shale'. The sandstone beds of the Bokabil unit are designated from top downward as 'A' sand, 'B' sand, 'C' sand, 'D' sand and 'E' sand (Figure 2.1). In the Haripur-1 (currently Sylhet 7) well, only the 'E' sand is oil bearing while the Bokabil sands above are gas bearing.

The natural gas is a homogeneous fluid of low viscosity and density. The gas viscosity depends on the reservoir pressure, temperature and compositions of gas. Gas viscosity decreases with reservoir pressure decreases. At high pressure, gas viscosity decreases with temperature increases and at

low pressure, gas viscosity increases with temperature increases compressibility factor (Z) factor changes with pressure changes. The gas compressibility factor (Z) is a thermodynamic property. It is used to correct the volume of gas estimation, as a function of pseudo reduced pressure and temperature the Z-factor is expressed.

Petroleum reservoir fluids are mainly composed of hydrocarbon constituents. Reservoir fluid properties include the gas properties, oil properties, rock properties and water properties. Gas properties are pressure, temperature, gravity, pseudo critical pressure and temperature, compressibility and compressibility factor, viscosity etc. Reservoir gases are composed mainly of hydrocarbon molecules of small and medium sizes as well as some light non hydrocarbon compounds such as carbon dioxide, nitrogen.

2.0 Study Area

Haripur gas field is located in Sylhet district that was the first discovered hydrocarbon field in Bangladesh that shown in figure 2.1. The Field is located in Sylhet district and under PSC block 13 about 22 km northeast of Sylhet town and beside the Sylhet-Jaintia road. Sylhet-7 is only half kilometer from

Sylhet-6 well. Gas Field Haripur is in the Surma Basin which stratigraphy and the well. Sylhet-7 is recompleted in the lower Bokabil zone. The Surma Series of Miocene consisting of Bhuban and Boka Bil Formations takes the name from this river and has excellent development in Surma Basin. Surma Valley and Sylhet Trough also conform more or less with the Surma Basin. Shillong Massif and Barail Range from the northern boundary while Tripura Fold Belt bounds it on the south. , the Pakistan Petroleum Limited (PPL) started drilling activities in Haripur structure back in 1955.



Figure 2.1: Haripur Gas Field (Sources: Petrobangla)

3.0 Methodology

Reservoir fluids are comprised of gas, oil and water. Without exception, the properties of these fluids at reservoir condition or at flowing condition are required to perform an analysis. In most cases fluid properties are generated by the use of published empirical correlation that has been developed over time. To estimates gas properties, water properties and rock properties the data are collected from different scientific journal and books. The calculation method used in the PE Essential Software as follows (PE Essentials, 2017):

Compressibility Factor (Z):

The correlation for gas Z factor is form (PE Essentials, 2017):

$$Z = \frac{0.27P_{pr}}{\rho T_{pr}}$$

Where, P_{pr} = Pseudo Reduced Pressure, T_{pr} = Pseudo Reduced Temperature. The P_{pr} range is 0 to 30 and T_{pr} range is 1.05 to 3.0.

Gas Viscosity:

Gas viscosity correlation is from Lee, A. L. et al (1966):

$$\mu_g = a \exp (b \rho^c)$$

Where, μ_g is in centripoise (cp)

Gas Isothermal Compressibility:

The correlation for gas isothermal compressibility (PE Essentials, 2017):

$$C_g = \frac{1}{P} - \frac{dzdp}{Z}$$

Where, C_g is in Psi^{-1} and P is the pressure (psia) of interest. The equation is valid in the P_{pr} range is 0 to 30 and T_{pr} range is 1.05 to 3.0.

Gas Formation Volume Factor:

The gas formation volume factor is calculated as follows (PE Essentials, 2017),

$$B_g = \frac{0.028279 Z(T+460)}{P}$$

Where, B_g is in ft^3/scf and P and T are the pressure (psia) and temperature ($^{\circ}\text{F}$) of interest. The expansion factor (E_g) is the inverse of B_g .

4.0 Result and Discussion:

Gas Properties:

To estimated gas properties, water properties and rock properties are necessary the reservoir parameter, gas parameters and rock/water parameters data. The reservoir, gas as well as rock/water properties are given in the Table 4.1, 4.2 and 4.3 respectively.

Table 4.1: Reservoir Parameters of the Haripur Gas Field

Parameters	Value
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Reservoir pressure, psia	2675.001
Reservoir temperature, ($^{\circ}\text{F}$)	155
Water Saturation	0.3
Oil saturation	0
Gas saturation	0.7

Table 4.2: Gas properties of the Haripur Gas Field

Parameters	Value
Gas gravity	0.587
H ₂ S, mol%	0
N ₂ , mol%	0
CO ₂ , mol%	0

Table 4.3: Rock/Water Properties of the Haripur Gas Field

Parameters	Value
Salinity, ppm	10000
Porosity	0.18

The estimated gas properties using the software as well as the given data on the table 4.1, 4.2 and 4.3, are given in the Table 5\4.4. The gas Pseudo critical temperature (T_c) , pseudo critical pressure (P_c), Compressibility factor (Z) , Compressibility, viscosity, gas expansion of Haripur Gas Field are 354.5 $^{\circ}\text{R}$, 672.9 psia, 0.878,

36.205e-5 1/psi, 0.0184 and 175.2 scf/ft³ respectively. The gas PVT model and gas relatively permeability model given 5.5 and 5.6 table.

Table 4.4: Estimated Gas Properties of Haripur Gas Field

Properties	Values
Pseudo Critical Pressure (Pc), psia	672.9
Pseudo Critical Temperature (Tc), °R	354.5
Compressibility factor (Z)	0.878
Gas compressibility, 1/psi	36.205e-5
Gas Viscosity	0.0184
Gas Expansion (1/Bg)	175.2

The gas properties plot of gas compressibility factor, compressibility, gas viscosity and gas formation volume factor are shown in the figure 4.1.

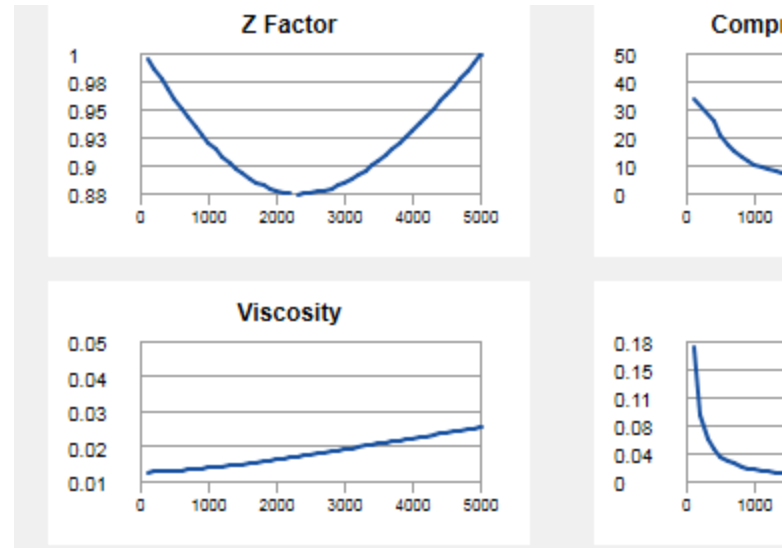


Figure 4.1: Gas Properties Plot.

5.0 Conclusion

The natural gas is a homogeneous fluid of low viscosity and density. The gas viscosity depends on the reservoir pressure, temperature and compositions of gas. Gas viscosity decreases with reservoir pressure decreases. At high pressure, gas viscosity decreases with temperature increases and at low pressure, gas viscosity increases with temperature increases compressibility factor changes with pressure changes. The gas compressibility factor (Z) is a thermodynamic property. It is used to correct the volume of gas estimation, as a function of pseudo reduced pressure and temperature the Z-factor is expressed. The

accuracy of gas compressibility factor values is related to gas formation volume factor values and the presence of nitrogen is not greatly affected on that gas factor values. Generally, the gas specific gravity remain less than 0.75 for dry gas reservoir and for wet gas it remain greater than or equal to 0.75

Hariapur gas field is one of the important gas fields in Bangladesh which contain sweet dry natural gas reserve.

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