Petroleum and Coal

Article **Open Access**

Production Forecasting by Decline Curve Analysis: A Case Study of Habiganj Gas Field, Bangladesh

*Md Sumon Chowdhury**, *Md Shaheen Shah*

Department of Petroleum and Mining Engineering, Jashore University of Science and Technology, Jashore, Bangladesh

Received July 3, 2019; Accepted October 10, 2019

Abstract

Habiganj gas field (HGF) is the second largest gas field in Bangladesh in aspects of gas initially in place (GIIP). The gas reservoir belongs to Surma Basin, which includes Bhuban and Bokabil Formation. This paper represents the study of two well of the Habiganj gas field, which are HGF-7 and HGF-10. The decline curve analysis method is applied to calculate the estimated ultimate recovery (EUR) and production forecasting performance using the production history data of 2007 for both well. Estimated ultimate recovery and reservoir forecasting performance determination play an important role in the petroleum industry to know the future performance of productivity and economical potentiality of the well. PE Essentials software version 2017.4 is used to predict the EUR value and reservoir forecasting performance for both HGF-7 and HGF-10. After completion, the analysis, the total EUR value for HGF-7, is estimated at 447.96 (Bscf), and the remaining EUR value is 299.57 (Bscf) as the minimum cut off rate is 1 mmscf/d. The forecasting analysis shows an exponential decline in production for HGF-7. Forecasting starts from 39.2 mmscf/d for HGF-7. Similarly, for HGF-10, the total EUR value is estimated at 353.96 (Bscf), and the remaining EUR is 206.78 (Bscf). The decline type for HGF-10 is also exponential. The nominal decline factor and effective decline for both HGF-7 and HGF-10 are determined by this study. The nominal and effective decline factors for HGF-7 are estimated at 0.0457 and 0.0367, respectively, and for HGF-10, these values are 0.0657 and 0.0482, respectively.

Keywords: *Habiganj gas field; Surma Basin; Decline curve analysis; Production history data; Estimated Ultimate Recovery (EUR); Forecasting; Exponential decline.*

1. Introduction

Bangladesh is a great part of the Bengal basin. The Bengal basin is situated in the north-eastern part of the Indian subcontinent. It is bordered by Precambrian Indian shield in the west and north, Indo-burman range (Orogen) to the east, and is open for a considerable distance into the Bay of Bengal to the south [1]. Sylhet Basin is a sub-basin of the Bengal Basin, a tectonically complex province in northeastern Bangladesh [2]. Habiganj gas field is one of the major gas producing fields in Bangladesh. The reservoirs are sandstones with Bhuban and Bokabil formations of Miocene-Pliocene age. The depth of the upper gas sand is 1320 m below the surface, and the maximum gross pay is 230 m thick. The lower gas sand is about 3000m below the surface. The average porosity is 30% for upper gas sands and 17% to 18% for lower gas sand. The permeability of upper gas sand is 2 to 4 darcy, whereas less than 100 md for lower gas sand. The gas initially in place (GIIP) of the Habiganj gas field was 3.66 Tcf with initial recoverable reserve 1.89 Tcf reported by IKM, 1992. Finally, in 2011 Petrobangla published a revised estimate of the gas field based on RPS Energy consultant, which shows estimated GIIP of 3.68 Tcf and initial reserve of 2.63 Tcf [3]. There are 11 wells in Habiganj Gas Field, among which 7 wells are productive, and the gas production capacity is 225.1 mmscf/d [4]. An Estimated ultimate recovery (EUR) is a value of reserve that is usually used in the oil or gas industry, which is economically recoverable or already been recovered from the well.

It represents the possible quantity of hydrocarbon recoverable from a well. Reservoir forecasting is a process of observing future reservoir performance from the existing production data. The decline curve is one of the reserve estimation methods. It can be applied to the reservoir, which is not under stimulation. The decline curve analysis method is applied to determine the reservoir forecasting of the Habiganj gas field well-7 and well-10. The forecast gas rate, forecast cumulative gas rate, decline model, and the decline rate is found in this study whose are very important. The gas production declination is exponential.

2. Study area and geological setting

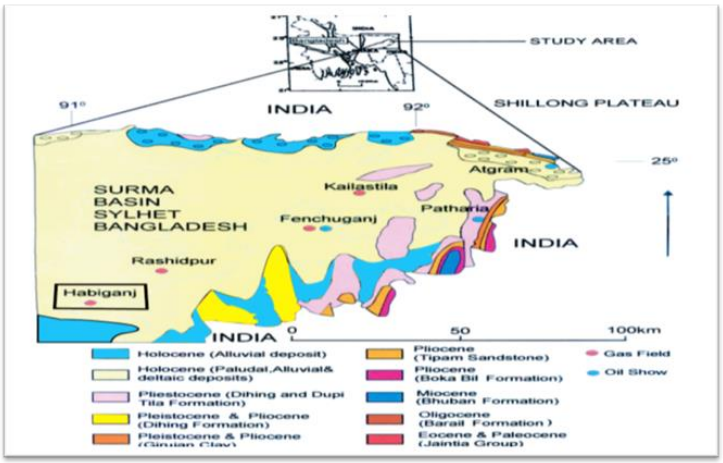

Figure 1. Location map of the study area (modified) [8]

Habiganj gas field lies in Madhabpur upazila under Habiganj district, which is 75 miles north of Dhaka and is located at 24.3750°N to 91.4167°E [5]. It is just adjacent to the Rashidpur gas field (12 km) [6]. This district is bounded by the Sunamganj district on the north, by Maulvibazar and Sylhet district on the east, by Tripura state of India on the south and by Kishoreganj and Brahmanbaria district on the west [7]. Habiganj gas field is situated in the Surma basin, Fig.1. [8].

The group is divided into the Bhuban and the Bokabil Formations, based on differences in their gross lithologies [9]. The Surma group has a thickness of about 3500 to 4000 meters [1]. The Sylhet basin is located just south of the crystalline Shillong Massif, with structural relief of about twenty to several hundred meters between the basin and the adjoining massif in the northeastern border [10]. Surma group is underlying by the Barail group and overlying by the Tipam group. Barail group is composed of predominantly sandstone, shale, and siltstone. The Surma group is composed of alternating sandstone, shale siltstone, conglomerate, and clay. The Sylhet succession is devided into six groups (Table.1) [2].

Table 1. Stratigraphy of the Sylhet basin, Bangladesh [2]

Age	Group	Formation	Lithology	Depositional environment
Recent	Alluvium	Alluvium	Sand, silt,clay	Fluvial
Late Pleistocene	Dihing	Dihing	Sandstone, shale	Fluvial
Pliocene-Pleistocene	Dupitila	Dupitila	Sandstone, shale	Fluvial
Late Miocene-Pliocene	Tipam	Girujan Clay	Clay, sandstone	Fluvial, lacustrine
		Tipam Sandstone	Sandstone, shale	Fluvial
Middle-Late Miocene	Surma	Bokabil	Sandstone, shale	Merine, deltic
		Bhuban	Sandstone, shale	
Late Eocene-early Miocene	Barail	Renji	Sandstone, shale	Shallow marine, deltic
		Jenam	Shale, sandstone	
Late Eocene	Jaintia	Kopili Shale	Shale, minor 1st	Shallow marine, deltic
Early-middle Eocene		Sylhet Limestone	Limestone	Shallow marine
Paleocene-early Eocene		Tura Sandstone	Quartz arenites	Shallow marine

3. Materials and methodology

Production forecasting is very much important in the petroleum industry. Several data and software can be used for determining EUR value and production forecasting.

For this analysis, the following data and materials were utilized
i. Production data of HGF-7 and HGF-10 (Appendix-1, Appendix-2).
ii. PE Essentials software, version 2017
The methodology of the study is shown in Fig. 2.

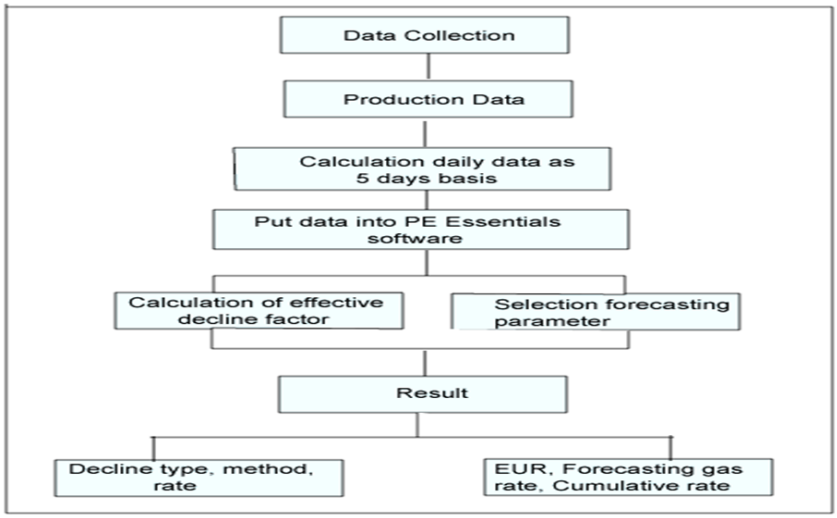

Figure 2. Working procedure of the study

4. Result and discussion

From log (gas rate) versus time (Fig. 3, Fig. 4) and gas rate versus cumulative gas graph (Fig. 5, Fig. 6), decline types can be identified.

The log (gas rate) versus time graph (Fig. 3) shows a decline after time period 0.9013699 year to 1 year for HGF-7, and for HGF-10, it shows a decline after time period 0.9424658 year to 1 year (Fig. 4).The gas rate versus cumulative gas graph (Fig. 5) shows a decline after cumulative gas production 13.60789 Bscf to 15 Bscf for HGF-7, and for HGF-10, this value is from 13.8883 Bscf to 14.71738 Bscf (Fig. 6).

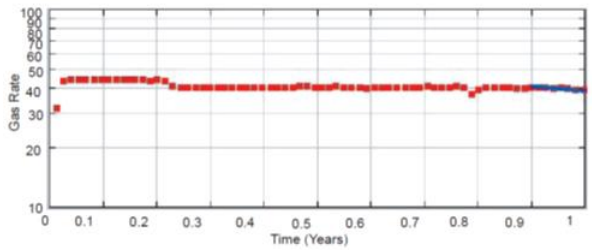

Figure 3. DCA analysis- log (gas rate) versus time for HGF-7

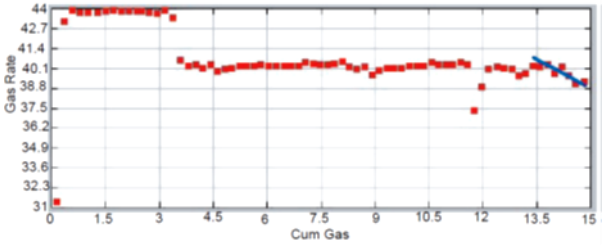

Figure 4. DCA analysis- gas rate versus cumulative gas for HGF-7

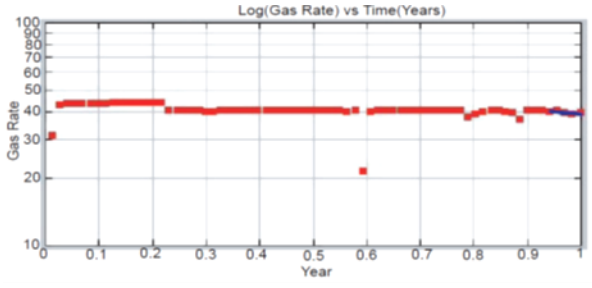

Figure 4. DCA analysis- log (gas rate) versus time for HGF-10

Figure 5. DCA analysis- gas rate versus cumulative gas for HGF-10

The forecast is run from 39.2 mmscf/d and the minimum/cutoff rate is 1 mmscf/d for HGF-7, and from 39.2 mmscf/d and the minimum/cutoff rate is 1 mmscf/d for HGF-10. The forecasting gas rate and cumulative gas rate for both HGF-7 and HGF-10 are shown through Figs. 7-10.

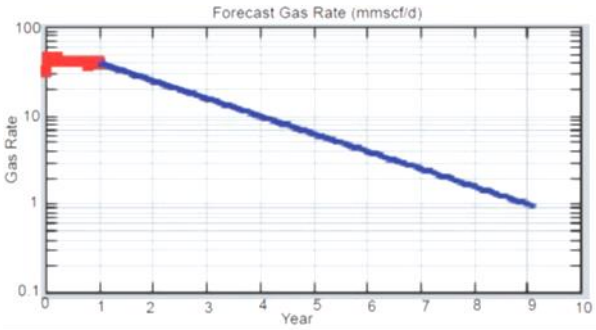

Figure 7. Forecasting gas rate of HGF-7

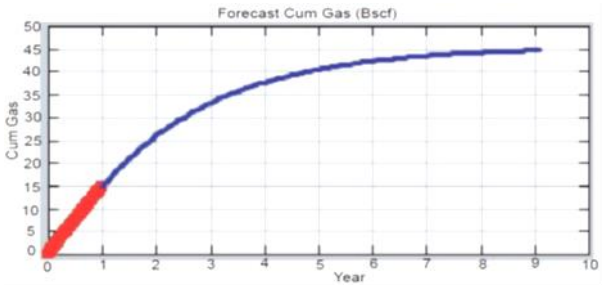

Figure 8. Forecasting cumulative gas of HGF-7

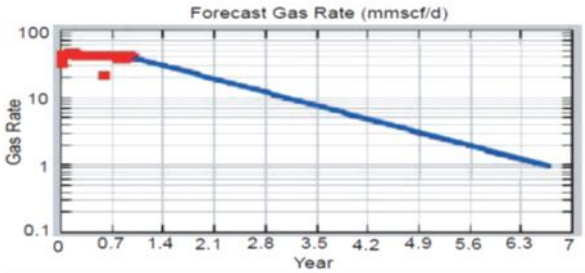

Figure 9. Forecasting gas rate of HGF-10

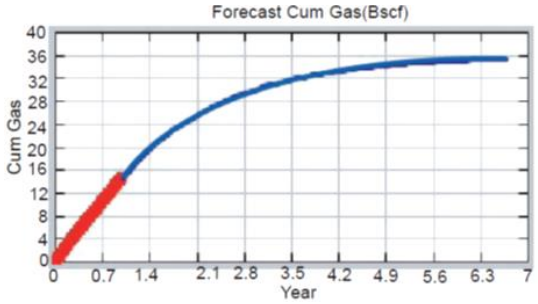

Figure 10. Forecasting cumulative gas of HGF-10

The decline method is exponential both for HGF-7 and HGF-10, which is shown in Table 2 and Table 3. The forecasting EUR result is shown in Table 4 and Table 5.

Table 2. Decline method and rate determination result for HGF-7

Graph Type	Decline type	Decline method	Decline rate
log(gas rate) versus time	Straight line	Exponential	0.0367 (effective)
Gas rate versus cumulative gas	Straight line	Exponential	0.0457 (nominal)

Table 3. Forecasting EUR result of HGF-7

HGF-7	
Total EUR	447.96 (Bscf)
Remaining EUR	299.57 (Bscf)

Table 5. Forecasting EUR result of HGF-10

HGF-10	
Total EUR	353.96 (Bscf)
Remaining EUR	206.78 (Bscf)

Table 4. Decline method and rate determination result for HGF-10

Graph Type	Decline type	Decline method	Decline rate
log(gas rate) versus time	Straight line	Exponential	0.0482 (effective)
Gas rate versus cumulative gas	Straight line	Exponential	0.0657 (nominal)

5. Conclusion

The decline curve analysis method is mainly used all over the petroleum industry for predicting the future performance of production well. It states the production decline types as well as the total recovery value. The decline curve analysis method is applied to HGF-7 and HGF-10 using the PE Essentials software version 2017.4. The production decline type for both HGF-7 and HGF-10 is exponential decline, where the nominal decline factor is 0.0457 and 0.0657, respectively. The total EUR value is found 447.96 Bscf, and 353.96 Bscf and the remaining EUR value is 299.57 Bscf and 206.78 Bscf respectively for HGF-7 and HGF-10. The production forecasting by the decline curve should be done by several year production data, which will give a more satisfactory result.

Appendix 1. (Production data of HGF-7)

Production days	Gas production (mscf)	Water production, (bbls)	Production hours
5 (1-5/1/2007)	156807	21.832	120
5 (6-10/1/2007)	215765	26.01	120
5 (11-15/1/2007)	219227	25.702	120
5 (16-20/1/2007)	218466	39.51	120
5 (21-25/1/2007)	218636	38.798	120
6 (26-31/1/2007)	262308	40.328	144
5 (1-5/2/2007)	218905	32.817	120
5 (6-10/2/2007)	219258	27.847	120
5 (11-15/2/2007)	218946	27.464	120
5 (16-20/2/2007)	219025	27.049	120
5 (21-25/2/2007)	218825	31.667	120
3 (26-28/2/2007)	131357	17.625	72
5 (1-5/3/2007)	218402	28.942	120
5 (6-10/3/2007)	218082	27.74	120
5 (11-15/3/2007)	219242	27.703	120
5 (16-20/3/2007)	216554	29.017	120
5 (21-25/3/2007)	202972	31.313	120
6 (26-31/3/2007)	241544	33.017	144
5 (1-5/4/2007)	201658	32.145	120
5 (6-10/4/2007)	200393	32.145	120
5 (11-15/4/2007)	201336	32.145	120
5 (16-20/4/2007)	199437	32.145	120
5 (21-25/4/2007)	200028	32.145	120
5 (6-30/4/2007)	200287	32.145	120
5 (1-5/5/2007)	201021	20.9457	120
5 (6-10/5/2007)	200939	21.41116	120
5 (11-15/5/2007)	201046	21.3231	120
5 (16-20/5/2007)	201351	20.92054	120
5 (21-25/5/2007)	200942	21.19101	120
6 (26-31/5/2007)	241190	24.77002	144
5 (1-5/6/2007)	200994	23.04027	120
5 (6-10/6/2007)	201177	23.14091	120
5 (11-15/6/2007)	201063	23.03398	120
5 (16-20/6/2007)	202215	22.00242	120
5 (21-25/6/2007)	201977	21.69358	120
5 (26-30/6/2007)	201483	23.43025	120
5 (1-5/7/2007)	201548	22.95221	120
5 (6-10/7/2007)	201777	23.37364	120
5 (11-15/7/2007)	202432	22.73206	120
5 (16-20/7/2007)	200860	23.50573	120
5 (21-25/7/2007)	199953	22.19741	120
6 (26-31/7/2007)	240909	27.66971	144
5 (1-5/8/2007)	198331	22.31063	120
5 (6-10/8/2007)	199808	22.57481	120
5 (11-15/8/2007)	200314	22.5811	120
5 (16-20/8/2007)	200563	23.56863	120
5 (21-25/8/2007)	200512	23.00253	120
6 (26-31/8/2007)	241425	27.20425	144
5 (1-5/9/2007)	201040	23.59379	120
5 (6-10/9/2007)	201107	24.35488	120
5 (11-15/9/2007)	202217	23.42396	120
5 (16-20/9/2007)	201436	35.2869	120
5 (21-25/9/2007)	201430	23.79507	120
5 (26-30/9/2007)	201484	22.93334	120
5 (1-5/10/2007)	202061	22.98995	120
5 (6-10/10/2007)	201412	23.02769	120
5 (11-15/10/2007)	186617	20.70039	120
5 (16-20/10/2007)	194293	22.17225	120
5 (21-25/10/2007)	199888	22.644	120
6 (26-31/10/2007)	240719	28.04082	144
5 (1-5/11/2007)	200549	22.78867	120
5 (6-10/11/2007)	200143	22.72577	120
5 (11-15/11/2007)	197686	20.77587	120
5 (16-20/11/2007)	198668	23.41767	120
5 (21-25/11/2007)	201268	22.90189	120
5 (26-30/11/2007)	200917	23.37993	120
5 (1-5/12/2007)	201511	22.21628	120
5 (6-10/12/2007)	198662	22.8956	120
5 (11-15/12/2007)	200600	22.96479	120
5 (16-20/12/2007)	197816	21.52438	120
5 (21-25/12/2007)	195420	22.3924	120
6 (26-31/12/2007)	235240	27.21683	144

Appendix 2. (Production data of HGF-10)

Production days	Gas production (mscf)	Water production, (bbls)	Production hours
5 (1-5/1/2007)	155028	21.588	120
5 (6-10/1/2007)	213335	25.715	120
5 (11-15/1/2007)	216787	25.325	120
5 (16-20/1/2007)	216035	39.215	120
5 (21-25/1/2007)	216203	38.371	120
6 (26-31/1/2007)	259391	39.925	144
5 (1-5/2/2007)	216235	32.515	120
5 (6-10/2/2007)	217422	27.601	120
5 (11-15/2/2007)	218899	27.406	120
5 (16-20/2/2007)	218976	27.024	120
5 (21-25/2/2007)	218776	31.709	120
3 (26-28/2/2007)	131328	17.626	72
5 (1-5/3/2007)	218354	29.024	120
5 (6-10/3/2007)	218035	27.772	120
5 (11-15/3/2007)	219194	27.659	120
5 (16-20/3/2007)	217506	28.992	120
5 (21-25/3/2007)	202005	31.087	120
6 (26-31/3/2007)	241544	33.024	144
5 (1-5/4/2007)	201658	22.765	120
5 (6-10/4/2007)	200393	22.864	120
5 (11-15/4/2007)	201336	18.721	120
5 (16-20/4/2007)	199437	24.168	120
5 (21-25/4/2007)	200028	22.783	120
5 (6-30/4/2007)	200287	23.35	120
5 (1-5/5/2007)	201021	22.78867	120
5 (6-10/5/2007)	200939	23.273	120
5 (11-15/5/2007)	201046	23.1472	120
5 (16-20/5/2007)	201351	22.72577	120
5 (21-25/5/2007)	200941	23.14091	120
6 (26-31/5/2007)	241190	26.92749	144
5 (1-5/6/2007)	200993	22.99624	120
5 (6-10/6/2007)	201177	23.19752	120
5 (11-15/6/2007)	201062	23.09059	120
5 (16-20/6/2007)	202215	21.97726	120
5 (21-25/6/2007)	201977	21.67534	120
5 (26-30/6/2007)	201484	23.43025	120
5 (1-5/7/2007)	201548	22.9951	120
5 (6-10/7/2007)	201776	23.41767	120
5 (11-15/7/2007)	202432	22.68174	120
5 (16-20/7/2007)	200860	23.48057	120
5 (21-25/7/2007)	199953	22.24144	120
6 (26-31/7/2007)	240910	27.676	144
5 (1-5/8/2007)	107284	12.69951	120
5 (6-10/8/2007)	199808	22.56223	120
5 (11-15/8/2007)	200313	22.60626	120
5 (16-20/8/2007)	200563	23.56863	120
5 (21-25/8/2007)	200512	23.00882	120
6 (26-31/8/2007)	241425	27.19167	144
5 (1-5/9/2007)	201040	23.60008	120
5 (6-10/9/2007)	201107	24.31714	120
5 (11-15/9/2007)	202217	23.42396	120
5 (16-20/9/2007)	201436	35.28061	120
5 (21-25/9/2007)	201429	23.7762	120
5 (26-30/9/2007)	201483	22.93963	120
5 (1-5/10/2007)	202061	23.04027	120
5 (6-10/10/2007)	201412	22.98366	120
5 (11-15/10/2007)	186617	20.67523	120
5 (16-20/10/2007)	194291	22.16596	120
5 (21-25/10/2007)	199888	22.63142	120
6 (26-31/10/2007)	240719	27.99679	144
5 (1-5/11/2007)	200549	22.80754	120
5 (6-10/11/2007)	200143	22.79496	120
5 (11-15/11/2007)	197686	20.82619	120
5 (16-20/11/2007)	182890	21.41745	120
5 (21-25/11/2007)	201268	22.92705	120
5 (26-30/11/2007)	200916	23.40509	120
5 (1-5/12/2007)	201512	22.24773	120
5 (6-10/12/2007)	198662	22.88931	120
5 (11-15/12/2007)	200603	23.03398	120
5 (16-20/12/2007)	197816	21.58099	120
5 (21-25/12/2007)	195420	22.37982	120
6 (26-31/12/2007)	235238	27.20425	144

References

[1] Imam B. Energy Resources of Bangladesh, second edition, University Grants Commission of Bangladesh 2013, ISBN 984-809-021-1.

[2] Shah MS, Hossain MHZ. Evaluation of natural gas production optimization in Kailashtila gas field in Bangladesh using decline curve analysis method, Bangladesh J. Sci. Ind. Res.,2015; 50(1): 29-38, 2015.

[3] Petrobangla, 2012. Annual report of Bangladesh Oil, Gas and Mineral Corporation (PETRO-BANGLA).

[4] Petrobangla, 2015. Annual report of Bangladesh Oil, Gas and Mineral Corporation (PETRO-BANGLA).

[5] Rahman A, Seddique AA, Khan MHR. 2017. Present Gas Reserve Estimation Using Wireline Logging Data of Habiganj Gas Field, Bangladesh, International Journal of Oil, Gas and Coal Engineering, 2017; 5(7): 44-50.

[6] Shikder MH. Study of Natural Gas Processing in Bangladesh, M. Sc. Project, Petroleum and Mineral Resources Engineering Department 2005, BUET, Dhaka.

[7] BBS., 2013.District Statistics 2011, Habiganj. Statistics and Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh.

[8] Ahammod S, Hai MA, Islam MR, Sayeem SMA. Petro-Physical Analysis of Reservoir Rock of Fenchuganj Gas Field (Well#03) Using Wireline Log, American Journal of Engineering Research, 2014; 3(8): 37-48.

[9] Mannan A. Stratigraphic Evolution and Geochemistry of the Neogene Surma Group, Surma Basin, Sylhet 2002, Bangladesh, ISBN 951-42-6711-7.

[10] Hossain HMZ, Roser BP, Kimura JI. Petrography and whole-rock geochemistry of the Tertiary Sylhet succession, northestern Bengal Basin, Bangladesh: Provenance and source area weathering. Sedimentary Geology, 2010; 228: 171-183.

To whom correspondence should be addressed: Md Sumon Chowdhury, Department of Petroleum and Mining Engineering, Jashore University of Science and Technology, Jashore, Bangladesh,
E-mail sumonpme12@gmail.com