A Review Over Major Gas Blowouts In Bangladesh, Their Effects And The Measures To Prevent Them In Future

Md. Ashraful Islam Khan, Fuad Bin Nasir

Abstract: In petroleum industry, gas blowout is one of the major hazards, causing damage to the reservoir and gas bearing formation, destructing the drilling rig, damaging the environment and so on. Many blowouts had happened in Bangladesh in the past and among them Sylhet-1(1955), Sylhet-4(1962), Moulvibazar-1(1997) and Chattak-2 (2005) gas field's blowouts were more destructive. Chattak-2 (known as Magurchara) had been affected twice by blowouts. The main target of this paper is to discuss the reasons behind these blowouts, their effects, both in the environmental and petroleum industrial aspects. As the losses are unrecoverable, so we must prevent blowout and in this paper, we recommend some preventive measure to avoid blowouts in the future.

Keywords: Gas blowout, Sylhet-1, Sylhet-4, Moulvibazar-1, Chattak-2, Blowout effects, Blowout prevention.

1. Introduction:

Natural gas, a primary source of energy, has a critical role in socio-economic development of Bangladesh. Its extensive use in generating power, producing fertilizer, running industry and households activities has made it the prime need of the country and it accounts for about 73% of commercial energy of Bangladesh. It is comparatively cheaper than other energy sources, which are imported from abroad. The availability of low cost fuel provides a competitive edge to the industrial products [**1**]. The use of natural as alternative fuel has been growing in recent years due to the considerable economic and environmental advantages and therefore, become more conventional fuel in internal combustion engines [**2**]. A powerful flow of gas into the drill string resulting, which causes the gas to come up to the surface and creating kick in the rig floor violently [**3**]. Our study is focused on some major blowouts (Sylhet-1, 4; Moulvibazar-1; Chattak-2) occurred in Bangladesh and to identify the causes of those accidents, effects and some preventive measure to impede it in future.

2. Geological characteristics of gas field in Bangladesh:

The geology of Bangladesh may be divided into three hydrocarbon geological provinces and they are- i) The folding bed in the eastern part of Bangladesh, ii) The fore deep in the central part of Bangladesh and iii) The stable shelf and hinge zone in the west-northwest part of Bangladesh[**3**].

- *Md. Ashraful Islam Khan, Department of Petroleum & Mining Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh.*
  E-mail: sarjilsust09@gmail.com
- *Fuad Bin Nasir, Department of Civil & Environmental Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh.*
  E-mail: binnasir.fuad@gmail.com

The 80% of the gas fields of Bangladesh discovered so far are located in the eastern part of Bangladesh. The three gas fields named Sylhet, Maulvibazar and Chattak which are affected by blowout are located in eastern fold bed. So our main concern is to discuss the eastern fold bed of Bangladesh.

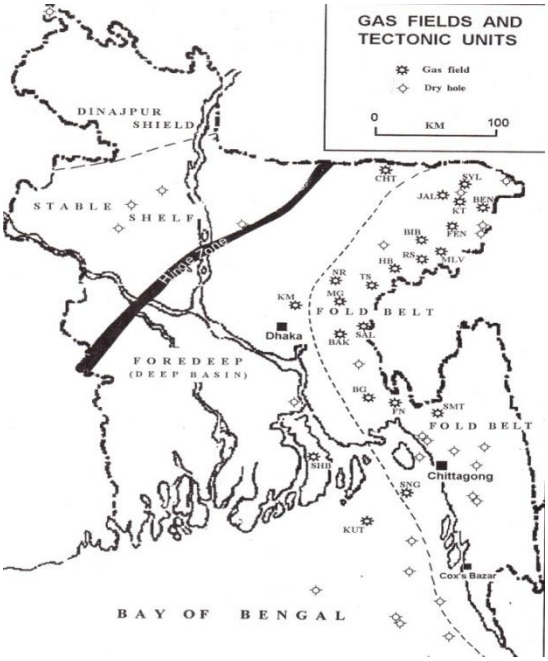

Fig. 1. Gas fields and tectonic unit of Bangladesh [3].

2.1. Eastern fold bed of Bangladesh:

The area extends north to south along the eastern part of Bangladesh which includes Sylhet, Comilla, Chittagong and Cox's Bazar where the sedimentary sequence in the fold belt measures up to about 20 km in the Sylhet area [**4**]. In addition, the gas of this zone has been generated at the depth of 6000 to 8000 meter below the surface and migrated up through multi-kilometer sand shale sequence for long vertical distance before being accumulated in the Mio-Pliocene sand reservoirs[**5**]. The reservoirs of the gas in the fold belt of the eastern part of Bangladesh are all Mio-Pliocene age sandstones, which are generally occurred in the depth of about 1000 to 3400 meters belonging Bokabil

and Bhuban formation. Some amounts of gas are less than 1000 meters deep and are known as pocket gas. Magurchara (Moulvibazar-1) blow out is the cause of this pocket gas at the depth of 840 meters [**3**].

3. Blowout:

Blowout is sudden, uncontrolled flow of fluids from the subsurface, when the fluid is gas then it is known as gas blow out. At overpressure oil, gas or water zone at the subsurface, while the drill string is penetrated, may cause the forceful flow of fluid (gas, oil or water) into the drill string. These fluids (gas, oil or water) may come up to the surface and kick the rig floor violently and create blowout [**3**].

3.1. Classification of Blowout:

Blow out can be classified into three broad categories and they are surface, subsea and underground blowout.

Surface blowout: When the blowout takes place on the surface, it is known as surface blowout. It can eject the drill string out of the well. The force of the escaping fluid can be strong enough to damage the drilling rig. In addition, the output of a well blowout might include sand, mud, rocks, drilling fluid, natural gas, water, and other substances. Again, it can often be ignited by an ignition source, from sparks or from rocks, or simply from the heat generated by friction. Sometimes, this incident can be so forceful that they cannot be directly brought under control from the surface, particularly if there is so much energy in the flowing zone that it does not deplete significantly over the course of a blowout. In such cases, other wells (relief wells) may be drilled to intersect the well or pocket, in order to allow killing-weight fluids to be introduced in depth [**6**]. The accident of Chattak-2 (Tengratila) occurred on 17 June, 2005; was this kind of blowout.

Subsea blowout: Subsea wells have the wellhead and pressure control equipment located on the seabed varying from depths of 10 feet (3.0 meter) to 8,000 feet (2,400 meter). It is very difficult to deal with a blowout in very deep water because of the remoteness and limited experience with this type of situation [**7].**

Underground blowout: An underground blowout is a special situation where fluids from high pressure zones flow uncontrolled to lower pressure zones within the wellbore. Usually this is from deeper higher pressure zones to shallower lower pressure formations. There may be no escaping fluid flow at the wellhead [**17**].

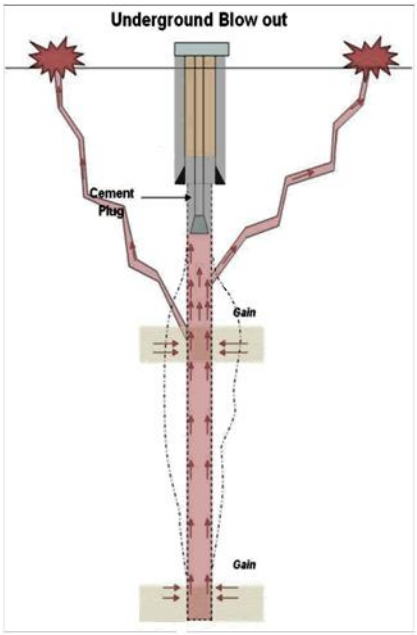

Fig. 2. Underground blow out

3.2. Reasons of blowout:

There may be many reasons behind a blowout. But in this paper, we only discuss the reasons behind Sylhet-1(1955), Sylhet-4(1962), Moulvibazar1(1997) and Chattak-2(2005) blowouts.

3.2.1. Reasons of blowout in Sylhet (Sylhet -1 and Sylhet -4):

The Sylhet-1 well was drilled to a depth of 2377 meters and then encountered gas, after casing was set, the blowout got out of control, was ignited and the total rig was destroyed. A large crater was formed, into which the rig sank. The Sylhet-4 well had a similar blowout when drilled to only 314 meters below the surface [**3**].

Table 1: blowout in Sylhet gas field [3]

Well	Spud date	Drilling days	Total depth (m)	Status
Sylhet-1	26-01-1955	97	2987	Blowout
Sylhet-4	11-04-1962	6	315	Blowout

3.2.2. Reasons of blowout in Moulvibazar-1 (Magurchara):

This subjected well was targeted to drill to a depth of about 3400 m below the surface and the drilling was conducted through a loosely consolidated sand layer named Tipam Sandstone Formation in the shallow subsurface and then through a consolidated shale layer known as Upper Marine Shale (UMS) without setting casing in the loose Tipam Sand unit above the UMS. The well encountered a gas zone at a depth of about 800 meters from the surface. After drilling a depth of 840 meter as vertical well, drilling stopped by the drillers and they started pulling out the drill pipes in order to make arrangement for well deviation from its vertical path, but during the pulling out operation that gas from the gas zone below, rushed into the drill hole, forcing

its way up which eventually caused the blow out of the well [**3**].

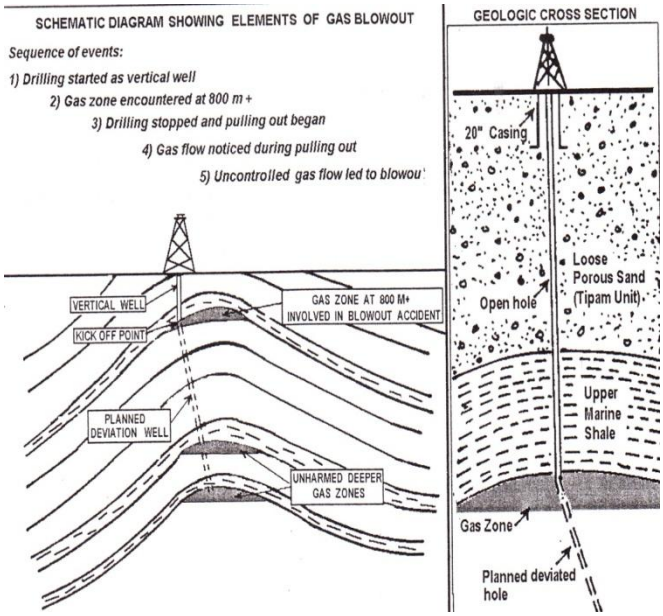

Fig. 3. Schematic diagram to demonstrate the Magurchara blowout effect (left) and a selection through subsurface rock sequence [3].

3.2.3 Reasons of blowout (8 January, 2005) in Chattak-2 (Tengratila):

When well was drilled through loosely consolidated sand unit following Upper Marine Shale without setting casing in the loose sand unit, the drillers began to pull out the drill string. This causes a swabbing effect on the gas zone and gas forced into the drilling hole, which caused blow out. The main two reasons for the accident were-

i) Without setting any casing at the loose sand zone (Tipam sand unit)

ii) Pulling out the drill string while the sand above remained uncased and unprotected, from the gas zone [**3**, **9**].

3.2.4. Reasons of blowout (17 June, 2005) in Chattak-2 (Tengratila):

The reasons of the second blow out are the same as first when the Canadian company Niko tried to drill a relief well to kill the main Chattak-2 with mud and sealed it off with cement. It was hoped to finish drilling up to 466 meters but at 435 meters,an explosion took place. A sudden uncontrolled mud was lost in the relief well, causing a very high flow rate of gas coming up through the well to the surface and created blowout. Then the rig was caught by fire [**12**].

3.3.1. Effect of blowout in Sylhet:

Owing to the blowout at Sylhet-1 well, a crater was formed and filled with water, creating a large pond which is still there today and vent gas from the subsurface into the year. The effect of blowout at Sylhet-4 is more dangerous as well was abandoned then and gas is still venting out from the fissures in the well site and nearby hill side which often cause fire. [**3**]

3.3.2. Effect of blowout in Magurchara:

A massive blowout torn apart in the Magurchara gas field in Moulvibazar's Kamalganj upazila while the US energy company Occidental was drilling a well there. The massive blaze that the blowout triggered wiped out property worth crores of taka. At Magurchhara, the affected people expressed their dissatisfaction to this correspondent over the role of the successive governments in realizing the damages. They wanted to know the mystery behind the long government silence when it comes to settling the compensation claims. The flora and fauna of the Lawachhara Reserve Forest adjoining the exploded well took the brunt of the explosion. The flame destroyed a teak grove raised between 1944 and 1950, bamboo shacks created between 1993 and 1995, and a strip of plantation established in 1994. About 96 acres of Lawachara forest were completely burnt. Fifty percent of the forest resources on 111.15 acres of land and 30 percent resources on 106.21 acres of land were also damaged. Experts said the loss is irrecoverable. Since the fire, wild animals stray into households on the outskirts of the forest in search of food. According to the committee reports, the damage to forest resources amounted to Tk 9,858 crore, while 29 tea gardens of the area suffered a loss of about Tk 46.07 crore. The railway suffered a loss of Tk 21 crore, Jalalabad Gas Company Tk 43 lakh, the electricity department about Tk 4.35 crore. Indigenous Khasia people lost betel leaf plantations worth Tk 18 lakh[**12**]. Another unofficial expert committee, appointed by the National Committee to Protect Oil-Gas-Mineral Resources and Port (NCPOGMRP), after an investigation revealed that the blowout caused an estimated Tk 9000 crore loss to the nation and gas reserve of about 245 billion cubic feet was burnt in the explosion while the environment, ecology and wildlife of the area were also severely affected [**8**].

3.3.3. Effect of blowout (8 January, 2005) in Chattak-2 (Tengratila):

On January 8, 2005, ten thousand of panic-stricken people fled their homes as a drilling-well exploded in Tengratila gas field. The raging flames were visible from 30 kilometers away at this gas field. The explosion of Niko's Tengratila gas field led to millions of cubic feet of gas burning [**10**,**11**].

Fig. 4. Magurchara blowout

3.3.4. Effect of blowout (17 June, 2005) in Tengratila:
Second blowout occurred on June 17, 2005, just six months after the first explosion [**13**]. The gas field burnt for a couple of months and no instant effective measures were taken by the concerned authority [**11**]. The Department of Environment (2005), submitted a report to determine the loss of environment and found soil of the surrounding field more affected. Generally the configuration of the land of the areas is northeast hilly, northeast alluvium and some areas of Sylhet basin. As a result of blow out the surroundings are hilly, rift valley, small mound, and low lands were affected by the emission of gas and sand. Surroundings of the blowout area like Tengrabazar, homestead area, forest trees, and hilly fruit bearing trees were affected by the fire. Underground sand and clay soil were throughout with gas from the main field to 2-3 km areas of the Tengratila. Total loss of soil resources was divided into 4 categories named as most affected areas, very affected areas, moderate affected [**14**].

More affected areas:
Surroundings of the main blowout area's hill, rift valley, hilly alluvium and lowland areas about 50 hectares of land was more affected. When researcher visited the area, they saw that gas was still emitting from that area. It was thought that 10 years needed to afresh the area like before blowout.

Very affected areas:
Very affected areas were spread out from the main field to 2 km away. It was seen that gas were emitting from some of that area. Cultivation was very risky in that area specially rift valley and under the rift valleys. It was thought that, minimum 3 years would be needed to afresh the area soil conditions like before blow out. To afresh the fertility of the agricultural lands, more fertilizer is needed.

Moderately affected areas:
Moderate affected areas were spread out 2-4 km from main blowout areas. To afresh the area soil conditions, 2 years were needed.

Small affected areas:
Small affected areas were spread out from 4-8 km from main blowout areas. To afresh the soil condition of the area, 1 year was needed. The water quality of Tengratila is deteriorating and will be deteriorated with time because the gas is still seeping from the reservoir to the surface and ground. The pH value ranges between 6.5 to 8.5, the maximum amount of iron and manganese are in near well tube wells which amount are 1.95 ppm and 0.135 ppm, respectively. Maximum total solids, dissolved solids and suspended solids are found 61, 50.2 and 15.5 ppm, respectively, and the maximum turbidity is detected as 6.71 NTU at near well tube wells and all the values are higher than the normal water quality [**15**].

Fig. 5. Tengratila blowout

4. Precaution of blowout:

After studying the above blowout accidents in Bangladesh, it is revealed that the reasons behind all the blowouts are quite same. The lack of the seriousness of the drilling personnel and the lack of experience working in the petroleum industry are two main reasons of these blowouts. To prevent further blowout in Bangladesh, we recommend the following steps [**16**]:

- The first response to detecting a kick would be to isolate the wellbore from the surface by activating the blow-out preventers and closing in the well as kick is the first sign of blowout.
- Sudden change in drilling rate should be monitored.
- Sudden change in surface fluid rate and sudden change in pump pressure should be monitored;
- The drilling crew or mud engineer should keep track of the level in the mud pits and/or closely monitor the rate of mud returns versus the rate that is being pumped down the drill pipe.
- An increasing mud return rate should be noticed as the formation fluid influx pushes the drilling mud to the surface at a higher rate.
- The formation pressure should be always kept under mud pressure.
- Automatic blowout preventer should be used.
- Automated drilling rig should be used.

5. Conclusion:

The losses of blowout are irrecoverable for a developing country like Bangladesh and it is hard to calculate them in money. Not only is the loss of money, but also environmental degradedness one of the biggest concerning issues. The effect may not appear in the economy just after the accident, but in the future, the country will suffer for a long period of time both economically and ecologically. If any other blowout happens further in future, that will be a threat of running out of gas reserve and a big blow in the energy sector of Bangladesh. It is impossible to go back to the past to stop the accidents, but we can stop them from occurring in the future by taking the preventive measures discussed earlier. Automated drilling rig may be costly for a developing country like Bangladesh, but for the security concern, we should go for this. If it is not possible, in manual drilling rig, all the personnel related in drilling operation should be concerned about their jobs and should

do the tusk needed to mitigate the kick, which is the first sign of blowout.

Acknowledgements:

The authors are grateful to Mr. Mohammad Shahedul Hossain, Assistant Professor of Petroleum and Mining Engineering Department, Shahjalal University of Science and Technology, for his help and encouragement. The authors are also thankful to him for reviewing this paper and for his valuable comments which greatly helped them to improve the paper.

Reference:

[1] Petrobangla, 2012, annual report (2012) Petrobangla, (Bangladesh oil gash mineral corporation) Publication pp 7, 49.

[2] Mtui, P.L. 2013, "Performance And Emissions Modeling Of Natural Gas Dual Fuelling Of Large Diesel Engines". International Journal of Scientific & Technology Research, 2(11), 317-323

[3] Imam, B. (2005) "Energy resources of Bangladesh", University Grant commission of Bangladesh Dhaka, pp.84-95 & 142-146.

[4] Hiller, K. and Elahi, M. (1984). "Structural development and hydrocarbon entrapment in the Surma Basin, Bangladesh (northeast Indoburman fold belt)". Porc.5th offshore South East Asia Conference, Seapex session, 1984, Singapore.

[5] Khan, M.M., Ismail, M., & Ahmed, M. (1988). "Geology and hydrocarbon prospect of the Surma basin, Bangladesh". Proc.7th Offshore South East Asia Conference, Seapex session, 2-5 February 1988, Singapore.

[6] Popular Mechanics (1934), "Wild Oil Tamed by Scientific Trick", July.

[7] Larry H. Flak, Boots & Coots (1997) "Ultra-deepwater blowouts - how could one happen" Offshore Magazine, January 1.

[8] The New Nation (2006), "BANGLADESH: Gas explosion: Compensation from Niko, Unocal demanded" June 13.

[9] Imam, B. (2005), "Tangratila gas well blowout: Cause and responsibility", Energy and Power, 2(15), January 16-31, 2005, pp12-14.

[10] International Gas Report (2005), 'Blast/fire hits gas field', New York: January, No. 515, 18.

[11] Nasreen, M., Hossain, K. and Kundu, D. (2006), 'The Interrelationship between Poverty, Environment and Sustainable Development in Bangladesh: An Overview", Bangladesh e-Journal of Sociology, 3(2).

[12] The Daily Star (2008), "Magurchhara Blowout: No compensation even after a decade" June 14.

[13] Energy Compass (2005), 'Bangladesh Energy Sector in Turmoil', London: June 30.

[14] DoE, 2005. Department of Environment, Ministry of Environment and Forest, Government of Bangladesh.

[15] Faruque, M. O., (2012), "Suitability assessment of groundwater around Tangratilla gas blowout affected area, NE Bangladesh". Asian Transactions on Engineering, (ATE ISSN: 2221 - 4267), 2 (04).

[16] Grace, R., (2003) "Blowout and Well Control Handbook" Gulf Professional Publishing, pp42.

[17] Barnhill, C.C. and Adams, N.J.(1979), "Underground Blowouts In Deep Well Drilling". SPE Deep Drilling and Prduction Symposium, 1-3 April,Amarillo, Texas.