

# Gas Blowout Impacts on Ground Water Environs around the Tengratila Gas Field, Chattak, Bangladesh

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## ABSTRACT

Gas blowout is one of the major hazard in petroleum field which normally damages the gas bearing geologic formation, structure, local tectonic setting, environment and so on. In Bangladesh, there have been three well known gas blowouts. Among them, the most dangerous gas well blowout took place on 8 January 2005 in Sunamganj district when chattak-2 (also known as Tengratila) gas field was drilled. As a result, the surrounding area is facing various problems among them water is the top of the list. From this point of view, the present study has been considered to find the impact of blowout on water around the gas blowout area. In this regard, the water samples (some are very near and some are away from the well) are collected and analyzed in the laboratory following the standard method. Some physical and chemical parameters of water such as pH, turbidity, EC, total solids, dissolved solids, suspended solids, manganese ion, calcium ion, magnesium, iron, chloride and total hardness have measured where without turbidity, manganese and iron, all are still in tolerable state for all purposes and ranging within standard limit based on WHO, EU and EQS for Bangladesh. The quality of the near well tube wells water is much decreased than far away tube wells water which might be the direct or indirect influence of the blowout incident around the area.

**Keywords:** Tengratila Gas Field; Gas Blowout; Water Quality; Blow out Impact

## 1. Introduction

A “blow out” is simply the blowing up and destructing the drilling rig and associated installations due to sudden, violent and uncontrolled flow of fluids *i.e.* water, gas or oil from underneath to the surface. In most of the cases, such accident is accompanied by fire and lead to damage of properties and often loss of lives. Oil or gas zone or over pressured water bearing rock layer in the subsurface, if penetrated by drilling pipe, may causes forceful flow of fluid through the drilling pipe. In the case of Bangladesh, there are three distinct gas well blow out incident happened such as the Sylhet-1 gas blow out, the Moulvibazar-1(Magurchara) gas blow out and Chattak-2 (Tengratila) gas well blowout (**Figure 1**) [1]. These blow out incidents have a great impacts on both environment and economics. Two blowouts occurred in Tengratila where the rising flames were visible from 30 kilometers away from this gas field which thoroughly damaged the geologic structures and nearby surface areas and also still venting out the gas from fissures in the well side and

nearby agricultural land.

Thus, this study is aimed at determining the effect of blow out on groundwater in Tengratila area and its vicinity through the laboratory analysis of different water parameters. Twelve functional tube wells samples located in Tengratila area were collected for quality checks by physicochemical analysis of the samples in the laboratory. The concentration of the physical and chemical parameters of water such as pH, turbidity, EC, total solids (TS), dissolved solids (DS), suspended solids (SS), manganese ion, calcium ion, magnesium, iron, chloride, total hardness (TH) were used to determine the water quality. The values of the physicochemical parameters were correlated with the World Health Organization (WHO), European Union (EU) and EQS for Bangladesh drinking water values.

## 2. Geology of the Study Area

The Chattak gas field located in Sumamganj district under Sylhet Trough (**Figure 1**). This is housed in structural traps *i.e.*, folded anticline. The folded trap is in

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north-south direction. The pattern of the fold structure as well as its vertical and areal closures varies considerably. The fold is affected by several faults. Seismic data indicate that the Sylhet Trough contains huge amount of elastic sediment. The stratigraphic succession of Sylhet Trough was initially established by lithostratigraphic correlation to type section in the Assam, north-eastern India. Seismic data indicate that the Sylhet Trough of northeastern part of Bangladesh contains about 17,950 m of Eocene to Holocene elastic sediments [2]. The sequence of the rocks encountered in the Sylhet Trough area is Eocene to Recent age where the Dupi Tila forma-

tion is the water bearing formation (Table 1). The Alluvium formation also contains some water.

### 3. Methodology

To determine the blowout impact on water, twelve samples from the study area are collected where six samples are from very near of the blowout area and rest samples are collected one or two kilometers away from the place of accident (Figure 1). During the time of sampling, the depth of tube wells, locations and time were recorded. The PHEP@ pocket sized pH meter by HANNA Instru-

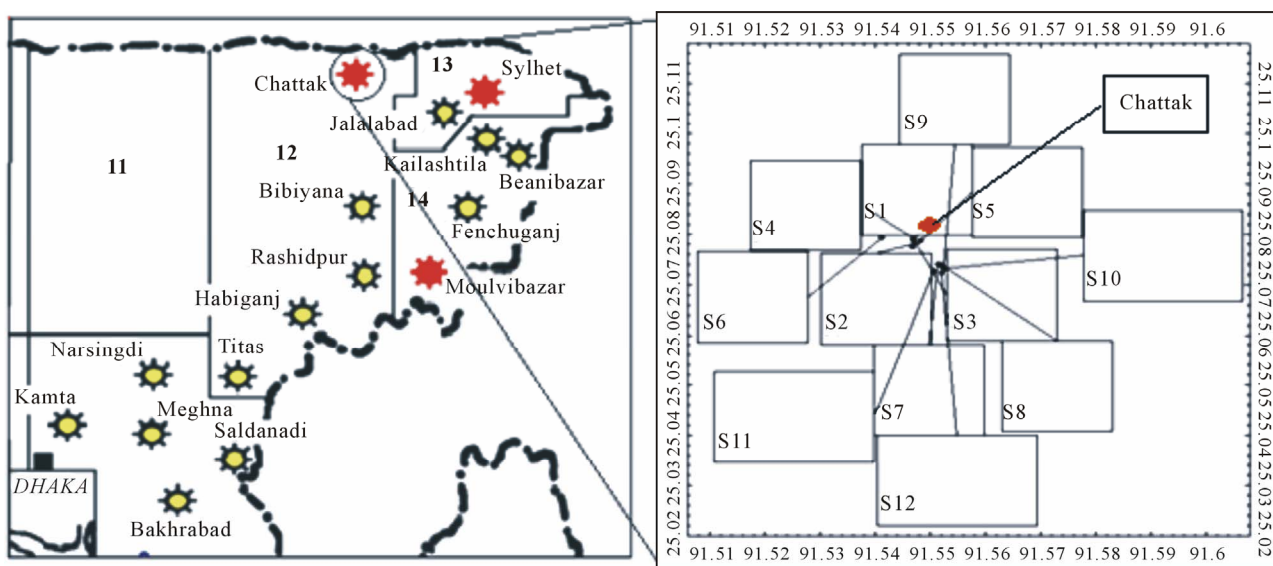


Figure 1. Location map of Tangratila (Chattak-2) gas field [1] and water sampling. Legend: S1-S12 means Sample 1 to Sample 12, respectively (Here, S1 - S6 are nearer and remaining are far away from the well).

Table 1. Stratigraphic succession of the Sylhet trough in the north-eastern part of Bangladesh [2].

Age (approx)	Group	Formation	Seismic marker	Thickness (max.) (m)
Holocene		Alluvium		
Pleistocene	Dihing Dupi Tila	Dihing Upper Dupi Tila	Yellow	3350
Late Pliocene		Lower Dupi Tila		
Mid-Pliocene	Tipam	Girujan Clay Tipam Sandstone	Brown	3500
		Upper Marine Shale		
Miocene-Early Pliocene	Surma	Upper	Red	3900
		Lower		
Oligocene	Barail	Undifferentiated	Violet	
		Kopili Shale		
Paleocene-Eocene	Jaintia	Sylhet Limestone	Blue	7200
		Tura Sandstone		
Pre-Paleocene	Undifferentiated sedimentary rocks (with some volcanics?) on the continental basement complex			?

ments was used to test pH. For Turbidity testing, Micro-processor Turbidity Meter HI 93703 by HANNA Instruments was used. Total solids (TS), dissolved solids (DS), suspended solids (SS), manganese ion ( $Mn^{2+}$ ), calcium ion ( $Ca^{2+}$ ), magnesium ( $Mg^{2+}$ ), iron ( $Fe^{2+}$ ), chloride ( $Cl^-$ ), total hardness were tested by Standard Methods developed by APHA, AWWA, WPCF (1998) [3,4]. All these tests were performed in Water Supply and Sewerage Engineering Laboratory, Department of Civil & Environmental Engineering, SUST, Sylhet. The results are presented in a tabular form (Table 2).

## 4. Results and Discussions

### 4.1. Evidences of Gas Blowout and State of Water Environment in the Area

The evidence of gas blowout and the current interruption of the state of water environment have been shown in Figure 2. From 2005 to 2007 about 426 positive and negative reports were published in two different newspapers about the present environmental condition around the area and also in some international newspapers. The articles specifically addressed the issues associated with the blow out impact as well as the Niko's rehabilitations activities against it [5]. However many allegations have been made about contamination and interruption of groundwater caused by this blow out and particular impacts on water wells observed in the field while some of the shallow and dug wells are not producing water well. On the other hand gas still seeping through some wells

and also in the pond water in the area. In a word, the total water environment greatly affected by this incident.

### 4.2. Blowout Impact on Physical Parameters of the Samples

Physical parameters define those characteristics of water that respond to the senses of sight, touch, taste or smell. The total solids, suspended solids, turbidity, pH, odor, color, taste and temperature in a water sample fall into this category [2].

#### 4.2.1. PH, Conductivity and Turbidity

The pH of the near gas field water of the study area



Figure 2. The flow of poisonous water from tube wells and nearby hoarse after many days of the second blowout on June 24 [6].

Table 2. Physicochemical results from the study area compared with WHO, EU, EQS (BD) limits [7-9].

Sample No <sup>**</sup>	PH	EC $\mu$ s/cm	Turbidity (NTU)	Fe <sup>2+</sup> ppm	Mn <sup>2+</sup> ppm	Ca <sup>2+</sup> ppm	Mg <sup>2+</sup> ppm	TS ppm	DS ppm	SS ppm	Cl <sup>-</sup> ppm	TH (ppm)
01	7.5	98	5.13	0.92	0.102	27.6	3.6	50.5	48	2.5	13	165
02	7.6	150	6.71	1.95	0.135	31.6	4.2	53	50.2	2.8	18	150
03	8.1	90	4.86	0.52	0.091	21	3.4	61	45.5	15.5	08	55
04	7.6	120	4.60	0.62	0.085	25	3.2	58	44	12	09	61
05	7.8	70	5.73	0.10	0.010	18	2.6	49	45	4	25	95
06	7.6	150	6.24	0.59	0.078	24.5	5.1	44	41	3	17	85
07	7.7	170	4.91	0.38	0.037	29	4.3	41.5	36	5.5	13	110
08	7.8	180	4.61	0.28	0.030	27	3.8	37.5	32.3	5.2	11	120
09	7.7	210	4.67	0.18	0.021	15.5	6.7	38	28.3	2.7	18	75
10	7.7	220	4.98	0.15	0.018	11.8	7.2	46.5	42.3	4.2	14	115
11	7.5	170	5.56	0.36	0.032	9.6	5.5	45	43	2	9.5	130
12	7.8	250	5.19	0.45	0.036	11.6	4.8	52.8	38.5	4.3	10.5	112
WHO	6.5 - 8.5	250	<5	<0.3	0.5	75 - 200	50 - 150	500		500	250	150 - 500
EU	6.5 - 8.5	250	*	<0.2	0.05	*	*	*	*	*	250	*
EQS (BD)	6.5 - 8.5	-	-	0.3-1	-	-	30 - 50	-	1000	*	150-600	40 - 180

\*Not mention; \*\*Sample Near well tube wells (1 - 6) and far well tube wells (7 - 12).

ranges from 7.1 to 8.1 where the standard pH value for drinking water in Bangladesh is 6.5 - 8.5. The  $p^H$  values of the far tube well water samples ranges from 7.5 to 7.8 (Figure 3). The acidity of the water depends on its value of  $P^H$  where 7.0, Considered as base line [7-9].

The conductivity values in the area ranges from 70  $\mu\text{s}/\text{cm}$  to 250  $\mu\text{s}/\text{cm}$  at locations 5 and 12 respectively (Table 2). Conductivity values for all the samples are within acceptable limit based on WHO, EU and EQS for Bangladesh (Figure 4). Conductivity of the water can be related to the total dissolved solids concentration but the relationship may not be a constant [10].

Turbidity is a measure of extent to which light is either absorbed or scattered by suspended material in water. Turbidity of near well tube wells water in the study area ranges from 4.60 NTU to 6.71 NTU where the far well tube wells represent 4.61 NTU to 5.56 NTU. Turbidity of water of the study area has represented given away in Figure 5. The turbidity values recorded for most of the samples were above the WHO acceptable limit of 5.00 NTU [9].

#### 4.2.2. Total Solids (TS), Dissolved Solids (DS), Suspended Solids (SS)

The values of total solids of water samples are within the range of 37.5 to 61 ppm where dissolved solids (DS) and suspended solids (SS) were 28.3 to 50.2 ppm and 2 to 15.5 ppm respectively. The water of near well tube wells show higher amount of solids than far tube wells. Data

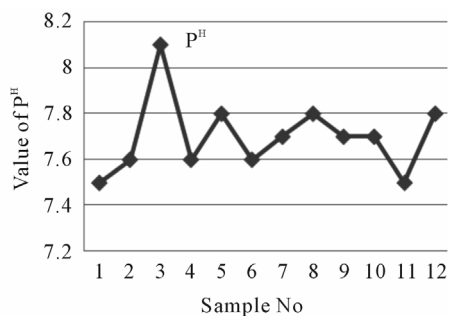


Figure 3. A two dimensional (2-D) line chart of pH variation.

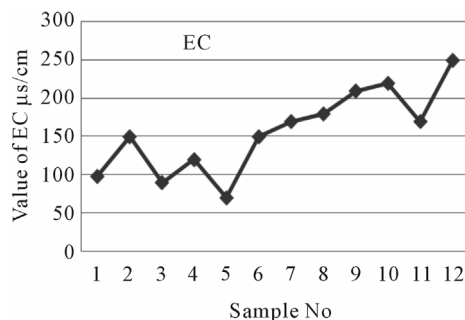


Figure 4. A two dimensional (2-D) line chart of EC variation.

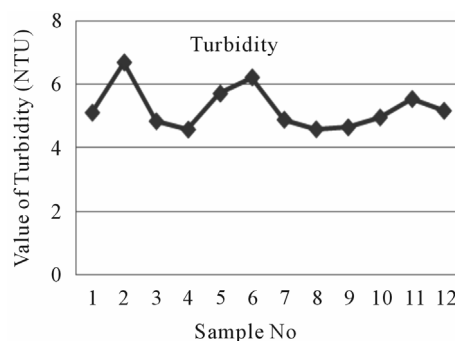


Figure 5. A two dimensional (2-D) line chart of turbidity variation.

obtained from examination all types of solids are within limit (WHO, EU and EQS for Bangladesh). Generally the electrical conductivity of water depends on the total solids of water. Dissolved solids comprise inorganic salts and some small amounts of organic materials that are dissolved in water. TDS originates from natural source, sewage, urban-runoff, industrial wastewater and the nature of the piping or hardware used to convey the water TDS test provides a qualitative measure of the amount of dissolved ions in water and could be used as an indicator test to determine the general quality of water [10]. The data obtained for dissolved solids of water are shown in Figure 6.

#### 4.3. Blowout Impact on Chemical Parameters of the Samples

Chemical parameters define those characteristics of water that respond structure and components [8]. Iron ( $\text{Fe}^{2+}$ ), Manganese ( $\text{Mn}^{2+}$ ), Calcium ( $\text{Ca}^{2+}$ ), Magnesium ( $\text{Mg}^{2+}$ ), Total Hardness and Chloride ( $\text{Cl}^-$ ) in water samples fall into this category [2].

##### 4.3.1. Iron ( $\text{Fe}^{2+}$ )

The iron concentration in the near field tube wells of the study area ranges from 0.10 ppm to 1.95 ppm where the WHO given value is 0.3 ppm [9] and 0.3 to 1.0 ppm for EQS for drinking water in Bangladesh [7]. The meditation of iron in far tube wells water of the study area ranges from 0.15 ppm to 0.45 ppm. The iron concentration of water samples have been shown graphically in Figure 7.

##### 4.3.2. Manganese ( $\text{Mn}^{2+}$ )

The values of Manganese of water samples range from 0.010 to 0.135 ppm (near well tube wells 0.010 to 0.135 ppm and far well tube wells 0.018 to 0.037 ppm) and that of near well tube wells shows higher amount Manganese than the far tube wells (Figure 8). The standard value of Manganese ( $\text{Mn}^{2+}$ ) ion in water samples are 0.5 and 0.05 ppm based on WHO and EU, respectively [8,9].

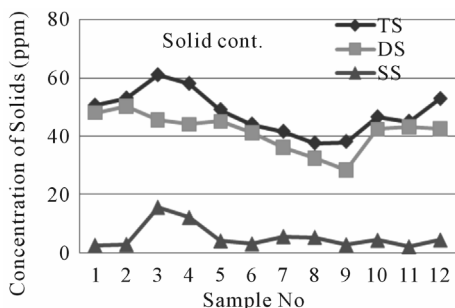


Figure 6. A two dimensional (2-D) line chart of various solids deviation.

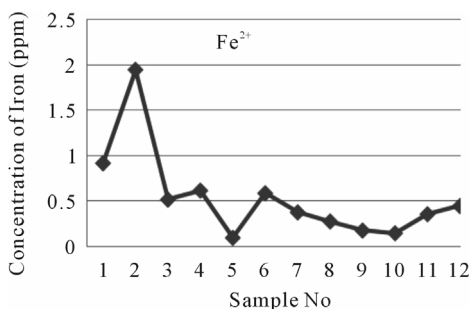


Figure 7. A two dimensional (2-D) line chart of Fe<sup>2+</sup> concentration disparity.

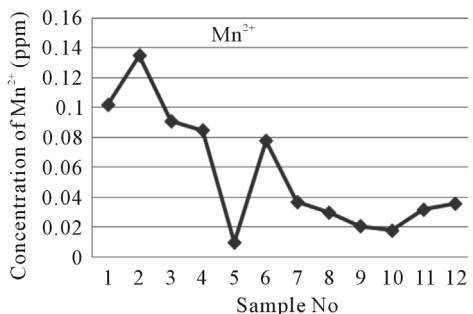


Figure 8. A two dimensional (2-D) line chart of (Mn<sup>2+</sup>) deviation.

4.3.3. Calcium (Ca<sup>2+</sup>) & Magnesium (Mg<sup>2+</sup>)

The highest concentration of Calcium ion in water of the study area is 31.6 ppm and the lowest one is 18 ppm (near well tube wells) and for far well tube wells it is 29 ppm and 9.6 ppm. The magnesium concentration in water of the study area ranges from 2.6 ppm to 7.2 ppm. The water samples in near well tube wells contain more Ca<sup>2+</sup> but less Mg<sup>2+</sup> than far well tube wells water (Figure 9).

4.3.4. Total Hardness

The hardness of the samples has been calculated as CaCO<sub>3</sub> in ppm (by convention). Hardness results from the presence of divalent metallic cations of which calcium and magnesium are most abundant. Total Hardness of near well tube wells water in the study area ranges

from 55 ppm to 165 ppm where the far well tube wells represent from 75 ppm to 130 ppm where the WHO and EQS for Bangladesh drinking water given value are 50 - 500 ppm and 40 - 180 ppm correspondingly [7,9]. Total Hardness of water of the study area has been shown in Figure 10.

4.3.5. Chloride (Cl<sup>-</sup>)

The chloride concentration of near well tube wells water in the study area ranges from 8 ppm to 25 ppm (sample 5) but the chloride content of the far well tube wells water are below 20 ppm and average value around 12 ppm (Figure 11).

4.4. Future Problems and Recommendation

From the total analysis, it is clear that all of the water parameters are almost within the standard limit but some cases iron shows that higher concentration in near well

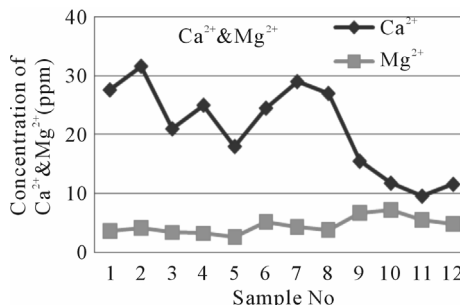


Figure 9. A two dimensional (2-D) line chart of Ca<sup>2+</sup> & Mg<sup>2+</sup> concentration inequality.

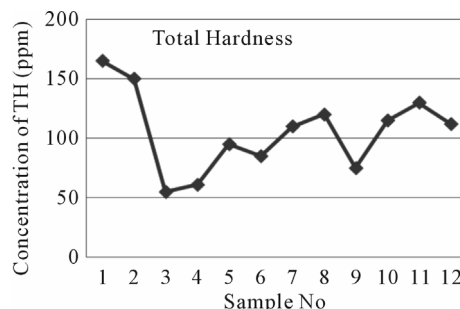


Figure 10. A two dimensional (2-D) line chart of total Hardness deviation.

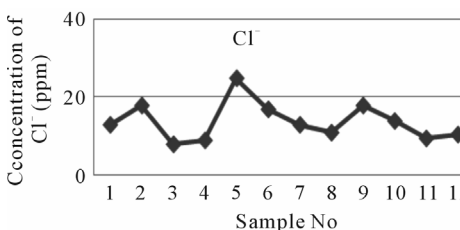


Figure 11. A two dimensional (2-D) line chart of chloride variation.

tube wells. But we know that the small concentrations of iron are essential for human health because iron helps to transport oxygen in the blood. High concentrations of dissolved iron (> 0.3 ppm) can result in poor tasting, unattractive water that stains both plumbing fixtures and clothing [11 and 9]. When iron-rich waters mixed with tea, coffee, or alcoholic beverages, they assume a black, inky appearance with an unpleasant taste. The parameters also clog water systems, plug filters or envelop pump screens resulting in expensive repairs. This may cause a great effect on human being as well as fertility of agricultural land [12,13]. Unrestrained behavior of iron is also responsible for some skin diseases that may turn into cancer. Thus, this research recommends a detail research with mitigation action plan for water environment in the area.

## 5. Conclusion

From the study, it is observed that the values of water of the near well tube wells are slightly higher from standard limit consequently this contaminated water polluting the nearby surface land and creating problems on human and animals. The water quality of near well tube wells are deteriorating and will be deteriorated with time being while the gas still seeping from the reservoir to the surface and ground. In the present study, the pH value ranges between 6.5 to 8.5. 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; where maximum turbidity is detected as 6.71 NTU at near well tube wells water. Other parameters are also higher in near well tube wells water. Thus from this result, it can be concluded that the impact of gas blow out is slightly noticeable in the case of near well water than the far well water and as a whole the impact of such incident on ground water environment is not so noticeable in the area at present. Moreover this research recommends a more detail research on the total water environment around the area.

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**Full Meanings of Different Abbreviations in the Research**

EC—Electric Conductivity	EQS—Environmental Quality Standard
TS—Total Solids	APHA—American Public Health Association
DS—Dissolved Solids	AWWA—American Water Works Association
SS—Suspended Solids	WPCF—Water Pollution Control Federation
Mg <sup>2+</sup> —Manganese ion	SUST—Shahjalal University of Science and Technology
Mn <sup>2+</sup> —Manganese ion	TH—Total Hardness
Ca <sup>2+</sup> —Calcium ion	ppm—Parts per Million
Fe <sup>2+</sup> —Iron ion	NTU—Nephelometric Turbidity Unit
Cl <sup>-</sup> —Chloride ion	BD—Bangladesh
Mg—Magnesium,	TDS—Total Dissolved Solids
WHO—World Health Organizations	<i>i.e.</i> —That is
EU—European Union	m—Meter
	S1—Sample 1
	CaCO <sub>3</sub> —Calcium Carbonate