Pressure Drop Analysis of Natural Gas Transmission Line in Bangladesh

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***Abstract*--**The main objective of this study is to implement a virtual simulation network of natural gas transmission system to observe the pressure drop along the pipeline when the gas consumption rate varies effectively. When the pressure falls to a certain value, higher hydrocarbon content of natural gas becomes liquid and the reduced pressure hinders the gas transmission especially when it is expected to transmit across a long distance. The Reduced pressure also clarifies the importance of setting up compressor station to boost up the pressure and transmit a larger volume of gas through an existing pipeline system. As the natural gas consumption rate of Bangladesh is increasing day by day, it is necessary to visualize the effect of pressure change when the consumption rate increases. North-South pipeline and Brahmaputra Basin gas transmission pipeline have been implemented in this simulation network of Pipesim and the effect of pressure variations have been observed.

***Keywords*--** BAPEX, BEGGS, MMSCF, PIPESIM

I. INTRODUCTION

Behavior of Pressure Change in Natural gas transmission is important as higher hydrocarbons are liquefiable in low to moderate pressure levels. Eventually high water content and hydrocarbon liquid perform as a bad actor for the sales gas pipeline. Prediction in pressure drop helps to determine the safe operation limits along with the volume of dry sales gas to be transmitted in a given situation.

NATURAL GAS TRANSMISSION SYSTEM OF BANGLADESH

The natural gas transmission pipeline infrastructure in Bangladesh represents a complex mechanical system that delivers about 1900 MMSCF [1] of natural gas per day, and is made up of over 1400 km (870 miles) [2] of pipe. This system has been developed over the last few years, and is controlled at a very low level of sophistication. A mathematical model to simulate pipeline system operation, as well as the impact of design changes and equipment enhancements, is urgently needed for this huge system.

Gas transmission Company Limited (GTCL) is now responsible for maintenance and operation of the gas transmission pipeline across the country. They are using "PIPELINE STUDIO" for simulation works. In this study PIPESIM 2009 has been used for gas transmission network analysis and simulation.

At present Gas is Produced by state owned enterprises i.e. companies of Petrobangla and International Oil Companies (IOC). Eighteen gas fields are producing around 1900 MMSCF [2] gas per day. BGFCL and Chevron (an IOC) are the two major production companies in Bangladesh each producing 700 and more than 1000 MMSCF gas per day. BAPEX is mainly the exploration company. To strengthen BAPEX financially the government allowed operating two gas fields, Namely Salda and Fenchuganj.

Currently four companies of Petrobangla are responsible for transmission and distribution:

1. Jalalabad Gas Transmission and Distribution Company limited (**JGTDGL**).
2. Titas Gas Transmission and Distribution Company limited (**TGTDCL**)
3. Bakharabad Gas System Limited (**BGSL**)
4. Paschimanchal Gas Company Limited (**PFA**)

The north south pipeline contains the major gas producing fields including Bibiyana (810 MMSCFD) and Jalalabad (230 MMSCFD). A new compressor station has been installed at Muchai that has increased the capacity of the existing pipeline and the supply pressure of the Ashuganj main gas transmission hub. The deigned network only covers the source and the supply points and simulates the pressure drop in the upstream when consumption increases downstream of the Ashuganj.

North south pipeline and the Brahmaputra basin pipelines are two major ones among the total gas transmission network of Bangladesh. The Gas production wells situated at the northern part of the country are connected with North South pipeline, which hardly contains any specific Gas Consumption points. The only Gas Consumption Point is FPS (Fenchuganj Power Station).

The Brahmaputra basin pipeline is the only link of our gas supply to the western part of the country. Currently this part is operating at full capacity. But the demand is increasing specially a new fertilizer company is going to be constructed at Sirajganj, and gas supply line should be extended to Khulna.

For this increasing demand the existing pipeline is not enough to transmit such huge volume of gas, unless a new pipeline is designed and added as a loop to the main gas transmission network. The largest gas producing field BIBIYANA is planning to expand its production from 800 MMSCF to 1.2 BCF per day and one dedicated pipeline has been planned to join the main north-south pipeline and a loop.

II. SIMULATION BY PIPESIM

The Natural Gas transmission process involves pressure and temperature change due to the frictional loss, difference in elevation, gas velocity, and Joule-Thompson effect. Effective heat transfer from or to the surroundings is also responsible for temperature change across the pipeline. Pressure and temperature change along with liquid and solid (hydrate) formation in the line also affects the pressure profile. Modeling and simulation of multiphase system, even under steady-state condition, is complex. There are a few tools designed specifically for modeling and analysis of complex multiphase systems such as PipePhase, PipeSim, OLGA, etc.

Before this simulation, a fluid model has been defined according to the sales gas specification data of GTCL. Beggs and Brill [3] fluid flow correlation has been used for horizontal flow. Though no vertical elevation has been defined in the gas transmission network Hagedorn & Brown Correlation has been defined as the fluid flow model for vertical flow. Allowable amount of water and liquefiable hydrocarbons are also defined according to the standard provided by GTCL.

The fluid model [4] is the main prerequisite that should be defined first when drawing a gas transmission network model. Here the model has been defined according to the sales gas specification of GTCL. Maximum allowable water in the supplied Gas = 7 lbs/MMSCF and maximum allowable Condensate = 2gal / MMSCF.

Table 4.1: Used Fluid Model in PIPESIM [4]

Element	Mol %
Nitrogen	0.339
Methane	95.678
Ethane	2.638
Propane	0.460
CO_2	0.052
Butane	0.080
isobutane	0.326
isopetane	0.087
n pentane	0.025
Hexane	0.084
Heptane+	0.231

Finally the pressure drop calculation method with an example has been shown before presenting the simulation work. The pressure drop data have been plotted along with the distance. The detailed result shows the pressure, temperature data at different points of the network.

The temperature effect has been considered negligible and has not been considered in the simulation plot. The pressure drop profile has been plotted with the horizontal distance. The simulated data have been compared with the actual data from the GTCL data sheet [2]

III. SIMULATION RESULTS

The Pipesim simulation report mainly contains two parts. They are analytical data i.e. pressure, temperature, mass flow rate, gas flow rate and water cut. The other part of the report contains graphical representation of data. This part contains elevation with dissonance, pressure drop with respect to the length of the pipe and temperature profile along with the length of the pipe.

As this report is dealing only with the natural gas transmission, the temperature profile is not one of the major factors for discussion. The pressure drop along with distance is the main concern for this report. The simulated data have been compared with the actual pressure temperature data and the compared result has been plotted together. Two separate graphs have been plotted representing the pressure profile of N-S and Brahmaputra basin pipeline. Only data from the specific sources and supply points have been analyzed.

TABLE I: PRESSURE AT DIFFERENT SOURCES IN N-S PIPELINE

Sources	Real Pressure (Psi)	Simulated Pressure (Psi)	Supply (MMSCFD)
Kaitashtila	1076	1077.7	100
Feni	1060	1022.7	5
Rashidpur	1008	891.96	50
Hobiganj	970	930.46	245
Titas-E	855	755.24	45
Bibiyana	1000	1155	450
Jalalabad	1077	1101	170
Moulavibazaar	1050	922.44	100

Figure A: Pressure of Different Gas Fields

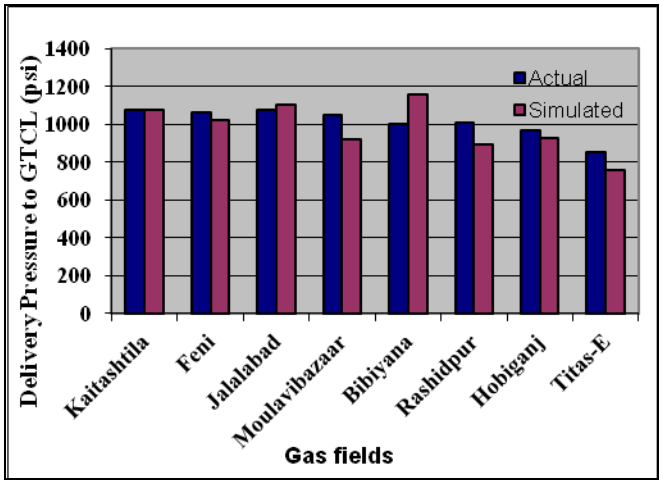
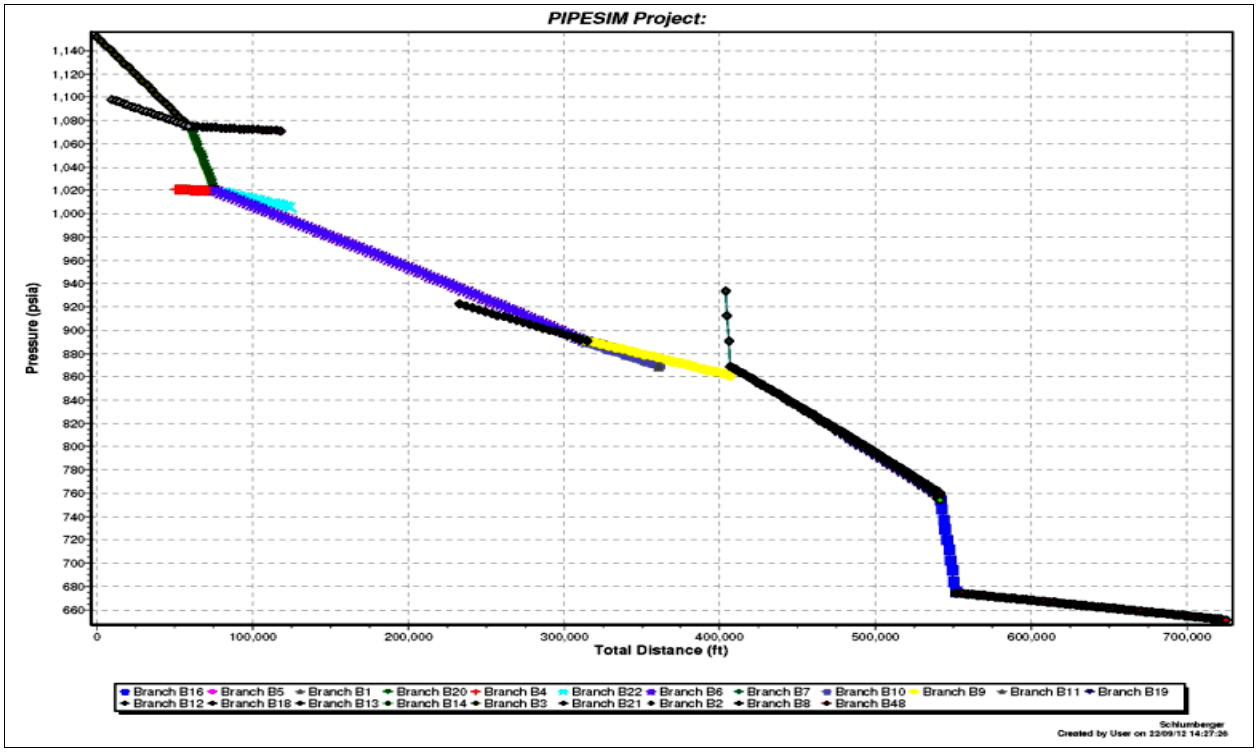
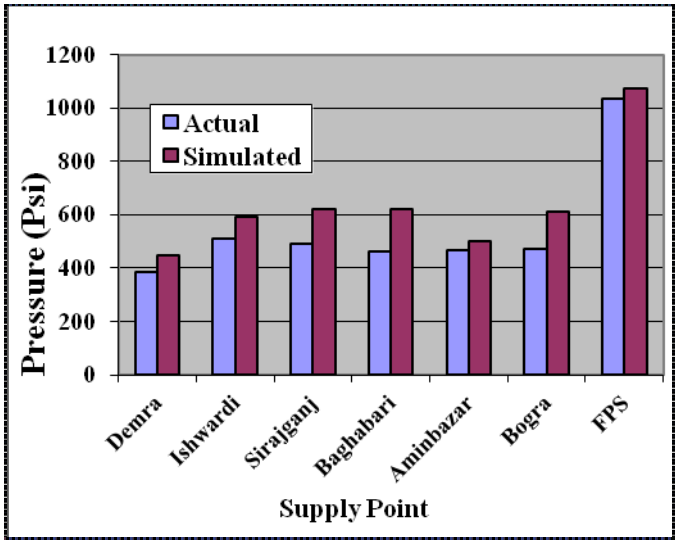


Figure B: Pressure Drop in North South Pipeline



From the Ashuganj hub to the Brahmaputra Basin Pipeline the profile is different. As the section has mainly major consumers of the north south pipeline producers, steep pressure drop is expected to be observed along the pipeline. The Simulated pressure profile has been compared with the real time data. During Low demand period or high demand projection in the future.

Figure C: Pressure of Gas Supply Points

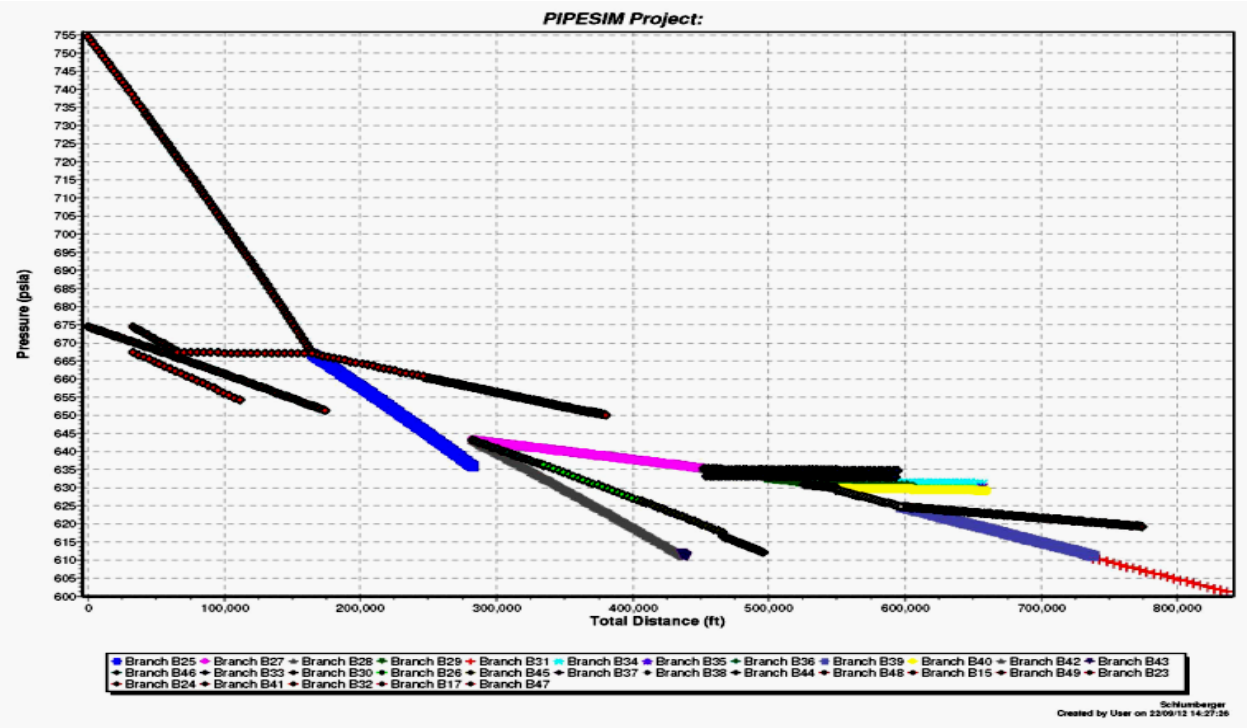


Pressure drop across the horizontal distance may be clarified on the following pictures. This is evident that the pressure drop is greater across the Brahmaputra basin pipeline as the major part of the consumers lies within the area. Each horizontal point in figure B has several branches and it clarifies the contribution of different gas processing fields. As there is limited number of users comparatively, the pressure drop profile has a less sharp declination across this pipeline.

On the other plot a completely different behavior of pressure drop has been observed. On each horizontal point, different pressure curves have been observed which is quiet unusual. The presence of different consumption point along with different supply arrangement has caused this unusual behavior of pressure drop. However, the overall pressure drop with horizontal distance is much sharper that that of the N-S pipeline. The curve has more vertical branches when the horizontal distance is more than 1, 00,000 ft.

The excel plot shows the value of actual and simulated pressure and it is evident that different supply points have higher value of simulated pressure than actual pressure. The pipe roughness and other contributing factors such as: temperature and frictional loss may be responsible in this regard.

Figure D: Pressure Drop from Ashuganj to Brahmaputra Basin Pipeline



VI. DISCUSSION

The Pipesim model has simulated the pressure at different supply points and also at different sources. There are important issues that have been clarified:

1. The compressor station at muchai has come online on April, 2012. On the existing gas transmission pipeline the quantity of gas transmission has been increased. The simulation has clarified the justification of installing the compressor station.

2. During Eid and other national holiday the consumption downstream of Ashuganj decreases and the gas processing plants heavily suffers to swing down their load during that period. The simulation has projected the conditions under various pressure conditions.

3. The natural gas consumption has increased exponentially over the last few years because of heavy industrialization and intense population. As a result, it is naturally expected that the demand will rise in the near future. The pressure plot from the Ashuganj hub to the Brahmaputra basin pipeline has a lot more clarification about the condition of the present consumption scenario of Bangladesh.

4. The liquid recovery system by individual gas producing fields has not been monitored by the Gas Transmission Company Limited. So the amount of liquefiable hydrocarbons on the sales gas needs to be monitored and during the sudden pressure drop condition on the consumer end the effect needs to be observed. This model has enabled the opportunity to change the fluid model according the sales gas composition and provided the opportunity to observe the effects on abnormal consumption on the consumer end.

5. Depending on a transmission system that is more than 30 years old, the existing transmission network has aged transmission pipelines that could be assumed to posses' different roughness and inside diameter than the installation period. Changing the parameters in Pipesim the transmission conditions could be simulated using more realistic data.

VII. LIMITATIONS AND IMPROVEMENT OPTIONS

Designing a simulation network that only has the segment of the total transmission system, has some limitations and improvements opportunities.

1. The government of Bangladesh is planning to extend the gas transmission network to the southern part of the country. The proposed expansion network can be added with the current network.

2. The transmission network on the south-east part of the country (Chittagong zone) has not been added with the existing simulation network. As a number of industries are waiting to be started the consumption is expected to rise in the next few years.

3. The Muchai compressor project has not been considered for simulation, adding the compressor station will enable the current model to simulate that how much additional

amount of gas is possible to transmit on this existing pipeline network.

4. The biggest gas processing field, Bibiyana gas plant operated by Chevron is going under an expansion project and total gas flow from Bibiyana is expected to rise up to 1.2 BCF from the year 2013 with the introduction of 5 additional wells. Considering these conditions an additional 24 inch dedicated pipeline will be installed for transmitting the total gas from Bibiyana to Ashuganj. This section could be added with the existing network model

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