Simulation of Bahr Essalam 36'' Gas Export Trunk-line Using OLGA

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Abstract

Pipelines are considered one of the most important sectors of the petroleum industry, as they are one of the most important ways to transport gas and oil from production to refining stations and also to treatment plants for several reasons, on top of which they are considered the safest and least costly, and they are difficult to steal. These pipeline networks are equipped with valves, pumps and controllers. There are several types of pipelines, some of which are intended for the transportation of crude oil, some of which are intended for the transportation of petroleum products, and marine pipelines to transport

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gas and petroleum, whether for export or for transportation from marine fields to onshore processing plants. In order for the pipeline to fulfill its purpose with minimum losses, there are pre-measures to be taken to guarantee flow assurance throughout the flowline.

The purpose of this paper is to perform a study and simulation using OLGA of the gas transport lines at Sabratha offshore platform in Libya. Specifically, Bahr Essalam 36'' Gas Export Trunk-line to test its ability to withstand new flow rates. focusing on two major challenges which are hydrate formation prevention and slug tracking, so to ensure smooth flows without any interruptions which may cause enormous economic losses, not to mention mechanical plugging or technical issues that may consume a large amount of time to repair. This is done through several possible scenarios that occur during operation, including the emergency shutdown and blowdown, as well as the breakdown of one of the gas processing units in the platform.

The results obtained from this study showed that the maximum flow rate which can be delivered by the 36'' export line is 1300MMSCFD and injection of hydrate inhibitors is needed in cases of shutdown. Results also show that the existing slug catcher size is small for the expected liquid in case of raw gas delivery (maintenance on platform).

***Keywords**: Flow assurance, eliminate slug, hydrate, OLGA software, Sabratha offshore platform.*

1. Introduction:

Flow assurance aims to ensure the continued flow of oil and gas. To achieve this goal, flow assurance depends on an engineering analysis that ensures preventing instability of the flow in order to continue production at the required level. Although multi-phase flow occurs in many industrial processes, methods of transporting multi-phase fluids through pipelines and wells have progressed rapidly in recent decades.

The behavior of multi-phase flow is more complex than single phase flow. With the complex nature of multi-phase flow, these conditions can often generate some flow phenomena, phenomenon can pose significant threat to oil and gas production facilities such as slug flow is the most undesirable flow system in multi-phase flow, due to the associated instability, that pose significant challenges to flow assurance in the oil and gas industry. Despite these challenges efforts are constantly being made to ensure maximum oil recovery.

Computer programs such as OLGA and HYSYS are powerful tool to evaluate flow parameters and study flow assurance. The Olga program was used to simulate a flow system. Olga is a multi-phase flow simulation program in pipelines with processing equipment included, determine fluid properties by PVTsim software. PVTsim is a versatile equation of state modeling software that allows the user to simulate fluid properties and experimental PVT data.

The objective of this study is to gain insight into and eliminate slug flow behavior in pipeline systems and conduct studies ensure flow for oil and gas pipelines from Libyan oil fields. Utilizing OLGA and PVTsim software.

Petroleum is an important use, as petroleum is not only a raw material used for the production of fuel and oils, but also the basis for a large industry in many forms is the petrochemical industry, which produces a huge amount of precious materials.

The safe and economic transportation of oil produced by undersea pipelines requires methods to avoid any losses in offshore oil production. This has led to advances in multiphase transport technology.

Flow assurance issues associated with deep-water flowlines and pipelines remain central to cost-effective field developments. Wax, asphaltene and hydrate plug formation comprise the key concerns. Corrosion, erosion and chemical incompatibility issues also fall within the flow assurance umbrella. Driven by the high cost of remediation, including deferred production, operators typically specify development schemes focused on ensuring high tolerance to production chemistry and operational upsets. Confident predictions of operating envelopes assuring a clear flow path appear commonplace; efforts to broaden these envelopes may lead to less costly development schemes and higher degrees of operating freedom.

The obstacles of flow may differ according to whether the hydrocarbon being produced is oil or gas, but they coincide in some aspects. For example, wax and asphaltene deposits are obstacles encountered in oil production, while hydrates formation is a key obstacle found in gas production.

Hydrates formation will partially or fully block the fluid flow in pipes, which results in backpressure on the wellhead and reduced well production. In the worst-case scenario, hydrates formation will kill the well. The prediction of hydrates formation in pipelines helps evaluate the problem and select the proper solution for solving it. [1]

Flow assurance is used to assess the effects problems of oil and gas transmission lines such as severe stagnation, hydrates, wax, asphalt, corrosion, scales, emulsions and their ability to disrupt production in the multi-stage flow system. [2].

Bahr Essalam 36'' Gas Export Trunk-line: Bahr Essalam, located about 120 kilometers northwest of Tripoli, contains over 260 billion cubic meters of gas. This is delivered through the Sabratha platform to the Mellitah onshore treatment plant

Gas field where gas and associated condensate are produced from (26) wells; (15) platform wells and (11) sub-sea wells. The production is gathered on the platform where the gas is primarily dehydrated and approximately (995 MMSCF/day) of sour gas delivered to Mellitah gas Treatment plants for further treatment by 36’’ sea-line (110 km). the side profile of this line as shown in Figure (1), The gas is transported through a 36’’ pipeline to Mellitah plant for final treatment and onward transmission to the local market and export to Italy through the Green Stream compression station and 540 km 32’’ sea line. [3]

2. Methodology:

Due to the importance of gaining a stable, safe and economically efficient gas production flowline the most common obstacles facing gas-liquid flow in Bahr Essalam 36’’ pipeline, simulation using OLGA to study the gas transport line is helpful, focusing on two major challenges which are hydrate formation prevention and slug tracking, so to ensure smooth flows without any interruptions which may cause enormous economic losses, This is done through several possible scenarios that occur during operation, first scenario consists of raising the gas flow along the export trunkline to around or beyond 1100 MMscfd, therefore this scenario to specify a higher gas flowrate going under a failed separation circumstance.

second scenario to indicate a possible futuristic flowrate. New gas wells are being discovered continuously, therefor there is a need for simulating the probable parameter changes in order to contain the production increase.

Control of hydrate formation in gas systems typically involves injection of methanol or glycol at a location where the fluids are above the hydrate formation temperature, with downstream separation and recycling common for glycols. Control of hydrate formation in oil systems typically requires heat-conserving flowlines, with special procedures for transient operations (e.g., cold start-up).

Continuous methanol injection, due primarily to the preference of the methanol for the oil vs. water phases, remains uneconomic for most oil systems due to large dosage requirements. [4, 5]

The study cases in flow assurance are simulated through using OLGA software, and typical transport systems are analyzed according to the flow assurance guidelines. two case studies Simulation of Bahr Essalam 36'' Gas Export Trunk-line Using OLGA have been done, these cases will help to improve the reliability of the system by identifying critical conditions to be avoided.

3. Results and discussion:

Results are presented and discussed on the basis of flow assurance principles, in order to avoid any flow problems such as future pauses and the need to intervene. The study of this case is to prevent the formation of slugs to ensure the stability of the flow. OLGA simulator is used to simulate a steady state flow. The pipeline profile as show in figure (1).

A gas quantity of 1100 MMSCFD. flows across the pipeline to reach an outlet pressure of (42barg). The temperature at Sabratha platform is 38 degrees centigrade, reduced along the flowline to 11 degrees centigrade. The reduction of temperature is due to low ambient temperature, where the water reaches its minimum temperature degree at 15 °C.

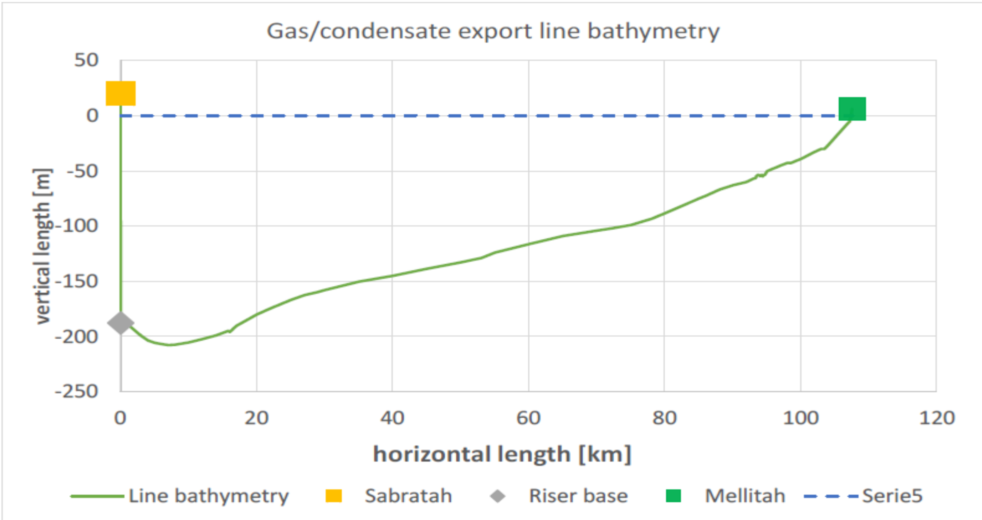
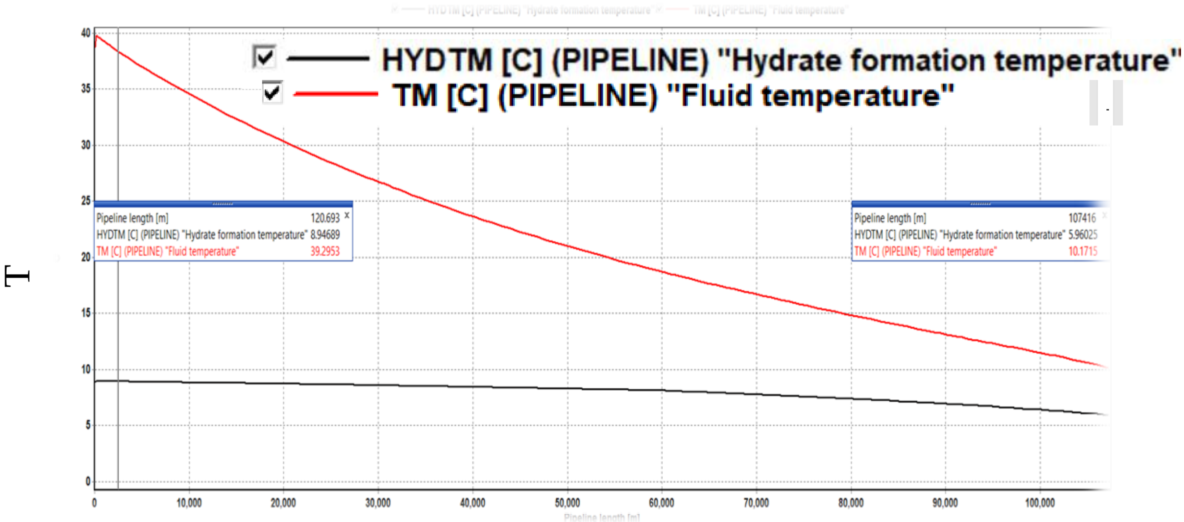


Figure (1) Export trunkline (36”) side profile. [3]

According to the simulation applied on this line displays the profile of the flow system along pipeline in normal operation the flow stability. The simulation for this case was 5 days runtime. With the specified flow rate and arrival pressure, an inlet pressure of 74.9337 bara is achieved. Stratified flow is witnessed along the pipeline.



Pipeline length

Figure (2) Hydrate Formation Temperature & Gas Temperature at 1100 MMSCFD flowrate through 36’’ pipeline.

Inlet temperature as shown on figure (2) is 38.7598 °C, while delivery temperature reaches 10.1775 °C, with approximately 4 degrees centigrade separating the gas temperature from its hydrate formation temperature.

This difference in temperatures is very narrow, therefore further chemical inhibition is needed to maintain the gas temperature above its hydrate formation conditions by lowering the last mentioned. Both TM and HYDTM get the closest at the end of pipeline, where TM is reported to be 10.1775 °C and HYDTM is 5.9 °C.

Accumulated liquid volume flow ACCLIQ and surge liquid volume SURGELIQ at the end of the pipe has been studied as shown on figure (3), accumulated liquid at the end of runtime reached 6800.56 m^3, with SURGELIQ of 5.49 m^3.

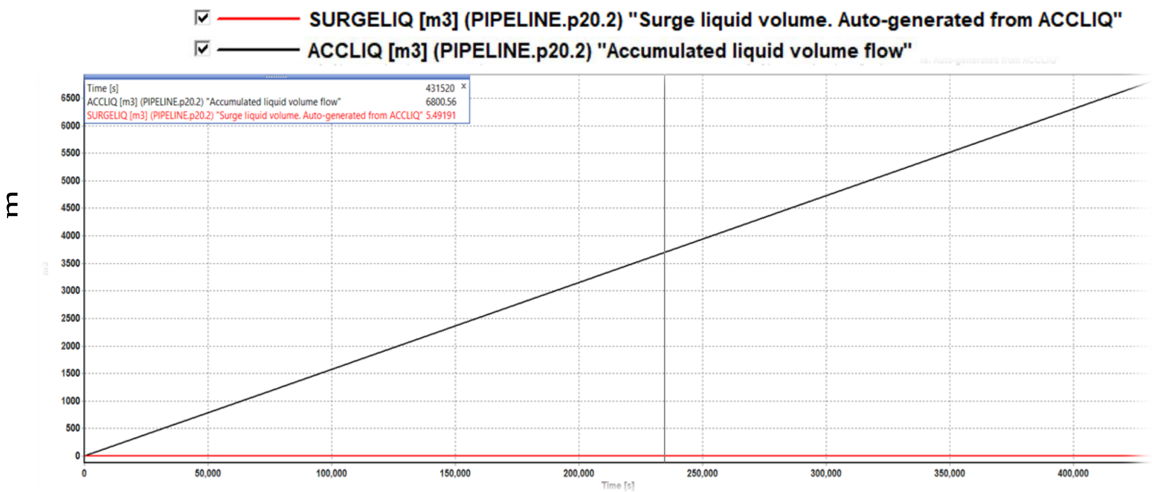


Figure (3) Accumulated & Surge Liquid Volume of 36'' line after 5 days of 1100 MMSCFD gas flow.

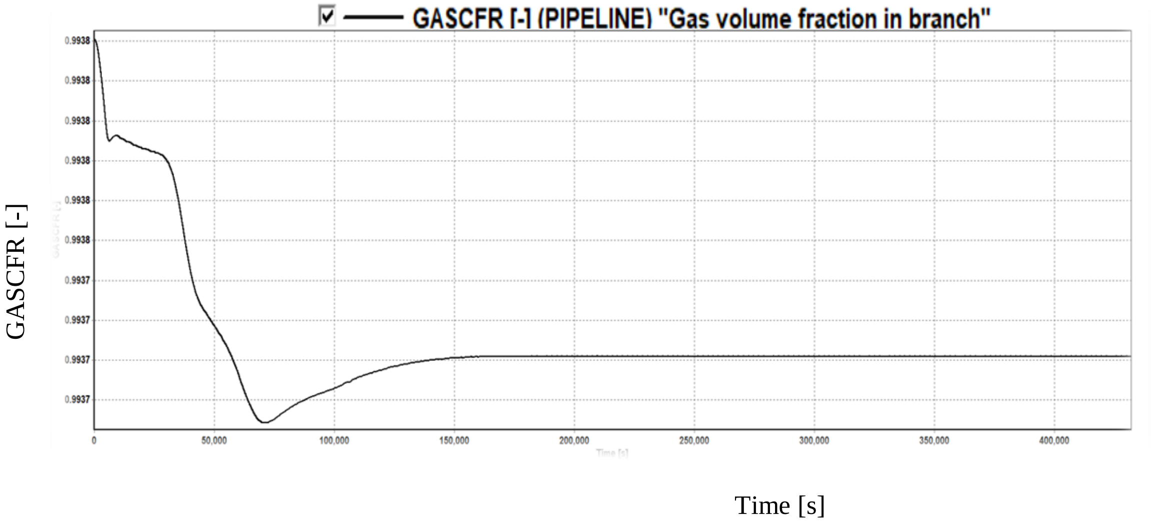


Figure (4) Gas volume fraction throughout 1100 MMSCFD flow period across 36'' pipeline.

In figure (4) this case where 1100MMscfd is achieved, high gas fraction is present. This reduces the chances of slugging and severe liquid blocking.

Scenario 1:

Bahr Essalam network production lines have been since the birth of the project subjected to a futuristic production increase plan. This plan consists of raising the gas flow along the export trunkline to around or beyond 1100 MMscfd, therefore this scenario specifies in a higher gas flowrate of 1200 MMscfd going under a failed separation circumstance.

For this scenario, 1214 MMscfd of raw gas flows through the pipeline from Sabratha to Mellitah causing issues related to hydrates and slugging. figure (5) report the circumstances under which the hydrates will surely form inside the pipeline.

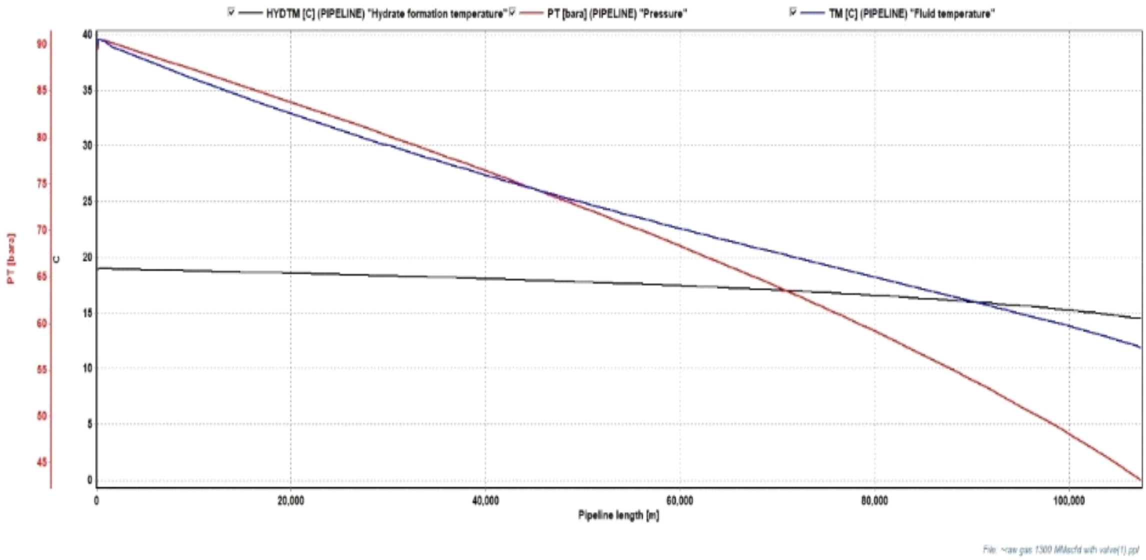


Figure (5): Hydrate Formation Temperature, Gas Temperature & Pressure curves of 1200 MMSCFD Raw gas flow through 36'' flowline.

The next figure (6) tracks surge liquid volume at the second section of the last pipe, recording an amount of 2.8 m^3 at the end of a 3-day runtime simulation.

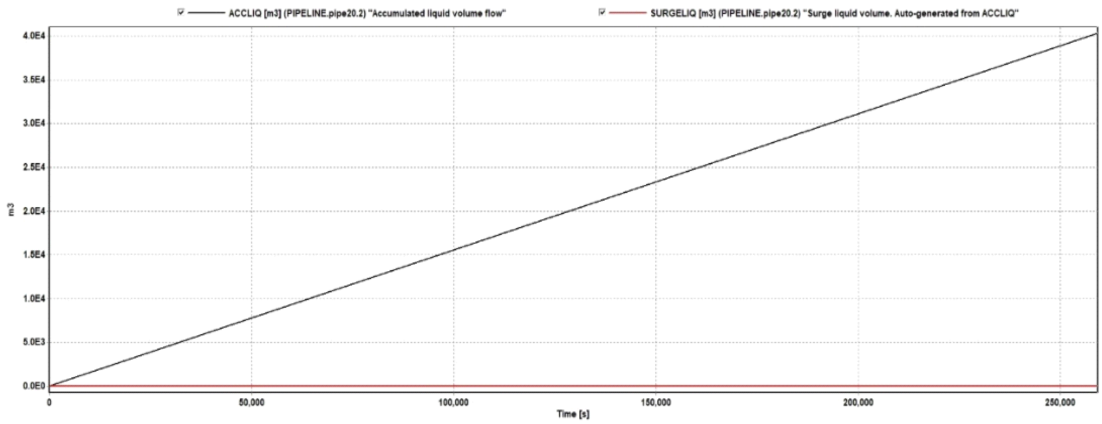


Figure (6): Accumulated & Surge Liquid Volume curves of 1200 MMSCFD Raw gas flow 36'' gas flowline

For the 1200MMscfd raw gas flow, any shutdown from Mellitah Complex is not acceptable due to surge pressure. The flowline pressure exceeds the design pressure by more than 5 bara difference.

Scenario 2:

This scenario indicates a possible futuristic flowrate. New gas wells are being discovered continuously, therefor there is a need for simulating the probable parameter changes in order to contain the production increase. The flowrate in this simulation is set to 1300 MMscfd.

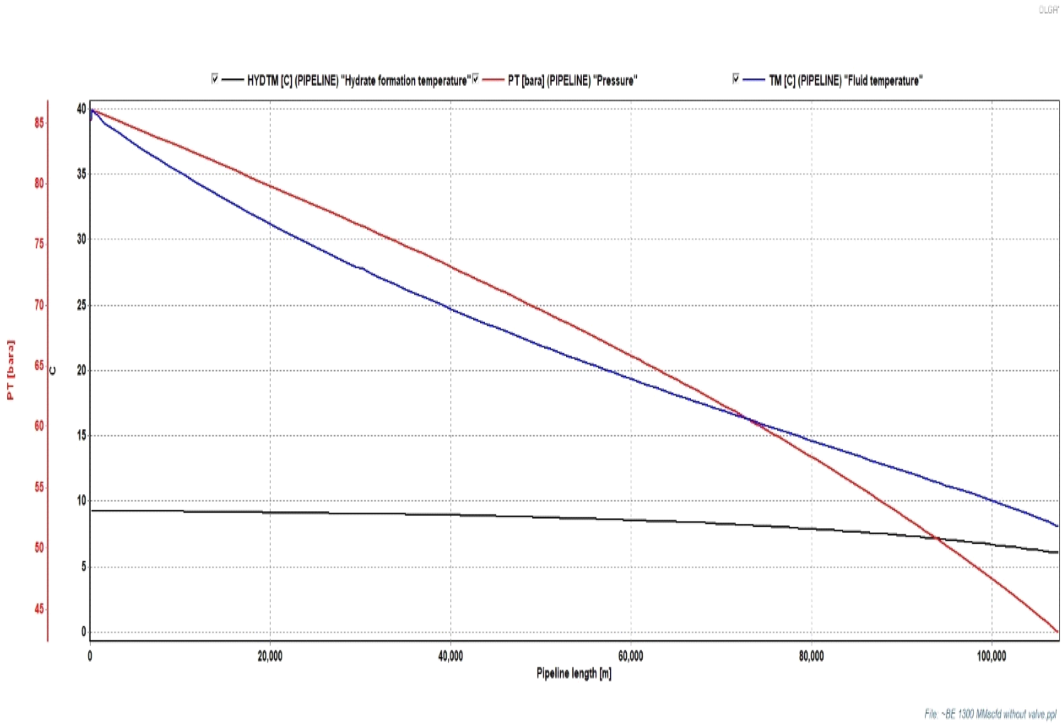


Figure (7): Hydrate Formation Temperature, Gas Temperature & Pressure curves of 1300 MMSCFD 36'' gas flowline.

The pressure witnesses a clear increase at the inlet of pipeline, with a value of 86 bara. This value is only 3 bara away from the design pressure, which means the flowrates of 1300MMscfd is the maximum safe value that could be used with this specific 36'' export trunk-line. Any further increase in flow rate will result in exceeding the design parameters of the pipeline.

The figure (7) reports a narrow gap between the TM and HYDTM curves, with only two-degree centigrade difference. The surge volume during this steady state flow is negligible as shown in figure (8).

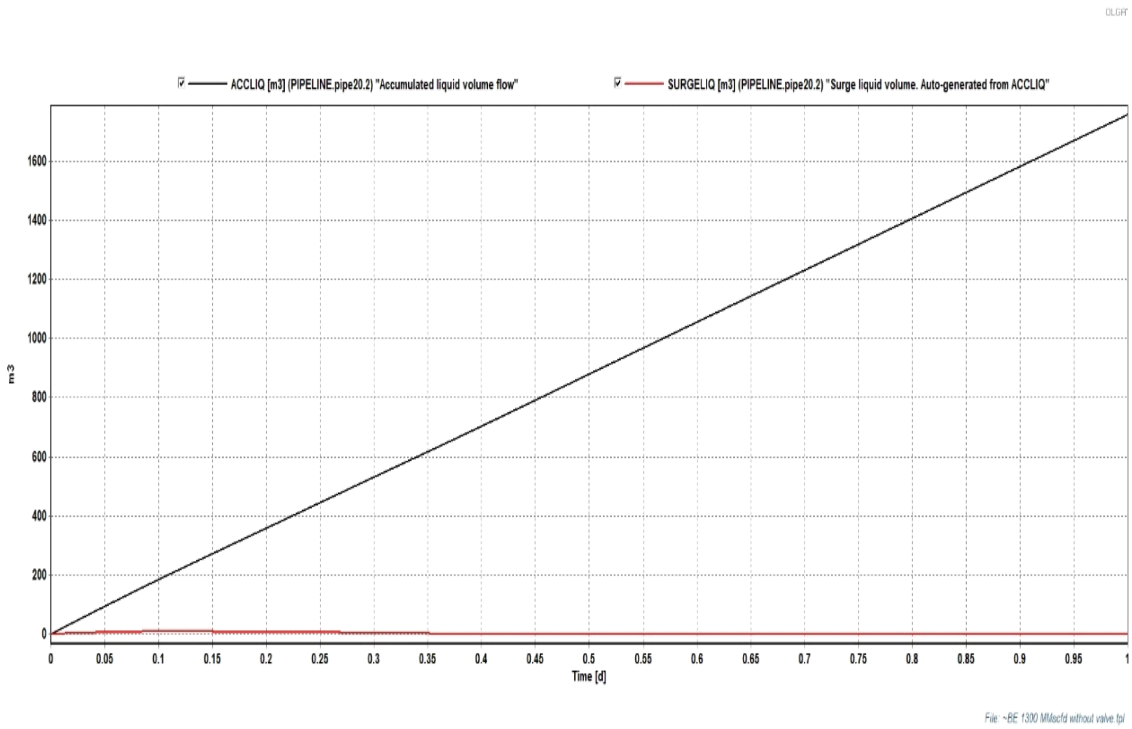


Figure (8): Accumulated & Surge Liquid Volume curves of 1300 MMSCFD 36'' gas flowline.

Conclusion:

This study presented the simulation of a pipeline connected to Sabratha platform. Results of this study show the importance of transient flow analysis for the safe operation of the platform. The simulator OLGA proves that it's very helpful in determining several factors that should be carefully studied over steady state simulators.

In this study, transient flow analysis results show that the Volume of the existing slug catcher is below the expected flow of liquid after shutdown, and the maximum allowable flow rate is 1300 MMSCFD.

Recommendations:

- Using OLGA software enhances accuracy of pre-process analysis. OLGA is highly needed for prediction of flow variable changes. OLGA is very helpful during design, operation and safety of gas plant. Therefore, training and use of OLGA simulator is highly recommended.

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