

Optimizing Discrepancy Reduction Of Natural Gas Distribution In West Java Area: AGA 3 Orifice Simulation At PT XYZ

Dwi Nurma Heitasari^{1*}, Gelar Argo Suseno¹, Sono¹

¹ Logistik Minyak dan Gas, Politeknik Energi dan Mineral Akamigas, Indonesia

ABSTRACT

PT XYZ is a company engaged in natural gas transportation to assist gas suppliers in delivering gas to industrial customers. West Java is an area with a gas demand of 246.36 MMSCFD. With the increasing utilization of natural gas in various industries, one crucial aspect of natural gas is the measurement of gas flow through equipment. Discrepancy reduction can be achieved using AGA 3 Orifice Simulation. The distribution of natural gas in the West Java Area, based on AGA 3 Orifice Simulation, can increase the company's revenue. The discrepancy in natural gas distribution in the West Java Area is caused by various factors categorized into five main groups. The AGA 3 Orifice simulation results show that several optimization steps can significantly reduce discrepancies in gas flow measurement by replacing the orifice size to optimize the natural gas flow rate measurement. Reducing discrepancies has a significant impact on the company's operations and finances. Based on research on optimizing discrepancy reduction in natural gas distribution in the West Java Area through AGA 3 Orifice simulation at PT XYZ, regular monitoring and maintenance of the equipment are recommended. In addition, it is essential to hold training programs and competency improvement for personnel involved in equipment operation and maintenance. Implementation of advanced technology and integrated analysis software is also recommended.

Keywords: natural gas, distribution, discrepancy, simulation



dwinurmaheitasari1987@gmail.com

1. Introduction

Along with the development of industry and technology, the energy sector is a vital element in supporting a country's economic growth. Efficient energy management is a strategic necessity to ensure the sustainability of energy supply. Some commonly used energy includes coal, oil, gas, and renewable energy, one of which is exciting and has been used for a long

time, namely the use of natural gas-based energy, which is relatively abundant in Indonesia according to the Central Statistics Agency data.

Based on data from the Central Statistics Agency in 2022 [1] shows a figure of 1,962,929 MMSCF for three decades in 2014 – 2022; the data is regressive because many natural gas supply sources are no longer operating. Natural

gas is a good energy source for power generation needs and fertilizer raw materials and derivatives. In the industrial world, fluid flow

measurement, especially natural gas, is crucial because it impacts operational sustainability and optimizing the use of resources.

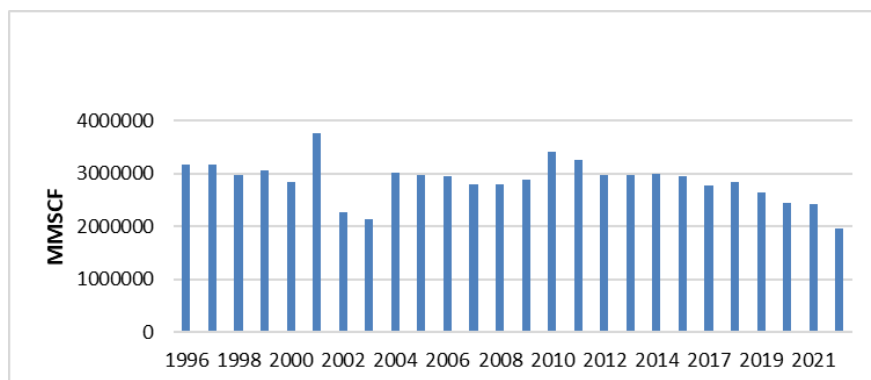


Figure 1 Natural Gas Production Data for the Period 1996 – 2022

PT XYZ is a company engaged in natural gas transportation to help suppliers distribute gas to customers. West Java has a gas demand of 246.36 MMSCFD as of February 15, 2024, with 45 industrial consumers, such as Pupuk Kujang, PLN, RU VI Balongan, and other industries. As one area that is operated and in high demand, Natural gas is one of the leading choices as a clean and efficient energy source. Therefore, the availability and accuracy of gas flow measurement in this region is essential to support various sectors.

Along with the increasing use of natural gas needs in various industries, one of the crucial aspects of natural gas is measuring gas flow through equipment. The equipment operated at PT XYZ is a critical device for determining the volume of gas to be distributed. However, in practice, there are problems related to the discrepancy or difference between the volume of gas measured by the equipment and the actual volume, which causes financial losses, operational sustainability, and reliability in maintaining natural gas distribution following Government Regulation No. 35 of 2004, Article 55, Government Regulation No. 36 of 2004, Article 44 and Article 95, and the Joint Decree of the Minister of Mining and Energy with the Minister of Trade No. 0233/ K096/ M.PE/ 1988.63A/ Kpb/ II/ 1988, which is 1% of the fluid flow rate. The importance of making measurements with high accuracy in the oil

and gas industry sector requires a reliable measurement system to minimize the difference between the measurement results of the system and the actual dimensions, to prevent losses for sellers and buyers [2]. Efforts to maintain the installed metering system are crucial to maintaining optimal performance, so evaluation of the equipment system in the field needs to be routinely carried out.

In daily operations, PT XYZ experienced challenges in maintaining the accuracy of gas flow measurements using West Java Area equipment. The discrepancy that occurs can have an impact on the accuracy of the calculation of the volume of gas distributed to consumers. Therefore, it is necessary to conduct in-depth research to identify the factors that cause Discrepancies and find solutions to optimize measurements.

Discrepancy may caused by various factors, such as operational conditions, equipment conditions, or measurement methods used. Several pieces of equipment are used in natural gas distribution, Including Ports, Turbines, USM, and Diaphragm. The type of equipment used in this distribution is Orifice. This equipment is used because it can be used for all pipe sizes, its differential pressure gauge device is easy to calibrate, and the price is relatively low, mainly depending on the primary element [3].

Based on the above problems, optimization of gas distribution measurement with simulation methods is needed. Analytical and Mathematical simulations are essential systems modeling, and analysis approaches that can help us understand and predict their behaviour. Analytical simulation involves using mathematical and analytical methods to derive exact solutions from system models. On the other hand, mathematical simulations use numerical computing to simulate the behavior of systems based on mathematical models, which are often too complex to solve. One method that can be used is the AGA 3 Orifice simulation. The Orifice AGA 3 simulation falls under the category of mathematical simulations because it involves using complex mathematical equations to calculate the flow rate of a gas based on various parameters such as pressure, temperature, and the physical characteristics of the Orifice and the gas itself.

AGA3 Simulation Orifice is a calculation method developed by the American Gas Association (AGA) to determine the gas flow through an Orifice equipment. An orifice equipment is a gas flow equipment that is widely used in industry. Through this simulation, the Equipment's performance can be analyzed in the West Java Area Based on equipment characteristics Orifice Based on a comparison of simulation software and field conditions of equipment in the field that are required to meet the AGA 3 [4].

Optimization can then be done to reduce discrepancy, which will undoubtedly impact increasing the gas flow measurement at PT XYZ Revenue and smooth operations at PT XYZ. AGA Report No. 3 is an industry standard recognized and respected in the natural gas industry. AGA Report No. 3 (AGA3) is the technical basis for measuring gas flow through an Orifice plate, and this standard was adopted and ratified by two other major organizations, FIRE and ANSI. API 2530 and ANSI 2530 are another name for the same standard, which embraces and publishes the methods and procedures described in the AGA 3. The guidelines and recommendations in this report have been compiled based on best practices and extensive

field experience from professionals in the natural gas industry [5].

According to previous research, analyzing whether the equipment system is still accurate or not, one of which is by calculating the deviation from the operational data flow comp with manual counting using the AGA-3 standard method [6]. Equipment must have good accuracy and be in good condition. It is necessary to make dynamic observations to evaluate the equipment system installed in the field, especially for the custody transfer equipment system. This dynamic observation compares manual calculations with actual data in the field and readings through the control room with the designation of flowcomp. However, the study is only limited to looking at the calculations. The discrepancy shows numbers within the tolerance limit; no optimization steps were taken.

The research carried out by the author in this thesis is an optimization step that will be carried out to reduce discrepancy so that it is a development and bridge between previous research and research conducted by the author. This study aims to optimize gas flow measurement by decreasing the West Java Area equipment discrepancy in the West Java region. By performing the AGA 3 Orifice simulation, it is hoped that solutions and recommendations can be found to reduce or eliminate the discrepancy between the measurement results and the supposed value so that the measurement accuracy can be improved. The author took 2-equipment points that will be used, including Area Y and Dawn. Through this research, it is hoped that PT XYZ can increase its revenue.

2. Research Methods

The company used as the research location was PT XYZ, which has 8 Operating Areas, including North Sumatra, Dumai, Rokan, Central Sumatra, South Sumatra, West Java, East Java, and Kalimantan. This study aims to optimize the reduction of natural gas distribution discrepancies in the West Java Area based on the AGA 3 Orifice Simulation to increase the company's revenue. This study was focused on

2 equipment in the West Java Area, an anomaly that occurred in the immediate state of the field described in the flow comp with the AGA 3 simulation carried out in detecting discrepan-

cies in the natural gas transportation process. The research stages are carried out in Figure 2.

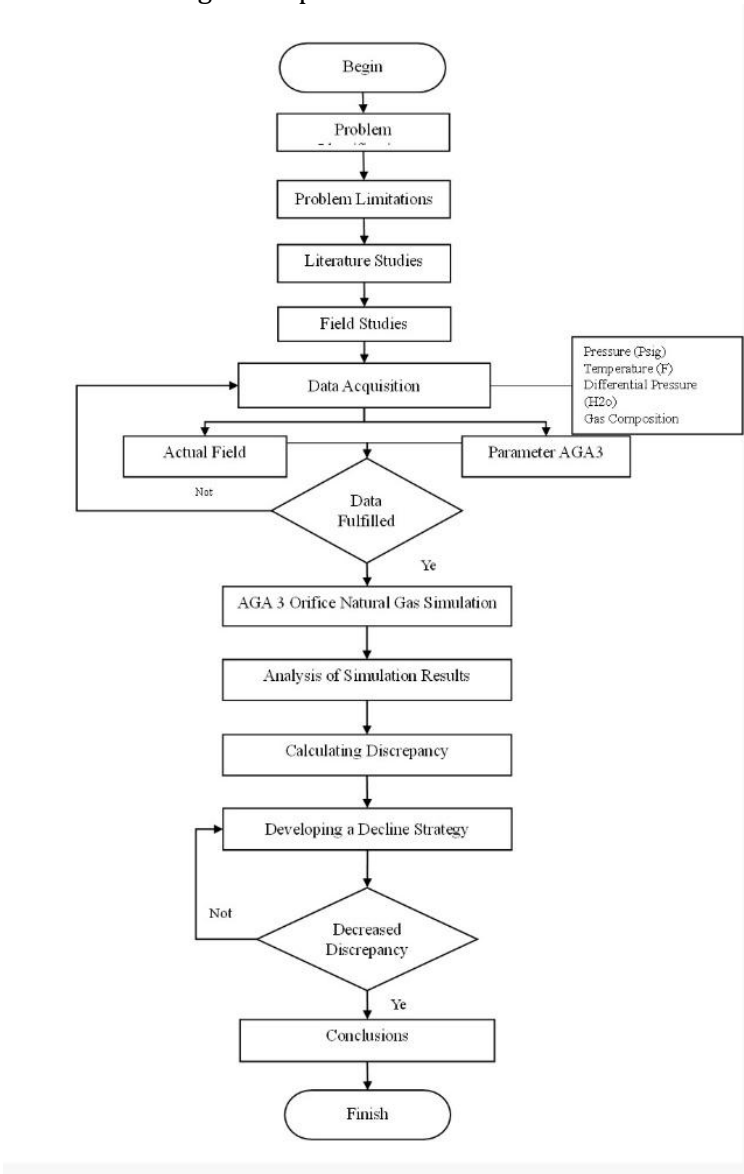


Figure 2 Research Flowchart

The quantitative method data analysis technique is a research approach that uses data in the form of numbers and statistics to analyze the relationship between variables or phenomena. In contrast to qualitative methods that focus on in-depth and interpretive understanding, quantitative methods emphasize statistical measurement and analysis to produce objectively measurable findings. The first stage is problem formulation, which means difficulties

that are felt, concrete, and require a solution. Problems can also be interpreted as an imbalance between desire (das sollen) and reality (das sein). A problem does not always have to demand/cause research, but research is carried out because of a problem. Field studies and literature are carried out by observing the object to be studied to obtain information about the problem. Identify and understand what has been researched and written before

about the topic to be investigated. At the same time, data collection can be done in various settings, sources, and ways—a method used to collect data or sources related to the topic raised in the research. Collect actual field data and AGA parameter 3—processing and Analysis According to the Method. Next, data processing and analysis are carried out. Data processing activities aim to provide meaning to data and help solve research problems that have been determined.

3. Result And Discussion

3.1 Discrepancy Factor

The Fishbone diagram identifies five leading causes of "Discrepancy in the West Java Area Natural Gas distribution": Method, Material, Machine, Human, and Environmental. In the Method category, the main culprits are improper Orifice sizing and ineffective flow rate readings, which can result in gas flow measurement errors. The Materials category identifies variations in the physical and chemical characteristics of fluids and critical fluid flow rates as the cause of gas delivery inconsis-

tencies. The Engine Category indicates that inaccurate transmitters and differential pressure readings may interfere with the control of the gas distribution system. Human factors include a lack of operator knowledge and experience, while environmental factors include pressure fluctuations due to weather conditions. Overcoming this discrepancy requires improving technology, operator training, and systems that are adaptive to environmental conditions.

3.2 Discrepancy Natural Gas Existing

3.2.1 Area Y

Data analysis shows that most gas simulation results (MSCF) have a low error rate, with an error below 1%, indicating that the simulation model is entirely accurate in replicating field conditions. On some dates, variables such as pressure (PSIG), average temperature (AV. TEMP), and differential pressure (AV. DP) are in a range that the simulation model well accommodates, so the similarity between the simulation results and the field results is high, as shown in Table 1.

Table 1 Discrepancy Area Y Existing

Date	PSIG	OF. TEMP	OF. DP (H2O)	Field Volume (MSCF)	MMSCF	Simulation Results (MSCF)	Error
1	373,14	82,21	68,3066	22069,9728	22,0700	22251,7410	0,82%
2	379,11	82,07	60,9238	21027,9379	21,0279	21193,5970	0,79%
3	389,50	81,85	59,2453	20992,8093	20,9928	21196,2571	0,97%
4	393,81	82,23	23,2595	12534,6479	12,5346	13365,2400	6,63%
5	378,88	86,66	0,1756	85,1123	0,0851	1136,4010	1235,18 %
6	380,45	82,79	43,9833	17783,2894	17,7833	18035,3260	1,42%
7	376,45	82,07	60,2078	22091,8473	22,0918	20993,6467	4,97%
8	375,61	81,78	69,8409	22366,5514	22,3666	22575,4386	0,93%
9	378,74	81,83	48,1611	18738,8431	18,7388	18837,9444	0,53%
10	387,06	81,37	67,2297	22489,4097	22,4894	22503,3494	0,06%
11	392,90	81,97	46,2917	18832,5823	18,8326	18855,9973	0,12%
12	381,64	84,65	46,4881	14303,4056	14,3034	18524,1910	29,51%
13	377,96	82	64,3579	21554,5215	21,5545	21738,6851	0,85%
14	378,66	81,73	66,2305	22148,3202	22,1483	22078,7111	0,31%
15	378,84	81,58	69,0124	22524,5087	22,5245	22553,6013	0,13%
16	380,79	81,41	66,4933	22159,1728	22,1592	22202,0381	0,19%
17	389,78	81,55	57,36157	20880,0154	20,8800	20871,0500	0,04%

18	394,45	82,01	44,5489	18401,4323	18,4014	18503,2180	0,55%
19	383,95	84,54	35,9817	12284,8785	12,2849	16360,9394	33,18%
20	377,46	81,7	98,3286	26724,1558	26,7242	26843,6083	0,45%
21	375,79	81,33	103,8163	27602,013	27,6020	27526,6299	0,27%
22	377,19	81	100,2111	27261,4745	27,2615	27171,3037	0,33%
23	376,72	80,66	95,7017	26144,7711	26,1448	26549,4950	1,55%
24	387,64	80,68	70,3588	22677,564	22,6776	23116,2535	1,93%
25	396,19	82,65	14,4588	8386,9223	8,3869	10592,1951	26,29%
26	387,16	81,62	-	-	-	-	-
27	328,86	84,78	-	-	-	-	-
28	255,49	86,85	-	-	-	-	-
29	202,46	84,56	-	-	-	-	-

However, some dates show an Error of more than 1%, signaling a significant discrepancy between the simulation and field results. Dates such as 4, 5, 6, 7, 7, 12, 19, 23, 24, and 25 have much higher Errors, indicating issues that need to be addressed. On the 5th and 19th, the error reached high numbers, 1235.18%, and 33.18%, respectively, indicating possible data errors or anomalies in the simulation model. For example, on the 6th, shallow differential pressure and small field volume indicate significant abnormalities, while simulation results show much larger gas volumes.

3.2.2 Area X

Based on the available data, the error analysis of the comparison between the simulation results and the field volume for gas in MSCF units,

shows several dates with significant errors. This data includes information about pressure (PSIG), average temperature (AV. TEMP), differential pressure (AV. DP), field volume (MSCF), and simulation results (MSCF) for a given period. The data analysis revealed several critical parameters related to the pressure, temperature, and volume of the gas measured and the results of the simulations. One of the main focuses is to evaluate the error rate between the measured field volume and the calculated simulation results, expressed in Error percentages. By making the necessary improvements and adjustments, it is hoped that the error rate between the simulation results and the field volume can be minimized, thereby improving the reliability of predictions and the efficiency of operations.

Table 2 Discrepancy Area X Existing

Date	PSIG	OF. TEMP	OF. DP (H2O)	Field Volume (MSCF)	MMSCF	Simulation Results (MSCF)	Error
1	293,02	96,98	53,3702	16328,4814	16,3284814	16020	1,89%
2	285,81	95,19	41,6698	14246,3036	14,2463036	14020	1,59%
3	310,45	94,04	36,4454	13801,5172	13,8015172	13990	1,37%
4	322,36	91,09	28,4086	12554,7432	12,5547432	12640	0,68%
5	294,42	90,34	44,7806	14987,6583	14,9876583	15150	1,08%
6	272,57	92,52	56,7862	16344,3408	16,3443408	16360	0,10%
7	262,06	93,07	40,4801	13241,6883	13,2416883	13440	1,50%
8	243,52	92,55	43,5321	13342,3501	13,3423501	13440	0,73%
9	239,47	92,48	55,2254	14987,4369	14,9874369	15000	0,08%
10	247,91	92,06	52,4925	14880,3927	14,8803927	14890	0,06%
11	258,83	92,22	27,6254	10549,2798	10,5492798	11050	4,75%
12	272,35	94,66	15,2419	8372,6676	8,3726676	8404	0,37%
13	257,04	97,46	16,8830	8536,1684	8,5361684	8566	0,35%
14	250,26	96,66	17,2001	8827,324	8,827324	8893	0,74%
15	249,44	96,80	17,1308	8792,6447	8,7926447	8905	1,28%

16	262,08	97,58	16,8574	8930,666	8,930666	8998	0,75%
17	276,8	97,96	16,1710	8976,7753	8,9767753	9052	0,84%
18	284,62	96,90	15,3986	8889,7985	8,8897985	8967	0,87%
19	281,42	98,27	15,1661	8429,4651	8,4294651	8836	4,82%
20	274,91	99,56	15,2302	8642,5613	8,6425613	8741	1,14%
21	268,26	98,89	10,8379	6499,7846	6,4997846	7087	9,03%
22	266,92	99,10	14,6345	8136,495	8,136495	8210	0,90%
23	265,91	99,00	14,8870	8189,9701	8,1899701	8266	0,93%
24	281,02	99,62	15,2010	8547,4421	8,5474421	8581	0,39%
25	294,53	99,00	14,4120	8521,481	8,521481	8561	0,46%
26	288,29	99,94	15,6131	8780,9302	8,7809302	8806	0,29%
27	275,07	98,30	16,2219	8753,586	8,753586	8782	0,32%
28	286,32	98,66	16,0720	8889,1031	8,8891031	8915	0,29%
29	320,34	100,70	14,5838	8936,1477	8,9361477	8969	0,37%

From Table 2, it is seen that there are several dates with a percentage of error between the field volume and the simulation results that exceed 1%. Errors that exceed 1% are considered significant and require further attention. On specific dates such as 1, 2, 3, 5, 7, 11, 15, 19, 20, and 21, this percentage of Errors is highlighted in red.

The highest error was recorded on the 12th, with the error percentage reaching 4.75%. The field volume is 10549.2798 MSCF on this date, while the simulation results reach 11050 MSCF. This difference creates an Error of 4.75%, indicating that the simulation model may need recalibration or that other variables have not been appropriately accounted for in the simulation.

Several factors can cause significant errors in these dates. First, there are inaccuracies in the measurement of input variables such as PSIG, average temperature, and differential pressure. Second, the simulation model may require further calibration to handle certain conditions that cause significant variations in results. Third, anomalies in data or unexpected fluctuations in field operating conditions can also contribute to these inaccuracies. To improve the accuracy of the simulation results, it is recommended that an in-depth analysis of the model used be conducted, including validation of input parameters and evaluation of simulation methodology.

3.3 Natural Gas Discrepancy After Reduction

The optimization step is to replace the Orifice size on the AREA Y and AREA X equipments to optimize the natural gas flow rate measurement to reduce the company's losses. On the AREA Y equipment, the Orifice's original size of 4.629 inches was changed to 4.4682 inches. Meanwhile, on the AREA X equipment, the original size of the Orifice was changed to 4.65291 inches. This change in the size of the Orifice aims to improve the accuracy of measuring the volume of gas flowing through the equipment, thereby reducing the Discrepancy between the actual usage volume and the calculated volume. With this step, the optimization of natural gas flow rate measurement can be achieved, directly reducing the company's losses and improving management efficiency and revenue.

3.3.1 Discrepancy Reduction Area Y

Based on the data presented in Table 3, an analysis of the field volume and simulation was carried out with a focus on several significant dates. There was a significant decrease in the simulation results on Day 4, with an Error of 4.95%. The field volume on the date was 12534.6479 MSCF, while the simulation results show 13155.0000 MSCF. This decrease reflects a considerable discrepancy between the volume of the field and the simulation results.

On day 6, the recorded error rate was 0.18%, indicating a decrease in error compared to day

5. The field volume was 17783.2894 MSCF, and the simulation results showed 17752.0000 MSCF. This decrease suggests an improvement in the compatibility between the field volume and the simulation results. While on day 12 there was a significant decrease with an Error of 26.29%. The field volume was recorded at 14303.4056 MSCF, while the simulation showed 14764 MSCF.

On day 19, a 12.95% decrease in Errors was recorded. The field volume was 12284.8785 MSCF, while the simulation results showed 14770 MSCF. This decrease indicates a pro-

blem in the compatibility of the simulation results with the actual field volume. Continued with days 23rd and 24th. The errors recorded were 1.59% and 1.93%, respectively, indicating stability with no significant decrease in simulation results compared to field volume.; it reflects a better fit between simulation and field data. On day 25, a decrease in error of 12.28% was recorded. The field volume was 8386.9223 MSCF, while the simulation results showed 9562.0000 MSCF. This difference indicates a significant mismatch between the simulation results and the volume of the field.

Table 3 Discrepancy Area & Pasca Reduction

Date	PSIG	OF. TEMP	OF. DP (H2O)	Field Volume (MSCF)	MMSCF	Simulation Results (MSCF)	Error
1	373,14	82,21	68,3066	22069,9728	22,0700	22251,7410	0,82%
2	379,11	82,07	60,9238	21027,9379	21,0279	21193,5970	0,79%
3	389,50	81,85	59,2453	20992,8093	20,9928	21196,2571	0,97%
4	393,81	82,23	23,2595	12534,6479	12,5346	13155,0000	4,95%
5	378,88	86,66	0,1756	85,1123	0,0851	1136,4010	1235,18%
6	380,45	82,79	43,9833	17783,2894	17,7833	17752,0000	0,18%
7	376,45	82,07	60,2078	22091,8473	22,0918	20993,6467	4,97%
8	375,61	81,78	69,8409	22366,5514	22,3666	22575,4386	0,93%
9	378,74	81,83	48,1611	18738,8431	18,7388	18837,9444	0,53%
10	387,06	81,37	67,2297	22489,4097	22,4894	22503,3494	0,06%
11	392,90	81,97	46,2917	18832,5823	18,8326	18855,9973	0,12%
12	381,64	84,65	46,4881	14303,4056	14,3034	14764,0000	3,22%
13	377,96	82	64,3579	21554,5215	21,5545	21738,6851	0,85%
14	378,66	81,73	66,2305	22148,3202	22,1483	22078,7111	0,31%
15	378,84	81,58	69,0124	22524,5087	22,5245	22553,6013	0,13%
16	380,79	81,41	66,4933	22159,1728	22,1592	22202,0381	0,19%
17	389,78	81,55	57,36157	20880,0154	20,8800	20871,0500	0,04%
18	394,45	82,01	44,5489	18401,4323	18,4014	18503,2180	0,55%
19	383,95	84,54	35,9817	12284,8785	12,2849	14770,0000	20,23%
20	377,46	81,7	98,3286	26724,1558	26,7242	26843,6083	0,45%
21	375,79	81,33	103,8163	27602,013	27,6020	27526,6299	0,27%
22	377,19	81	100,2111	27261,4745	27,2615	27171,3037	0,33%
23	376,72	80,66	95,7017	26144,7711	26,1448	26549,4950	1,55%
24	387,64	80,68	70,3588	22677,564	22,6776	23116,2535	1,93%
25	396,19	82,65	14,4588	8386,9223	8,3869	9562,0000	14,01%
26	387,16	81,62	-	-	-	-	-
27	328,86	84,78	-	-	-	-	-

28	255,49	86,85	-	-	-	-	-
29	202,46	84,56	-	-	-	-	-

3.3.2 Area X

Based on the data presented in Table 4, an analysis related to the field volume and simulation results was conducted with a focus on several significant dates. On day 1, the simulation results showed an Error of 0.12%. The field volume on this date was 16328.4814 MSCF, while the simulation results showed 16348 MSCF. This decrease indicated a good match between the field volume and the simulation results. On day 2, Errors were recorded at 0.31%, indicating a decrease in Errors compared to the previous date. The field volume was 14246.3036 MSCF, and the simulation results showed 14291 MSCF. This decrease reflects an increase in the suitability between the field volume and the simulation results.

On day 7, a decrease in Errors of 0.25% was recorded. The field volume was 13241.6883 MSCF, while the simulation showed 13407 MSCF. This decrease indicates increased conformity between the simulation results and the field volume. On day 10, the error recorded was 0.06%, indicating a significant decrease. The field volume was 8792.6447 MSCF, and the

simulation results showed 8787 MSCF. The compatibility between the simulation results and the field volume was excellent.

On day 11, the Error was recorded at 0.34%. The field volume was 10549.2798 MSCF, while the simulation results showed 11015 MSCF. This decrease showed an improvement in the suitability of the simulation results with the volume of the field. On day 13, there was a decrease in error by 0.35%. The field volume was 13801.5172 MSCF, and the simulation results showed 13942 MSCF. Although there were still differences, this decrease indicates an increase in suitability.

On day 19, there was a decrease in error by 0.90%. The field volume was recorded at 8429.4651 MSCF, while the simulation results showed 8760 MSCF. While there were still differences, this decline indicates a significant improvement. On day 21, the error recorded was 0.36%. The field volume was 6499.7846 MSCF, while the simulation results showed 7063 MSCF. This decrease reflects increased conformity between the simulation results and the field volume.

Table 4 Discrepancy Area X Post Optimization

Date	PSIG	OF. TEMP	OF. DP (H2O)	Field Volume (MSCF)	MMSCF	Simulation Results (MSCF)	Error
1	293,02	96,98	53,3702	16328,4814	16,3284814	16020	0,12%
2	285,81	95,19	41,6698	14246,3036	14,2463036	14020	0,31%
3	310,45	94,04	36,4454	13801,5172	13,8015172	13990	1,02%
4	322,36	91,09	28,4086	12554,7432	12,5547432	12640	0,68%
5	294,42	90,34	44,7806	14987,6583	14,9876583	15150	0,82%
6	272,57	92,52	56,7862	16344,3408	16,3443408	16360	0,10%
7	262,06	93,07	40,4801	13241,6883	13,2416883	13440	1,25%
8	243,52	92,55	43,5321	13342,3501	13,3423501	13440	0,73%
9	239,47	92,48	55,2254	14987,4369	14,9874369	15000	0,08%
10	247,91	92,06	52,4925	14880,3927	14,8803927	14890	0,06%
11	258,83	92,22	27,6254	10549,2798	10,5492798	11050	4,41%
12	272,35	94,66	15,2419	8372,6676	8,3726676	8404	0,37%
13	257,04	97,46	16,8830	8536,1684	8,5361684	8566	0,35%

14	250,26	96,66	17,2001	8827,324	8,827324	8893	0,74%
15	249,44	96,80	17,1308	8792,6447	8,7926447	8905	0,06%
16	262,08	97,58	16,8574	8930,666	8,930666	8998	0,75%
17	276,8	97,96	16,1710	8976,7753	8,9767753	9052	0,84%
18	284,62	96,90	15,3986	8889,7985	8,8897985	8967	0,87%
19	281,42	98,27	15,1661	8429,4651	8,4294651	8836	3,92%
20	274,91	99,56	15,2302	8642,5613	8,6425613	8741	0,27%
21	268,26	98,89	10,8379	6499,7846	6,4997846	7087	8,67%
22	266,92	99,10	14,6345	8136,495	8,136495	8210	0,90%
23	265,91	99,00	14,8870	8189,9701	8,1899701	8266	0,93%
24	281,02	99,62	15,2010	8547,4421	8,5474421	8581	0,39%
25	294,53	99,00	14,4120	8521,481	8,521481	8561	0,46%
26	288,29	99,94	15,6131	8780,9302	8,7809302	8806	0,29%
27	275,07	98,30	16,2219	8753,586	8,753586	8782	0,32%
28	286,32	98,66	16,0720	8889,1031	8,8891031	8915	0,29%
29	320,34	100,70	14,5838	8936,1477	8,9361477	8969	0,37%

3.3.3 Decrease in Discrepancy

Based on the data presented in Table 5, an analysis related to the field volume and simulation results was conducted with a focus on several significant dates. Technically, the total initial error percentage for the "Area X" equipment was 1.31%, decreasing to 1.05% after optimization. This decrease of 0.26 percentage points reflects an improvement in measurement accuracy. Various factors, such as improvements in tool calibration, improved sensor quality, or the implementation of better error correction algorithms can cause this reduction in errors. This optimization not only reduces the Error value at specific points but also shows an improvement in the overall stability of the measurement system. With this decrease, the accuracy and reliability of the

measurement data for the "Area X" equipment has improved significantly, reducing the potential for errors in further data analysis.

Meanwhile, the "Area Y" equipment experienced a more significant decrease in error, from 4.70% to 2.43%, with a reduction of 2.27 percentage points. This decrease showed that optimization measures were very effective in reducing significant errors. The technical causes of this decline can include improvements in the data processing process, replacement or improvement of sensory components, and implementation of more effective maintenance procedures. Reduced Discrepancy on the "Area Y" equipment has successfully eliminated many high Error points, contributing to the improved reliability and accuracy of measurement data.

Table 5 Discrepancy Reduction Comparison

Date	Area X		Area Y	
	Exist	Optimization	Exist	Optimization
1	1,89%	0,12%	0,82%	0,82%
2	1,59%	0,31%	0,79%	0,79%
3	1,37%	1,02%	0,97%	0,97%
4	0,68%	0,68%	6,63%	4,95%
5	1,08%	0,82%	1235,18%	1235,18%
6	0,10%	0,10%	1,42%	0,18%
7	1,50%	1,25%	4,97%	4,97%
8	0,73%	0,73%	0,93%	0,93%

9	0,08%	0,08%	0,53%	0,53%
10	0,06%	0,06%	0,06%	0,06%
11	4,75%	4,41%	0,12%	0,12%
12	0,37%	0,37%	29,51%	3,22%
13	0,35%	0,35%	0,85%	0,85%
14	0,74%	0,74%	0,31%	0,31%
15	1,28%	0,06%	0,13%	0,13%
16	0,75%	0,75%	0,19%	0,19%
17	0,84%	0,84%	0,04%	0,04%
18	0,87%	0,87%	0,55%	0,55%
19	4,82%	3,92%	33,18%	20,23%
20	1,14%	0,27%	0,45%	0,45%
21	9,03%	8,67%	0,27%	0,27%
22	0,90%	0,90%	0,33%	0,33%
23	0,93%	0,93%	1,55%	1,55%
24	0,39%	0,39%	1,93%	1,93%
25	0,46%	0,46%	26,29%	14,01%
26	0,29%	0,29%	-	-
27	0,32%	0,32%	-	-
28	0,29%	0,29%	-	-
29	0,37%	0,37%	-	-
Total	37,99%	30,40%	112,85%	58,41%
Presented	1,31%	1,0%	4,70%	2,43%
Reduction	0,26%		2,27%	

3.4 Revenue Calculation Analysis

3.4.1 Natural Gas Distribution Toll Fee

Indonesia's Downstream Oil and Gas Regulatory Agency (BPH Migas) regulates the toll fee for gas distribution through pipelines. These rates are based on pipeline capacity, transmission distance, and operational conditions. Regulations related to the determination of tariffs are regulated in Law Number 22 of 2001 concerning Oil and Gas [7], Government Regulation Number 36 of 2004, which has been amended by Government Regulation Number 30 of 2009 [8], as well as Regulation of the Minister of Energy and Mineral Resources (ESDM) Number 4 of 2018 concerning Natural Gas Exploitation Through Pipelines[9]. The Downstream Oil and Gas Regulatory Agency (BPH Migas) is essential in supervising and setting toll fee rates. Through regulations such as BPH Migas Regulation Number 1 of 2023 [10], BPH Migas provides detailed guidance on the mechanism for setting and evaluating fees and ensuring transparency in the process. This

regulation aims to create a conducive investment climate and ensure that the price of natural gas received by final consumers is reasonable.

Table 6 provides information on toll fee rates for natural gas pipelines in the West Java Area, where gas is delivered through several pipeline segments with varying diameters, lengths, tariffs, and capacities. We chose to highlight the Citarik - Tegalgade pipeline segment with a diameter of 32 inches because it is part of the route through which gas is delivered, which is relevant to the company's needs. In the West Java Area context, the toll fee rate for the Citarik - Area Y pipeline with a diameter of 32 inches is US\$0.16 per MSCF (Million Standard Cubic Feet). Although this rate is slightly higher than that of other pipelines with smaller diameters, its larger carrying capacity, 450 MMSCFd (Million Standard Cubic Feet per Day), makes it an efficient choice and suitable for regional gas distribution needs.

Table 6 Toll Fee West Java Area

Description		Segments / Sections of Pipes					
Streets		Citarik - Dawuan	Citarik - Area Y	Citarik - Area Y	Area Y- Nagrak	Nagrak - Bitung	Bitung - Cilegon
Diameter	Inch	18	24	32	24	24	24
Distance	Km	7	45	45	27	51	72
Tariff	US \$/MScf	0,03	0,15	0,16	0,15	0,07	0,03
Capacity	MMScfd	350	350	450	270	270	270

3.4.2 Revenue Comparison

Optimization of Area X and Area Y equipment has had a significant positive impact on reducing the company's losses due to Discrepancy (the difference between the actual usage volume and the calculated usage volume). Initially, the Area X equipment suffered a loss of IDR 6,654,713. After optimization and adjustment to the equipment, the loss was successfully reduced to IDR 6,292,313. This shows a decrease in losses of IDR 362,400. Meanwhile, the Area Y equipment initially showed a much more significant loss, IDR 32,425,677. However, after the optimization process, the loss on this equipment was drastically reduced to IDR 15,925,938. This means that there was a decrease in losses of IDR 16,499,739.

This optimization process involves identifying and correcting data with an Error rate above 1%, which has proven to be the leading cause of losses. The data with the high Error rate is analyzed and adjusted so that the calculated usage volume is closer to the actual usage volume. This optimization helps reduce measurement errors and directly improves the accuracy of the company's revenue calculations.

Table 7 shows that the costs associated with losses in the existing conditions are pretty high compared to those after optimization, indicating that the optimization measures taken have reduced losses significantly. For the "Area X" equipment, the loss cost in the existing condition was IDR 6,654,713, which was later reduced to IDR 6,292,313 after optimization. This decrease shows a savings of Rp362,400. Meanwhile, for the "Area Y" equipment, the loss

cost in the existing condition is Rp32,425,677, which is drastically reduced to Rp15,925,938 after optimization. This savings amounted to Rp16,499,740. This reduction reflects that the optimization has effectively reduced measurement errors and inaccuracies, which previously led to higher losses.

The optimization carried out has a positive impact on the company's revenue. By reducing losses by Rp362,400 for "Area X" and Rp16,499,740 for "Area Y," the total savings reached Rp16,862,140. This reduction in loss costs directly increased the company's profit margins, as lower costs meant more net income could be realized. Therefore, the optimization measures taken not only reduce measurement errors but also have a significant positive impact on the company's profitability.

Table 7 Reduction Comparison Revenue

Sample Equipment	Condition	
	Existing	Optimization
Area X	IDR 6,654,713	IDR 6,292,313
Area Y	IDR 32,425,677	IDR 15,925,938
Reduction	IDR 16,499,740	IDR 362,400

4. CONCLUSION

Based on the research, it can be concluded that optimizing discrepancy reduction in natural gas distribution in the West Java Area through the AGA 3 Orifice simulation at PT XYZ has succeeded in identifying several key factors and necessary optimization measures. The discrepancy in natural gas distribution in the West Java Area is caused by various factors grouped into five main categories: Method

(selection of orifice size), Material (physical and chemical characteristics of fluids), Machinery (transmitter readings and differential pressure), Human (knowledge and experience), and Environment (weather conditions).

The AGA 3 Orifice simulation results show that several optimization steps can significantly reduce gas flow measurement discrepancies by replacing the Orifice size on Area Y and Area X equipment to optimize natural gas flow rate measurement. At Area Y equipment, the Orifice's original size of 4.629 inches was changed to 4.4682 inches. Meanwhile, in the Area X equipment, the original size of the Orifice was changed to 4.65291 inches. The Orifice size change aims to improve the accuracy of measuring the volume of gas flowing through the equipment.

The decline in discrepancy significantly impacts the company's operations and finances. By reducing the accuracy of gas volume calculations, this optimization directly improves the accuracy of the company's revenue calculations. This decrease in losses shows that the effective optimization of discrepancies positively impacts the Company's revenue.

REFERENCES

- [1] Central Statistics Agency, Petroleum and Natural Gas Production in 1996-2022. 2024. [Online]. Available: <https://www.bps.go.id/id/statistics-table/1/MTA5MiMx/produksi-minyak-bumi-dan-gas-alam--1996-2022.html>
- [2] F. O. Mangar, R. H. Triyanto, and W. Waskito, "Measurement of Gas Custody Transfer Flowequipment at the State Gas Company (PGN) Surabaya," Pros. Semin. Nas. Technol. Energy and Miner., vol. 2, no. 1, pp. 1380–1387, 2022, doi: 10.53026/sntem.v2i1.876.
- [3] A. Mujiyanto, "Introduction to the World Class Gas System Management," Gas Syst. Manag. - Publisher. State gas, vol. 1, no. 1, 2015.
- [4] H. Ghorbani et al., "Prediction of oil flow rate through an orifice flow equipment: Artificial intelligence alternatives compared," Petroleum Vol. 6 No. 4 pp. 404–414, 2020, doi: 10.1016/J.Petalum.2018.09.003.
- [5] R. Instruments, "PROCESS INSTRUMENTATION Division of Refining," 2003.
- [6] F. F. Sabono and S. H. Budi, "Tik-04 Flowrate Deviation in Flowcomp to Manual Aga 3 at Pt. Ansi Mega Instrument Indo to Pt. xx," Pros. Semin. Nas. Technol. |||, vol. 1, no. November, pp. 943–949, 2021, [Online]. Available: <https://akamigas.esdm.go.id/jurnal/index.php/sntm/article/view/563%0Ahttps://akamigas.esdm.go.id/jurnal/index.php/sntm/article/download/563/125>
- [7] P. Indonesia, "Law of the Republic of Indonesia Number 22 of 2001 concerning Oil and Gas," Mar. Biol., vol. 159, no. 7, p. 1, 2001.
- [8] Government of Indonesia, "Government Regulation Number 36 of 2004 concerning Downstream Oil and Gas Business Activities," 2004.
- [9] Minister of Energy and Mineral Resources, "Natural Gas Exploitation Through Pipelines," Regulator. Minister of Energy and Mineral Resources. Republic of Indonesia. Number 4 of 2018, vol. 151, no. 2, pp. 10–17, 2022.
- [10] BPH Migas, "Procedures for Calculating and Determining Natural Gas Transportation Tariffs Through Pipelines," Regulator. Miny Downstream Regulatory Agency. And Natural Gas of the Republic of Indonesia. Number 1 of 2023, vol. 151, no. 2, pp. 10–17, 2022.