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Comparation of metering LPG Truck loading and metering accuracy at site Shylhet Gas Field project, Bangladesh

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ABSTRACT

PT. Istana Karang Laut company is located in Jakarta with a truly international team of highly motivated and experienced specialists, IKL offers a wide range of products and project capabilities and is able to execute projects either for lump-sum EPC (Engineering, Procurement, Construction) or individual Process Equipment as well as O&M contracts (Operations and Maintenance). This research aims to examine and compare the measurement methods used in the LPG truck loading process with the measurement accuracy level carried out at the Shylhet Gas Field project site in Bangladesh. Use method statistical quality control for trouble shooting LPG truck loading metering is to improve quality thereby reducing manufacturing costs, scrap, rework, rescheduling, increase consumer confidence and tighten specification limits and increase productivity and production yields. The conclusions and recommendations resulting from this study include meter adjustments to reduce systematic and random errors, as well as measures to prevent random errors in the future. Meter adjustments are made by calculating the new meter factor based on the average of the observed mismatches. In order to reduce random errors, it is recommended to collect as many samples as possible, pay attention to the condition of the truck and the environment before each load, as well as improve the operator's skills in reading the measuring instrument to avoid parallax errors.

Keywords:

LPG Measurement Method
LPG Truck Measurement Accuracy
Shylhet Gas Field Project
LPG Truck Loading

INTRODUCTION

PT ISTANA KARANG LAUT (IKL), was incorporated in 1981 to supply process equipment, plants and facilities for the Oil and Gas Industry. Over the years PT ISTANA KARANG LAUT has become an experienced EPC Contractor involved in Design, Construction, Commissioning, Operation and Maintenance of Process Plants both on-shore and off-shore.

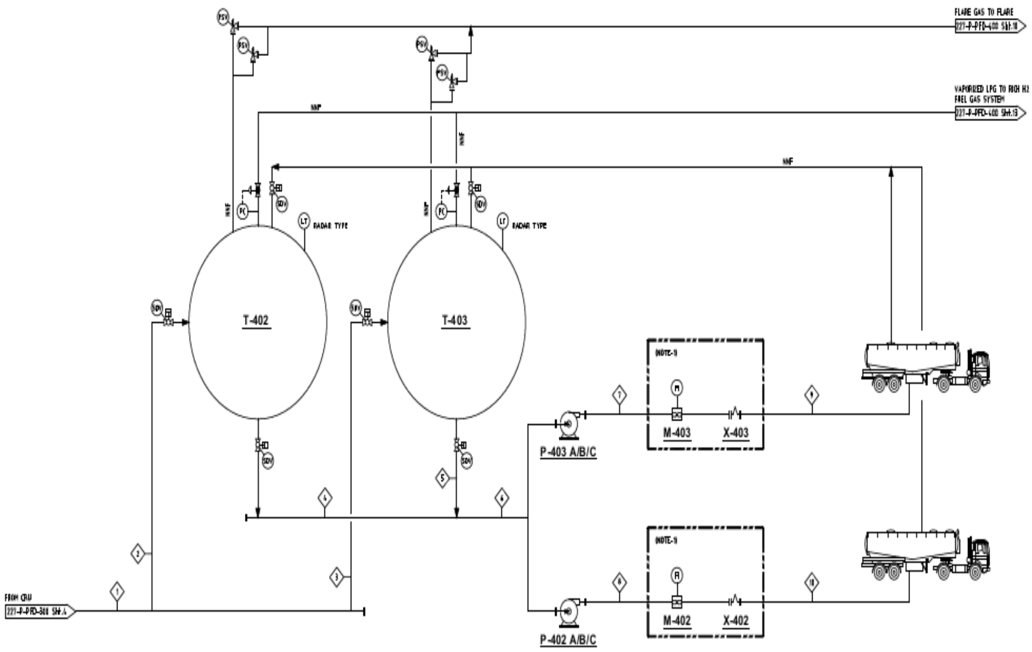
The company is located in Jakarta with a truly international team of highly motivated and experienced specialists. In order to meet the highest international codes and standards, IKL has equipped its engineers and managers with the latest computer software and technology tools. All of our projects are managed by professional and experienced managers dedicated to specific assignments with full responsibility to execute the work to satisfy the client's requirements in terms of performance, quality, schedule and safety. PT IKL has proven its reliability and efficiency as well as competitiveness and flexibility to offer customized and personalized solutions to domestic and overseas clients.

Through continued expansion and diversification PT ISTANA KARANG LAUT is today organized into 4 divisions independently managed and responsible for utilization of the in-house resources and capabilities necessary to execute and complete the contracts awarded. These divisions include:

1. Process Plant Division (On-Shore and Off-Shore)
2. Metering System Division
3. Process Equipment Division
4. Operation and Maintenance Division

Today IKL offers a wide range of products and project capabilities and is able to execute projects either for lump-sum EPC (Engineering, Procurement, Construction) or individual Process Equipment as well as O&M contracts (Operations and Maintenance) for the Oil and Gas Industry. To ensure that our projects are executed in accordance with International Standards, IKL is certified ISO 9001:2008 by Société Générale de Surveillance (SGS) Yarsley since 1994 as well as OHSAS 18001 since 2011.

Refer to employer contract number: SGFL/3000 CRU/EPC/C-2 3000 BBL/DAY CAPACITY SEMI REGENERATIVE CATALYTIC REFORMING UNIT & ASSOCIATED FACILITIES AT RASHIDPUR, BAHUBOL, HABIGANJ, BANGLADESH PT. Istana Karang Laut built plant Shylhet gas Field with capacity 300 barrel per day Semi Regenerative catalytic reforming unit and associated facilities at Bangladesh. LPG truck loading is part of the project equipment to installed and commissioning for selling LPG liquid local market. Shylhet gas field have 20 (two) unit truck loading facility, but 2 (two) LPG truck loading have problem metering not accurate reading compare with volume of truck storage (Lori) M-402 and M-403.



Facility consists of:
1. LPG product tank
2. LPG pumps
3. Loading arm
4. Metering
5. Batch Controller
6. Truck Lory

The function of statistical quality control is to improve quality thereby reducing manufacturing costs, scrap, rework, rescheduling, increase consumer confidence and tighten specification limits and increase productivity and production yields (Nurherawati, 2024; Susetyo, 2023). First time control chart introduced by Dr. Walter Andrew Shewhart of Bell Telephone Laboratories, USA, in 1924 with a view to eliminating abnormal variations through separation of variations caused by a special-cause variation of the variation caused by common causes (common-causes variation) (Farabi, 2019; Hofifah, 2023). Control chart is a statistical method which distinguishes the existence of variations or deviations due to general causes and due to special causes in control limit (Abdullah, 2015). When the deviation or error has exceeded the control limit, indicating that a specific cause has been entered into the process and the process should be examined to identify the causes of such excessive deviations or errors and the general causes usually exist within the control limits (Akbar, 2018; Kurniawidjadja et al., 2019).

The average control map is a control map to see if the process is still in place in the process. The average control map shows whether the average product produced is appropriate with the control standards used by the company (Hairiyah et al., 2019; Sidartawan, 2014). The production process is said to be good if the product generated is located around the centre line. However, the data that was inside the map statistical control is still referred to as being within the limits of statistical control. Even if there are deviations due to common causes. While the data are outside the control limits of the average must be referred to as (out of statistical control). caused by special causes (Meutia et al., 2018; Supriyadi, 2022).

The distance control map (range) is used to determine the level of accuracy or process accuracy which is measured by the range of the samples taken in the observation. As with controller On average, the remote control map is used to identify and eliminate causes especially those that cause deviations (Junaedi et al., 2022; Rifqi Suprapto & Azizi, 2020). Data that is data that is within limits statistical control for a range is called in statistical control where there is a deviation because common cause. Meanwhile, data that is outside the statistical control limit for the range is called as out statistical control caused by special causes (Diniaty et al., 2019; Syaputra & Sofiyanurriyanti, 2022).

This research aims to examine and compare the measurement methods used in the LPG truck loading process with the measurement accuracy level carried out at the Shylhet Gas Field project site in Bangladesh. By making this comparison, it is hoped that the most effective and accurate measurement method can be found in ensuring the quantity of LPG loaded. The benefits of this study include increased operational efficiency, reduction of the potential for measurement errors that can lead to financial losses, and improved work safety in the field. The results of this study are expected to make a significant contribution to the optimization of the LPG distribution process in the oil and gas industry, especially in Bangladesh, and can be used as a reference for similar projects in the future.

METHOD

This study uses statistical quality control methods, especially control charts, to analyze truck loading activity data. Source data take from truck loading activities in site Shylhet Gas Field July-August 2023. Data analysis obtained from the results of further research were analysed quantitatively. From data above we can find out the extent to which production results are under controlled conditions by using statistical quality control method, namely the control chart. Because the data above is in the form of variables, the average control chart and range control chart are used to control the results above production and to find out the special cause variation in the process which is characterized by the presence of data that is out of control. The steps in making the average control chart and control chart range are as follows:

1. Collect data during LPG truck loading July – August 2023.
2. Compare between metering and truck lory metering.
3. Calculate average of sampling $\bar{X}$ and standard deviation R.
4. Calculate from all sampling $\bar{X}$: $\bar{\bar{X}}$ which is centre line from average deviation and R range deviation average centre line and get $\bar{R}$ centre line.
5. Calculate 3 sigma control limits from the average control chart and the R, control chart.
   - ✓ Standard deviation average 3 sigma.
     $UCL=\bar{X}+A_2(\bar{R})$ and $LCL=\bar{X}-A_2(\bar{R})$
   - ✓ Standard deviation range 3 sigma.
     $UCL=\bar{R}D_4$ and $LCL=\bar{R}D_3$
6. Create an average control chart and a range control chart using three sigma control limits on. After that plot and spread the data $\bar{X}$ and R of each sample taken on the control chart average and control chart R and observe whether the data is under control statistics.
7. If the process is under control (stable process), then calculate the process capability Cp, and Process Capability index Cpk, is as follows:

   $$Cp = \frac{(UCL-LCL)}{6\sigma} \text{ and } \sigma = \frac{\bar{R}}{d_2} \quad \text{Range of UCL and LCL} = X \pm 0{,}05$$

   If Cp $\geq$1 then the process is in a capable state and if Cp$\leq$1 then the process is not in a state capable.

   $$Cpk=\min(Cp_a-Cp_b), \text{ then } C_{pa}= \frac{(UCL-\bar{X})}{3\sigma} \text{ and } C_{pb} = \frac{(\bar{X}-LCL)}{3\sigma}$$

   if Cpk $\geq$1 then the process is in good condition and if Cpk $\leq$ 1 then the process is not in good condition.

   The new process capability index is used to calculate the processes under control. Use average control chart and range control chart to monitor the ongoing process of from time to time, so that corrective action is taken immediately if there are visible changes unwanted in the process.

RESULTS AND DISCUSSION

Analysis And Problem Solving

Table 1. Data metering M-402 and truck loading meter 2024 with independence truck

No.	Date Loading	Target (Kg)	Metering M-402	Meter truck Lory
1.	3 Jan	17.000	16.800	17.200
2.	4 Jan	17.000	17.900	17.300
3.	5 Jan	17.000	16.700	16.100
4.	6 Jan	17.000	18.100	17.900
5.	7 Jan	17.000	16.600	16.800
6.	11 Jan	17.000	17.900	18.200
7.	12 Jan	17.000	16.500	16.800
8.	13 Jan	17.000	16.800	16.700
9.	14 Jan	17.000	17.900	17.200
10.	20 Jan	17.000	16.800	16.900
11.	31 Jan	17.000	17.900	17.500
12.	2 Feb	17.000	16.600	16.800
13.	7 Feb	17.000	16.700	16.800
14.	8 Feb	17.000	17.500	17.100
15.	10 Feb	17.000	16.800	16.500
16.	11 Feb	17.000	17.800	17.900
17.	12 Feb	17.000	17.500	17.000
18.	12 Feb	17.000	16.800	16.400
19.	13 Feb	17.000	17.100	17.000
20.	13 Feb	17.000	16.800	16.400
21.	14 Feb	17.000	17.400	17.000
22.	15 Feb	17.000	16.600	16.900
23.	15 Feb	17.000	16.700	16.900
24.	16 Feb	17.000	17.200	17.000
25.	17 Feb	17.000	16.900	17.200

1. Collect data during LPG truck loading Jan-Feb 2024.
2. Compare between metering and truck lory metering.
3. Calculate average of sampling $\bar{X}$ and standard deviation R.
4. Calculate from all sampling $\bar{X}$: $\bar{\bar{X}}$ which is centre line from average deviation and R range deviation average centre line and get $\bar{R}$ centre line.

	Measurement unit M-402(n=5)							
No.	1	2	3	4	5	Amount	Avarage $\bar{X}$	Range R
1.	16.800	17.900	16.700	18.100	16.600	86.100	17220	1.500
2.	17.900	16.500	16.800	17.900	16.800	85.900	17180	1.400
3.	17.900	16.600	16.700	17.500	16.800	85.500	17100	1.300
4.	17.800	17.500	16.800	17.100	16.800	86.000	17200	1.000
5.	17.400	16.600	16.700	17.200	16.900	84.800	16960	800
						Amount	85.660	6.000
						Average	17.132	1200
							$\bar{\bar{X}}$=17.132	$\bar{R}$=1200

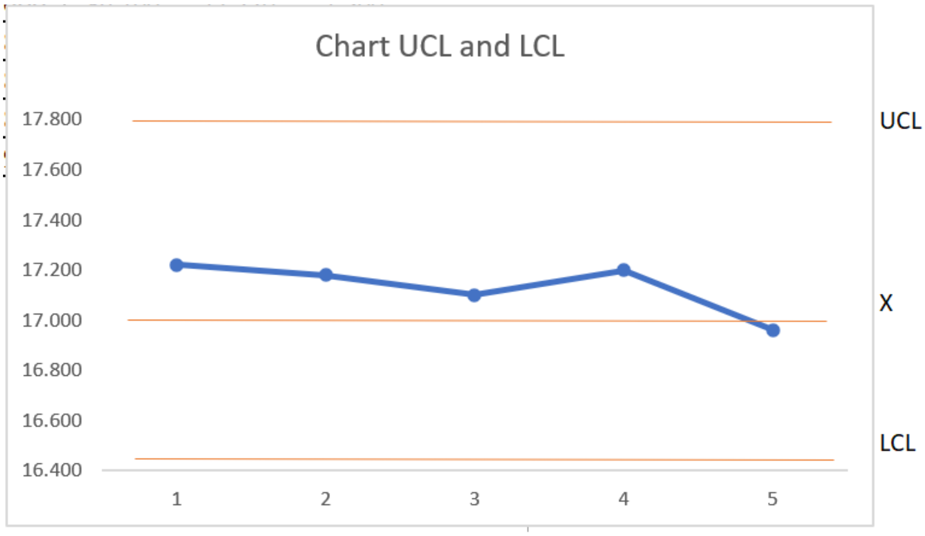
5. Calculate 3 sigma control limits from the average control chart and the R, control chart 0,9973 on the product control chart.
   - ✓ Standard deviation average 3 sigma.
     UCL=$\bar{X}$+A_2($\bar{R}$) and LCL=$\bar{X}$-A_2($\bar{R}$)
   - ✓ Standard deviation range 3 sigma.
     UCL=$\bar{R}D_4$ and LCL=$\bar{R}D_3$

Standard deviation average 3 sigma
UCL=17.132 + (0,577) (1200) = 17,824.4
$\bar{X}$ = 17,132

LCL=17.132 - (0,577) (1200) = 16,439.6

Standard deviation range 3 sigma.
UCL=1200 (2,115) = 2,538
LCL=1200 (0) = 0

6. Create an average control chart and a range control chart using three sigma control limits on. After that plot and spread the data $\bar{X}$ and R of each sample taken on the control chart average and control chart R and observe whether the data is under control statistics.



Conclusion and Recommendation

How to perform meter adjustment:

1. Get as much as possible discrepancies samples data. More sample will eliminate more bias.
2. Calculate random error and combine it with systematical error to estimate discrepancies it should be.
3. Calculate discrepancy average as reference to adjust the meter
4. Get new meter factor of the meter new Mf = ((100% + Mean) / 100%) x old MF
5. Input new meter factor to the mass meter

What we can do to prevent random error?

1. Get as much as possible samples before meter adjustment.
2. Pay attention to the truck and ambient condition before each loading such as:
   a. Is it truck really empty?
   b. Is gauge in good condition?
   c. LPG and ambient temperature? Beyond our capabilities to control it.
3. Operator skill to reading gauge. Prevent to parallax error
4. Steady flow

CONCLUSION

The discrepancies observed in the measurements are highly uncertain, influenced by both random and systematic errors. Numerous factors contribute to these discrepancies, with random error being a significant influence. Despite the Coriolis Meter having a maximum measurement error of 0.1% as stated in its certificate and datasheet, achieving discrepancies below this threshold is challenging. The Coriolis meter's K-factor is 0.005 liter/pulse, which is much more sensitive than the truck gauge's 380 liters/scale. This sensitivity difference makes it nearly impossible to use the truck as a standard for meter adjustment while expecting consistent results. Consequently, it is almost impossible to maintain discrepancies consistently lower than half the gauge resolution or below 190 liters. There is minimal deviation between manual mass calculations and batch controller calculations, with measurement deviation being the primary contributor to discrepancies. Calculations using available samples suggest that the most confident discrepancies estimation, if the meter is adjusted using available data as a reference, will be around ±1.2% for meter M402 and ±0.71% for meter M403 with a 95% confidence level. While it is theoretically possible to achieve discrepancies close to zero, it is extremely rare. The best results for meter adjustment are obtained after multiple loadings and discrepancy sampling.

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