American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-12, Issue-1, pp-25-27
www.ajer.org
Research Paper Open Access

Fault Tree Analysis on the 365kva Caterpillar Generator

[1]Oghu, E., [2]Ogbeide, O. O and [3]Ariavie, G.O
[1-2]*Department of Production Engineering, University of Benin, Benin city, Nigeria.*
[3]*Department of Mechanical Engineering, University of Benin, Benin City, Nigeria*

ABSTRACT
The purpose of carrying out the equipment failure analysis using fault tree analysis is to provide a fast pictorial representation of exhaust subsystem diagnosis of likely causes of high AGO consumption on the 365KVA caterpillar generator. This is an improvement on what was written on the generator manual concerning how troubleshooting of failed subsystem should be tackle. This study will be of help to maintenance engineers, technicians, craftsmen and operators alike in handling equipment failures and thereby leading to significant reductions in cost of running the generator.

Date of Submission: 18-12-2022 Date of acceptance: 02-01-2023

I. INTRODUCTION

Many production or manufacturing equipment (machines) failed to operate or breakdown intermittently while production is in process, resulting to loss of man-hour, low production, poor revenue, failed business target (Ståhl, et al. 2012) and several other reasons.

Lokoja Pump Station established in 1979 is one among the seven (7) Pump Stations on System 2C Pipeline Pumping/Boosting crude oil to Kaduna Refinery & Petrochemicals (KRPC) of Nigeria Pipeline and Storage Company, NPSC a subsidiary of Nigerian National Petroleum Corporation (NNPC). The Pump Station is carrying out the job of pumping crude oil with the help of these equipment: Pipeline, Allen Engine, Nuovo Pignone, Pump, Valves, Generators, Fan blowers, Compressors, Lighting fittings, Fire booster pumps etc.

The pump station since from inception forty-one years (41yrs) ago solely depend on generator to accomplish it task of pumping crude oil to Kaduna Refinery and Petrochemical (KRPC). In light of above there is urgent need to carryout analysis on the 365kva caterpillar generator using Fault Tree Analysis(FTA) as proactive measure to advert any forms of breakdown or downtime.

The aim of this study is to carry out fault tree analysis on 365KVA Caterpillar generator in Lokoja Pump Station for easy visualization and aid in tracing the root cause of failed components as regard whether they are independent or dependent causes using required Boolean gates.

Causes and effects are important attributes that required proper analysis in the study of components failures and all these critical features can analysis using fault tree analysis that visual diagram to represent effect, logic gate to showcase whether the causal factors are dependent or independent(Jari and Antti, 2012). In other words a top- down approached was utilized to minimize the harmful effect of equipment failurein the overall operation of a nuclear power plant by applying the fault tree analysis to visualize the efficiency of safety equipment, testing and required maintenance as regards prevention procedures for continuous running of the nuclear power plant (Marko, 2000). In further research effort fault tree analysis as reliability enhancing tool was used in the analysis of cause and effect of a 4-stroke, 4-cylinder petrol engine using necessary logic gates that highlights whether these causes are standalone or combinational (Mahadev et al., 2017). In avowed commitment to provide solution toequipment and plant process failures, fault tree analysis was used to cascade the root causes of those failures to critical components in pictorial form for easy identification in order to aid in providing preventive measures and other mitigation process(Savadamuthu, Muthu and Gunasekharan, 2012).In a similar effortto reduce risk, improve on equipment availability in Khoy cement factory, it becomes evitable to use a different reliability enhancing technique such as fault tree analysis in crusher subsystem in the mining process in Iran(Nouri.Gharahasanlou, Mokhtarei, Khodayarei and Ataei, 2014). Nuclear powerplant and Railway system infrastructure are key investment that recognizes these three parameters such as Reliability, Availability, Maintenance and Safety (RAMS) that are critical concept that need daily, weekly, monthly and yearly optimization measures to enhance efficient and effective performance, fault tree analysis was utilized to

dissect interrelationship between effect and cause using necessary logic gates (Guck, Spel, and Stoelinga, 2015). In furtherance world wide application of fault tree analysis in solving various equipment failures, similar approach was applied to use of lathe machine by having a graphical representation of critical failures and related causes in order to provide counterapproach to resolves those faults and makes machine more reliable in its performance(Rajkumar, 2012) and other researchers tried to streamline procedures on fault tree analysis should be carried out to in order to improve on equipment uptime, such top event should be define, understanding system behavior, construct tree that encapsulate all failed subsystem, carry out validation and accomplished it by evaluating ,draw up recommendation of counter measures and finally consider alternative action (Mohammad, Azim and Ali, 2011). CNC turning center with the aim of getting in right in machining industry in India captured the various forms of failures such as improper coolant suppl, turret indexing mechanism and spindle failure and how fault tree analytic tool can aid in finding the root cause of these failure and present it in pictorial format in order to improve on its accuracy, precision and quality finishing in its various production(Rajkumar et al.,2018)

II. METHODOLOGY

The methodology used in fault tree analysis of are stated below:

(i) Top event is regarded as the effect: The effect is the main problem affecting the overall performance of the subsystem and it is being tag using a rectangular box.

(ii) Uses of arrow lines: it serves as aid to direction of flow information, and at same time showing the relationship between the effect, Boolean logic gate and the root cause of the equipment failures.

(iii) Boolean logic gates: These logic gate symbols that comes in form of AND, OR, NAND, NOT etc tends to show whether the root cause of the problem is independent or dependent causes which gives the engineers, technicians, operators and craftsmen the kind of hurdles they need to address before the countermeasures put in place can address or eliminate the effect.

(iv) Bottom event: it is regarded as the root cause of the failures. The pictorial representation aid the workmen to easily identify the various causes that resulted in the effect shown up at the top. The use of this reliability tool in an advance approach towards solving component failures in complex engineering facilities and giving additional solutions that is beyond what the original equipment manufacturers manual contained therein.

III. RESULT AND DISCUSSION

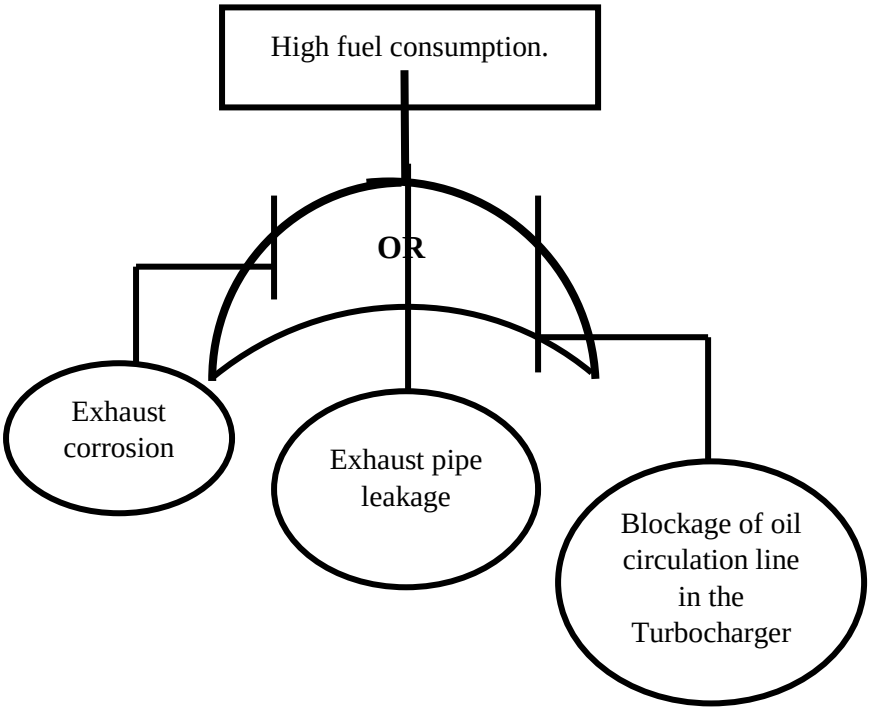

Fig 3.1 Fault Tree Analysis for Exhaust System Sub-System.

From Fig3.1, it is shown that the effect on the generator is that it lead to high Automotive Gas Oil (AGO)and from daily running records, the 365KVA generator consumes 300litres and price of AGO otherwise called diesel per litre is ₦345. The aggregate cost of running the generator on daily basis amount to₦103,500. It

implies that any other factor that will increase this established cost of consumption required proper brainstorming, evaluation and countermeasures that will address it.

One of identified cause of high fuel consumption is exhaust pipe corrosion, it leads to several leak points and exhaust is expected to maintain certain pressure and when this not maintained its leads to high AGO consumption. There is need for quarterly inspection of exhaust pipe in light of the fact that it leads to additional cost of running of the generator.

Secondly, exhaust pipe leakage should be seen as a source of additional running cost to any internal combustion engine because it directly link to high fuel consumption. There is need for quarterly inspection, to check tiny leaking points, corroded points or highly vibrated contact points, abrasion on the exhaust pipes, because sealing off or welding those points will lead to saving extra cost of running the generator.

Thirdly, Blockage of oil circulation line in the Turbocharger do leads to high exhaust temperature, which will definitely lead to high fuel consumption, so if it is observed that there is excesses temperature rise then there is urgent need for proper inspection of turbocharger, exhaust pipe and cylinder head to see if it is internal combustion problem. By taking early countermeasures, it lead to reduction in fuel consumption, which implies that it will lead to reduction in cost of running

IV. CONCLUSION

The fault tree analysis is another form of pictorial representation of fault and the accompanying causes and with application of Boolean logic gates which tends to draw more meaning to the cause whether it is independent or dependent causes. We can draw inference from the analyzed Fault Tree Analysis for Exhaust System Sub-System that the cause of each individual problem can lead to high AGO consumption and when you aggregate all the causes, there is possibility of having incremental AGO consumption.

REFERENCE

[1]. Geymayr, J. A. B., & Ebecken, N. F. F. (1995). Fault-tree analysis: a knowledge-engineering approach. IEEE Transactions on Reliability, 44(1), 37–45. doi:10.1109/24.376519 Geymayr, J. A. B., & Ebecken, N. F. F. (1995). Fault-tree analysis: a knowledge-engineering approach. IEEE Transactions on Reliability, 44(1), 37–45. doi:10.1109/24.376519

[2]. Guck, D., Spel, J., & Stoelinga, M. (2015). DFTCalc: Reliability Centered Maintenance via Fault Tree Analysis (Tool Paper). Lecture Notes in Computer Science, PP-304–311.(doi:10.1007/978-3-319-25423-4_19)

[3]. Jari H. & Antti A., (2012). Fault tree analysis for maintenance needs, 25th International Congress on Condition Monitoring and Diagnostic Engineering, Journal of Physics: Conference Series 364 (2012) 012102, (doi:10.1088/1742-6596/364/1/012102), PP-1-11.

[4]. Marko Č.,(2000). Improvement of Testing and Maintenance Based on Fault Tree Analysis, International Conference Nuclear Energy in Central Europe 2000, PP-1-8

[5]. Mahadev N., Prabodhan K., Swapnil K., Dhiraj K., & Digvijay K.,(2017). Fault Diagnosis and experimental analysis of 4-stroke, 4-cylinder petrol engine using Fault Tree Analysis, International Journal of Engineering Trends and Technology (IJETT) – Volume 46 Number 8, PP-445-453

[6]. Mohammad S. J., Azim N., & Ali M., (2011). Fault Tree Analysis Approach in Reliability Assessment of Power System, International Journal Of Multidisciplinary Sciences And Engineering, Vol. 2, No. 6, PP- 46-50.

[7]. Nouri.Gharahasanlou, A., Mokhtarei, A., Khodayarei, A., & Ataei, M. (2014). Fault tree analysis of failure cause of crushing plant and mixing bed hall at Khoy cement factory in Iran. Case Studies in Engineering Failure Analysis, 2(1), PP-33–38.(doi:10.1016/j.csefa.2013.12.006).

[8]. Rajkumar B. P., Waghmode L.Y, Chikali, P.B, & Mulla, T.S. (2012). An Overview of Fault Tree Analysis (FTA) Method for Reliability Analysis & Life Cycle Cost (LCC) Management, IOSR Journal of Mechanical & Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 14-18

[9]. Rajkumar B. P., Digvijay A. M., Pruthwiraj B. K., Basavraj S. K., (2018). Fault Tree Analysis: A Case Study from Machine Tool Industry, An International Conference on Tribology, TRIBOINDIA-2018 13th -15th December 2018, VJTI, Mumbai, India, PP-1-5

[10]. Savadamuthu L, Muthu,S. Gunasekharan, S.(2012). Study on Equipment Failure and Loss Estimation through Taguchi Method with Risk Management, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-1 Issue-3, PP-174-176