Evaluation of Fire Pumps FP1 and FP2 at Oando Energy Resources Nigeria Limited: Kwale Gas Plant Location

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Abstract
Large firefighting teams typically result in increased prosperity, better worker safety standards, and the local adoption of related new technologies. Nevertheless, these advantages have not yet materialized to a considerable degree in OANDO Energy Resources Nigeria Limited. In order to accomplish these intended improvements, this paper examines what has to be done in the industry as a whole to secure a reliable fire-fighting safety procedure.

1. Problem:
Incessant failures and downtime with critical fire pumps ***FP1 and FP2*** at Kwale location is affecting operation in terms of cost and energy required for sustainable activity in the plant, [1,3,4]. Severally the following defects/failure issues itemized below have affected smooth operations of the fire pumps:

i. pumps failure to start;
ii. low pressure fault;
iii. lack of servicing materials for fire pumps;
iv. lack of experienced and competent personnel;
v. delayed and irregular PM activity;
vi. damaged pump coupling; and
vii defective control panels.

2. Prospective solution:
An unpleasant situation can compel operators and users of equipment to look for alternative to keep maintenance activity up and awake, [5,7,6]. When maintenance takes one-third of the cost of equipment value in one year, such is an indication of deterioration period/equipment end of useful life, [1,8,2,11].

3. Target and audit:
Required is a detailed goal oriented productive activity, a typical audit of the activity would include the measurement of effectiveness and comparison of the outcome of the process corresponding with required goals, [2,4,9], A performance appraisal or productivity measurement is expected to reveal: -

- costs of not solving, as well as solving, the problem being faced; and
- the necessary action required to overcome the problem, and how to relate output to the action.

The audit is expected to (i) determine the effectiveness of existing operations, (ii) highlight the strength and weaknesses in the system and process, and devise/suggest an implementable plan and controls for the activity to achieve higher productivity, [5,3,14].

4. Pumps (FP1 and FP2) data analysis:
Data collected from case study unit 8200 (FP1 and FP2) on condition of working unit for the years (2022 -2023) have been tabulated as raw data shown in Table 1 and the failure analysis of the unit 8200 FP1 and FP2 for calculation of OEE as shown in Table 2. The data presented in Table 2 was recorded from maintenance planning and execution of daily work activities and were obtained for one (1) year period to examine the trend in failure intervention calls by operators/users of the equipment, [12,10,13].
Table 1: Fire pumps (FP1 and FP2) Raw Technical data

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s/n	Plant unit location	Installed capacity	Working capacity	Observation period	Number of failure	Remarks
1.	8200 FP1	200m^3/h	85m^3/h	8760	40	Awaiting spare part
2.	8200FP2	200m^3/h	80m^3/h	8760	28	Awaiting spare part
.3.	**Total**	**400m^3/h**	**165m^3/h**			

Table 2: Fire pumps (FP1 and FP2) Technical data analysis

s/n	Plant unit location	System failure period	System repair period	No. of failure	Total downtime per period
1.	8200 FP1	25/05/22-23/04/23	30/05/22-26/04/23	40	4000 hrs.
2.	8200 FP2	25/05/22-25/05/23	30/05/22-26/07/23	28	2750 hrs.

Now, carrying out individual analysis of pumps FP1 and FP2 shown in Table 2 will provide separate results of work performance as following: -

1. For 8200 fire pump FP1

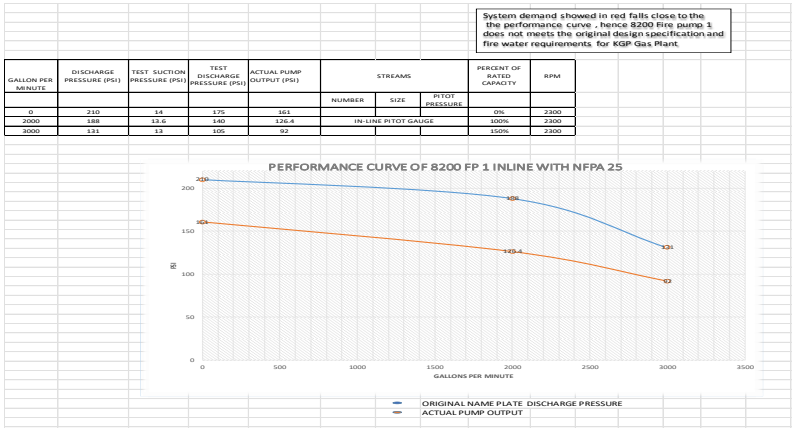
Planned production time = 8760 hours
Total downtime = 4000 hours
Operating time = Planned production time - Total down time
= 8760 - 4000= 4760 hours

Availability $(A) = \frac{MTBF}{MTBF+MWT}\ X\ 100\% = \frac{4760}{8760}\ X\ 100$ = 0.543 X 100 = 54.3%

From Table 1:
Actual output of pump = 85m^3/h
Ideal output of pump = 200m^3/h

Performance $= \frac{Actual\ output\ of\ equipment}{Ideal\ output\ of\ the\ equipment}$ X 100 % $= \frac{85m3/h}{200m3/h}$ X 100 = 0.425 x 100 = 42.5%

Performance curve 8200 FP1



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2. For 8200 fire pump FP2

Planned production time = 8760 hours

Total downtime = 2750 hours

Operating time = Planned production time - Total down time

= 8760-2750 = 6010 hours

Availability $(A) = \frac{MTBF}{MTBF+MWT}\ X\ 100\% = \frac{6010}{8760}\ X\ 100$ = 0.686 X 100 = 68.6%

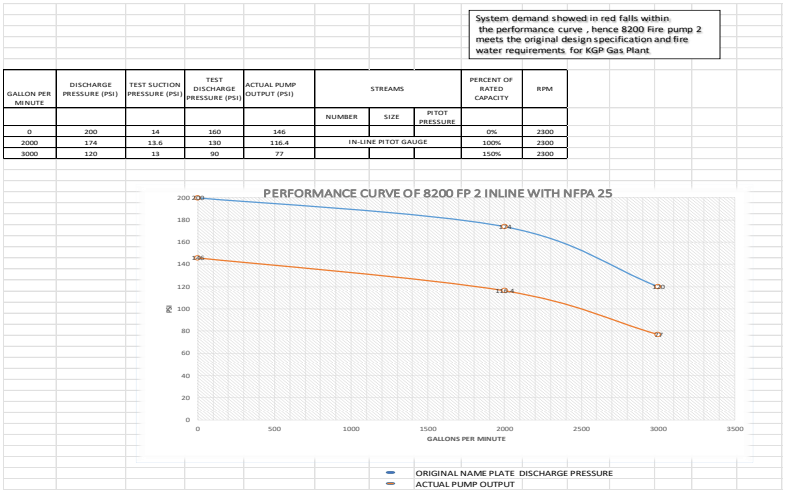
From Table 1:

Actual output of pump = 80m^3/h

Ideal output of pump = 200m^3/h

Performance $= \frac{Actual\ output\ of\ equipment}{Ideal\ output\ of\ the\ equipment}$ X 100 % $= \frac{80m3/h}{200m3/h}$ X 100 = 0.4 x 100 = 40%

Performance curve 8200 FP2



GALLON PER MINUTE	DISCHARGE PRESSURE (PSI)	TEST SUCTION PRESSURE (PSI)	TEST DISCHARGE PRESSURE (PSI)	ACTUAL PUMP OUTPUT (PSI)	STREAMS			PERCENT OF RATED CAPACITY	RPM
					NUMBER	SIZE	PITOT PRESSURE		
0	200	14	160	146				0%	2300
2000	174	13.6	130	116.4	IN-LINE PITOT GAUGE			100%	2300
3000	120	13	90	77				150%	2300

Calculation of Fire pumps (FP1 and FP2) Effectiveness (O E E)

1. Fire pumps quality rate $= \frac{\text{Annual output capacity}}{\text{Total installed capacity}} = \frac{\mathbf{165m3/h}}{\mathbf{400m3/h}}$ = 0.4125 x 100 = 41.25%
2. Fire pumps Availability = Product of individual pumps availability:
   = 0.543 x 0.686 = 0.373 x 100 = 37.3%
3. Fire pumps performance = Average sum of individual pumps performances:
   = 0.425 + 0.4 = $\frac{0.825}{2}$ = 0.413 X 100 = 41.3%
4. OEE of Fire pumps = Pumps Availability X Pumps Performance X Pumps quality rate:

= 0.373 X 0.413 X 0.413 = 0.0636 X 100 = 6.36%, OEE = 6.36%

5. Discussion:

From the observed patterns of behaviour of the two fixed fire pumps in Kwale, a performance was noticed. The typical values of the performance factor namely 42.3% and 40% considered in the analysis are below the average worldwide performance index for the pumps production.

In practice, the generally accepted “world-class” goals for each factor are quite different from each other, as shown:

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OEE factor	World class standard
Availability	90.0%
Performance	95.0%
Quality	99.0%
Overall OEE	85.0%

Studies indicate that the average OEE rate in most industries is 60%. As can be seen from the table, an accepted OEE is considered to be 85% and above. Clearly, indicating that there is room for improvement in what is obtained with the fire pumps FP1 and FP2 in Kwale.

6. Conclusion

The poor OEE rating is a reflection of how the fire pumps FP1 and FP2 are loaded or doing what they are supposed to do. In this case, low quantifiable performance indicator show that the fire pumps are not effective. This means there is opportunity to increase capacity and productivity to a large reasonable percentage.

Individual fire pump problems affect the entire unit and hence the pumps effectiveness under this circumstance, the availability of the process becomes the product of the individual's availability. A productive maintenance plan, if implemented will improve the OEE by providing a structure to quantify losses or downtime, and subsequently give priority to critical equipment like the fire pumps.

With the equipment criticality at all-time high, a good strategic productive plan may be the only thing that stands between success and total failure at Kwale. Based on the results obtained, the following weaknesses (though opportunities for improvement) were found:

- a poor OEE rating indicates that the maintenance management system is affected/suffering, i.e. low morale and poorly motivated personnel;
- written maintenance policies are not followed, and most of the descriptions require review, i.e. lack of spares and delay in supply of spare parts for repairs;
- both Pumps FP1 and FP2 were designed to operate at capacity of 200m^3/h, but are been operated at low capacity of 80m^3/h and 85m^3/h respectively. Which indicate poor quality rate, i.e. not giving required pressure needed for operations (low pressure fault): a condition of weakness, wear out due to old age and defective internal components, which require total replacement or complete overhaul of the fire pumps.

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