Risk Assessment Using FMEA to Identify Potential Risks of Positive Displacement Pump Failure in Aluminum Industry: A Case Study

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Introduction

FMEA, is one of the most popular method, hence it is comprehensive, systematic, skill dependent and quantifiable. It is a systematic technique that, prior to the final implementation of each project, defines, identifies potential risks, causes and consequences, assesses the risk of their occurrence, and takes measures to eliminate or reduce them. Each failure mode can be evaluated by three factors as severity, likelihood of occurrence, and the difficulty of detection of the failure mode.

Materials and Methods

Steps of FMEA are presented below:

1- Collecting information related to the process: The device where the risk assessment is performed must be thoroughly identified and the activities and processes carefully examined.

2- Determining potential risks: All environmental, equipment, materials, human and other hazards that threaten safety must be considered.

3- Examining the effects of each hazard: The effects of any hazard are potential effects that endanger the safety of individuals. Dangerous effects such as fire, poisoning, fractures, etc.

4- Determining the causes of danger: Adequate knowledge of the device or activity being evaluated can be of great help in identifying the causes of the hazard.

5- Determining the severity of occurrence (deterioration rate): The severity or severity of the risk is considered only in terms of its "effect". For risk severity, there are few indicators that are expressed on a scale of 1 to 10.

6- Probability of occurrence: The probability of occurrence determines the frequency with which a potential cause or mechanism of danger occurs. The probability of occurrence is measured on a scale of 1 to 10. It is very useful to check past records.

7- Risk detection probability rate: Probability of discovery is a kind of assessment of the ability to identify a cause or mechanism of occurrence of a hazard. In other words, the probability of discovery is the ability to detect danger before it occurs.

RPN = Severity × Occurrence × Detection

The resulting RPN number is commonly referred to as the risk priority number and will be between 1 and 1000.

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Results

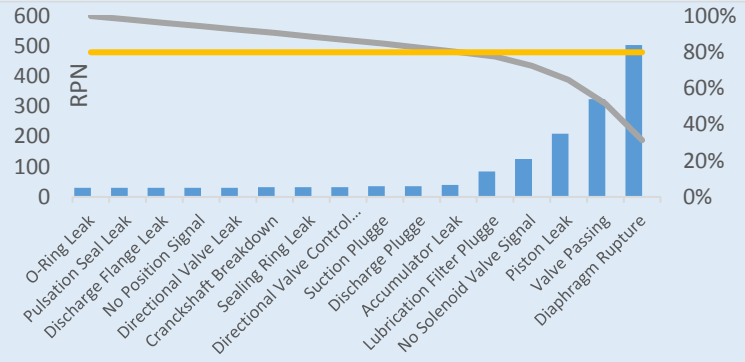

Figure 1 Pareto of Failures

Table 1 Scoring recommended actions

Failure	Recommended Action	Efficiency %	Cost $	Man-Hour
Lubrication Filter Plugged	Install a flow transmitter with low alarm to discover possible plug	42.9	600	32
No Solenoid Valve Signal	Train inspectors to discover problems and follow instruction in case of failures to prevent further damages	28.6	10	80
Piston Leak	Replace piston sealing and packings after 360 days of work	50.0	68	50
Valve Passing	Change the housing design to more efficient type	22.2	750	216
	Use ultrasonic analyser to discover passing at early stage	16.7	1	18
	Take Both Actions	35.2	751	234
Diaphragm Rupture	Purchase higher quality diaphragm from another supplier	14.3	220	32
	Replace every other overhaul	42.9	310	20
	Take Both Actions	57.1	530	52

Table 2 Ranking of actions by AHP score

Rank	Recommended Action	AHP
1	Use ultrasonic analyser to discover passing at early stage and prevent total failure	0.222
2	Take Both Actions (purchase better material and replace part on overhaul)	0.142
3	Replace piston sealing and packings after 360 days of work	0.128
4	Replace diaphragm every other overhaul	0.121
5	Install a flow transmitter with low alarm to discover possible plug	0.113
6	Train inspectors to discover problems and follow instruction in case of failures to prevent further damages	0.088
7	Take Both Actions (change housing and use ultrasound monitoring)	0.085
8	Change the housing design to more efficient type	0.054
9	Purchase higher quality diaphragm from another supplier available on the market	0.047

Conclusion

By examining the relevant tables and diagrams, it was found that by applying nine recommended actions, which requires collaborations between different departments, the risks of the pump failure can be greatly reduced, which in turn leads to increased reliability and resilience of the system. Each action has different effectiveness (reducing RPN number), cost and man-hour needed, so the options have been prioritized by AHP decision making method.

Researches like this one, by collecting comprehensive information and converting tacit knowledge into practical, can lead to an increase in productivity by reducing unwanted breakdowns and improving the maintenance program, which is a big step in the direction of sustainable development.