New Approach to Enhance an Effect of Condition Monitoring of Mid/Small Size Rotating Equipment in Nuclear Power Plants

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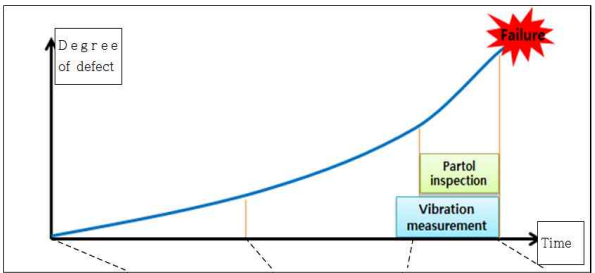
1. Introduction

Finding a fault and a degradation of equipment before failure is very important to improve equipment reliability. Korea Hydro & Nuclear Power Co. (KHNP) has implemented vibration, lube-oil analysis, infrared thermography, and ultrasonic analysis as condition monitoring technologies to detect a flaw of rotating equipment to prevent failure during operation.

Condition monitoring for small and medium-size rotating equipment is mainly done by a patrol inspection and a vibration measurement. These methods are useful to recognize a significant change in a sound, temperature and vibration amplitude on the bearing housing. However, such a significant change shows an abnormal condition just before failure so that there is not much time to take a right action to recover. In other words, there is a severe damage when someone detects the phenomenon as shown in figure 1.



Defect Stage	Initial	Middle	Final(Failure)	
Growth Speed of defect	Slow	Acceleration	Increase Sharply	-
		There is no time to fix appropriately		
Condition monitoring	N/A	N/A	Patrol inspection	-
			Vibration measurement	

Fig. 1. Condition monitoring at small and medium size rotating equipment

To enhance a condition monitoring effectiveness for small and medium size rotating equipment, it is required to detect a flaw in the initial status of the failure. In this paper, a different approach of condition monitoring methods will be discussed and proposed to recognize a failure in advance.

2. Condition monitoring at current state

2.1. Vibration measurement on small and medium size rotating equipment

A periodic vibration measurement of small and medium-size rotating equipment is performed to check amplitude value of vibration. It is considered to be abnormal condition when the overall amplitude value is exceed a certain level of the value according to an industry standard such as ISO 7919 Part1 [1].
However, this value can only analogize the defect. And it does not recognize the characteristic of defect.

Supplement to the amplitude value methods, a spectral analysis on the low-middle band frequency has been applied. This analysis is to check a rotational harmonic frequency and bearing fault frequency as complementary way of the overall vibration amplitude. Still the defect detected through this analysis is also too late to recognize the defect before damaging on the equipment.

2.2. Patrol inspection on the small and medium size rotating equipment

Maintenance personnel and operators check heat generation and strange noise on the bearing housing of the small and medium size rotating equipment by using their hands and ears. This patrol can find an abnormal condition which is already broken. Strange noise and heat generation of bearing housing are usually final step of equipment failure.

3. New approach to enhance an effect of condition monitoring

It is recommended to analyze a high band frequency for early recognition of defect on small and medium-size rotating equipment in industrial standard ISO 13373-2[2].
When a minor defect generate in the interior equipment, it can be shown a haystack in high band frequency as depicted in figure. 2.

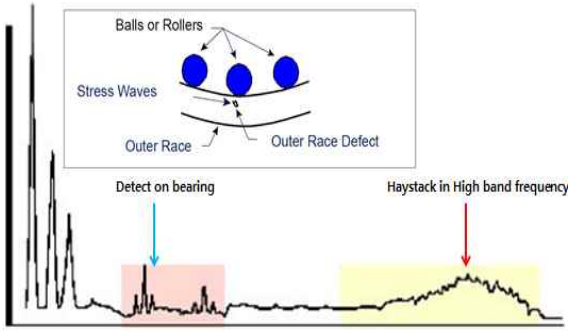


Fig. 2. Defect generate haystack in high band frequency

To determine initial defect from a haystack, a signal processing is required. One of signal processing is an envelope method to find a repeatable impact spectrum from a haystack as shown in figure. 3 which enables to recognize an initial defect of equipment.

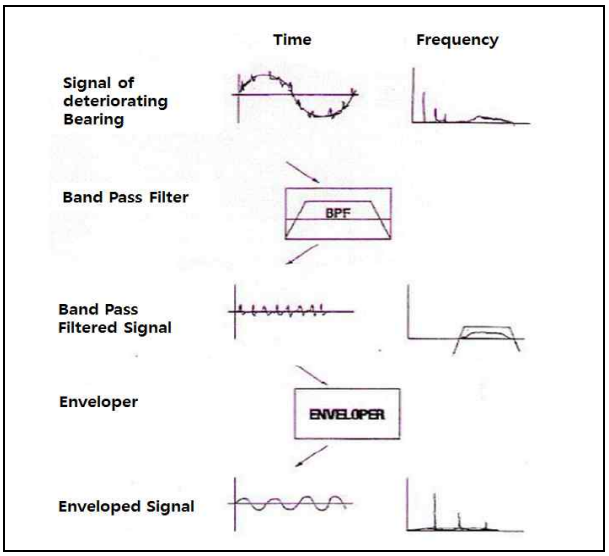


Fig. 3. Signal Processing in high band frequency

Sometimes, a minor defect signal is not caused by internal parts so that it is required to consider a contamination or lack of lubricant in this case. Lubricant (grease), ultrasonic and temperature trend analysis are applicable [3], [4]. EPRI recommends an integrated measurement to enhance a condition monitoring effect [5]. The integrated measurement consists of vibration, lubricant analysis, ultrasonic and temperature trend monitoring. These will be implemented as shown in figure 4. to detect a flaw earlier.

Defect Stage	Current Monitoring Methods	New approach Monitoring Methods
Initial	N/A	Vibration High band spectrum analysis(envelope)
middle	N/A	Ultrasonic Internal Friction & lack of lubricant
	N/A	Lubricant Wear, contamination, moisture in grease
	N/A	Temperature Trending
	Vibration Low-Middle band Spectrum analysis	Vibration Low-Middle band Spectrum analysis
last	Vibration Overall amplitude	Vibration Overall amplitude
	Patrol Abnormal Noise & Temperature	Patrol Abnormal Noise & Temperature

Fig. 4. Integrated measurement for condition monitoring

Those measurement results will be stored in a data server as shown in figure. 5. to improve on accuracy of evaluation.

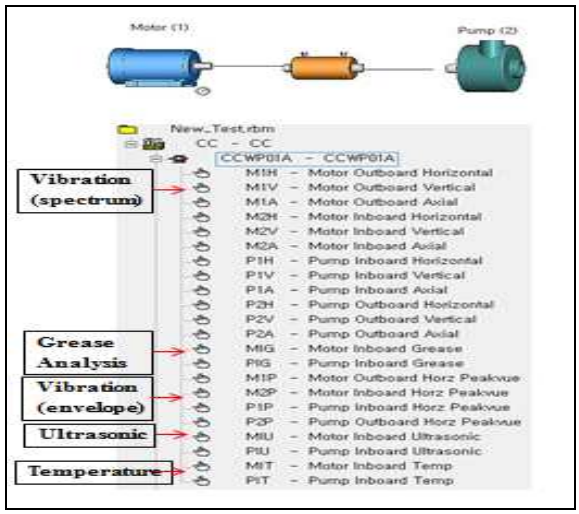


Fig. 5. Integrated measurement results store in a sever

The integrated measurement including High band frequency will be demonstrated at one of nuclear power plants in June 2016. Eighty seven small and medium size rotating equipment have been selected to be tested with a two week interval for validation of the integrated measurement.

4. Conclusion

Condition monitoring of small and medium-size rotating equipment in nuclear power plant has been done by operator and maintenance patrol inspection and amplitude vibration measurement. These methods are good way to detect a flaw but too late to fix. It can't detect early recognition of defect

To enhance the effect of condition monitoring and recognize a defect earlier, an integrated measurement including high band frequency analysis is required. It will be implemented at one of nuclear power plants in Korea as a pilot to verify an effect and applicability at nuclear power plants.

REFERENCES

[1] ISO 7919 Part1, Mechanical vibration of non-reciprocating machine-Measurement on rotating shafts and evaluation criteria, Second edition pp4-8, 1996
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