Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 6, June -2017

Investigation and Inference of Boiler Tube Leakages with Proposed Techniques to Arrest Inception of Leak Event.

Samir K Raval

Lecturer, Department Of Mechanical Engineering,
K D Poytechnique, Patan, Gujarat, India

ABSTRACT:- *A continuous process system such as a steam generator process has many components. The steam generator system includes a boiler that has tubes through which water flows. Because of heat, pressure, and wear over time, the boiler tubes eventually begin to leak, i.e., the beginning of a "leak event." When a boiler tube(s) starts to leak, steam which flashes over from the water escaping through the leak therein is lost to the boiler environment. In general, the amount of leaked water/steam may be small at the inception of a tube leak event. However, unless the tube is repaired, the leak will continue to grow, i.e., the tube leak rate increases with time until the tube eventually ruptures. Further a rupture in one tube may damage adjacent tubes resulting in a huge overall leak. Thus, once a rupture occurs the utility operating the boiler is forced to shut the boiler down immediately. [1]*

Moreover the severe service condition in coal fired thermal power plants causes failures such as the effects of high temperature, erosion, stress, vibration and corrosion combined resulting in failure of the boiler tubes thus it is extremely important to determine the location & beginning of leak event to get your boiler back on line and reduce or eliminate future forced outages.

INTRODUCTION

In the modern increasing competitive environment, an efficient operating criterion for pulverized coal fired furnace is vital for the future of thermal power station. Thermal power plants contribute about 75% to all India installed capacity of electric power generating stations. In worldwide energy sector, total 37% of electricity is produced by combusting coal. [1-2] In the thermal power station, the boiler performance is a backbone for power production. With ever increasing demand for electricity, it is very necessary for the power plants to generate electricity without forced outages. The power plants are facing the problem of boiler tube leakage and it is more critical when they are running on full load. It becomes one of the critical reasons among numerous reasons of the energy crisis. Utilities have been fighting boiler tube failure since long. The tube failure cost crores of rupees lost, as it causes loss in generation. Boiler tubes have limited life and can fail due to various failure mechanisms. Tube failures are classified as in-service failure in boilers. These failures can be grouped under six major causes. stress rupture, fatigue, corrosion, erosion, material failure and welding defects.[3]

BOILER TUBE FAILURE MECHANISM

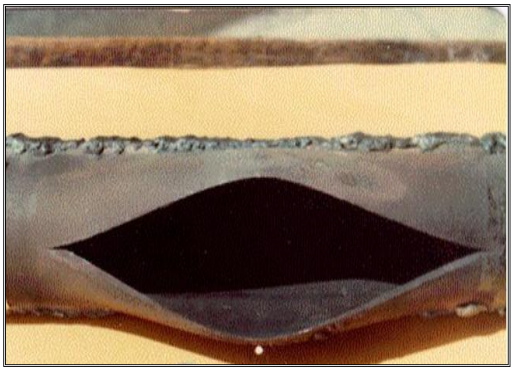


Fig: 1 Tube failed due to short term overheating

Fig: 2 Tube failed due to high temp creep.

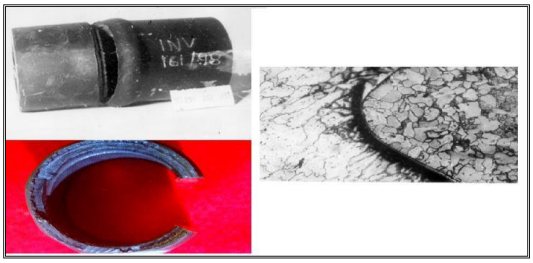


Fig: 3 Tube failures because of dissimilar welds

Fig:4 Tube failures because of LTOH.

Fig:5 Tube failures due to caustic corrosion.

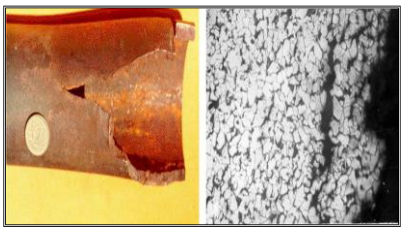


Fig: 6 Tube failures because of H2 damage.

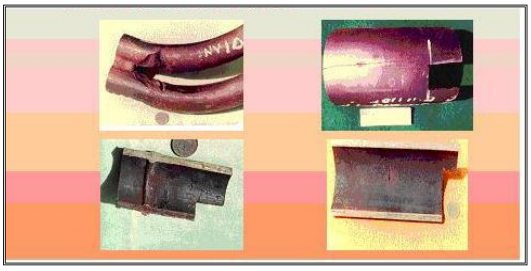


Fig: 7 Tube failures because of fatigue failure

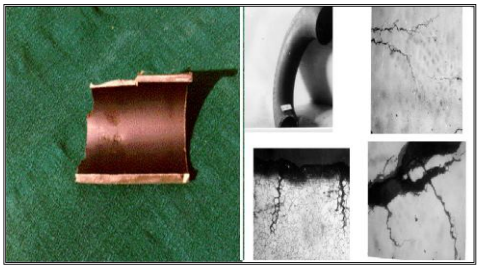


Fig: 8 Tube failure due to stress corrosion

CASE STUDY

The data shown in Table 1 pertaining to boiler tube failures for one of Thermal Power Plant in Maharashtra State of last ten years is referred. The plant is of 210 MW generation capacity with the prime fuel used as pulverized coal. Major four areas of boiler are identified i.e. Water wall, Economizer, Repeater, and Final super heater and the tube failure occurred in different zones with the loss in generation on account of tube failures were studied. Based on the data, it was found around 30% of failures occurred in Water wall and Economizer zone.

Table: 1 Failure history of Boiler tubes of past five years.

Sr. No	Year	Total BTL	ZONE					
			Water wall	Economizer	Reheater	Final Super heater	LT. Super heater	Gen .Loss (MUS)
1	2004-05	15	4	5	1	2	3	214.71
2	2005-06	12	8	2	0	1	1	191.98
3	2006-07	10	1	4	0	2	3	115.53
4	2007-08	7	3	2	0	1	1	61.63
5	2008-09	12	2	4	2	1	3	133.9
TOTAL	**5**	**56**	**18**	**17**	**3**	**7**	**11**	**717.75**

Modern Techniques To Arrest Tube Leak :
D-metering: Conventional
Oxide scale measurement
Remote Field Electromagnetic Technique (RFET)
Low Frequency Electromagnetic Technique (LFET)
Time of Flight Diffraction
CFD Modeling and CAVT testing
CAVT (Cold Air Velocity Test) TESTING
Robotic Inspection Using Magnetic Flux

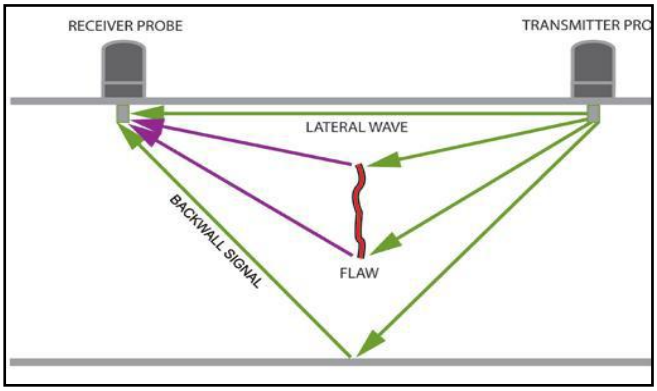


Fig.9 Time of Flight Diffraction Baroscopic Inspection

Monitoring Techniques :
Temperature excursion monitoring
Five Core Chemical Parameters (pH,Na,DO,NH3 & PO4)
Dissolved Oxygen In Condenser/Dearator
Asld Installation (Acoustic Steam Leak Detection)

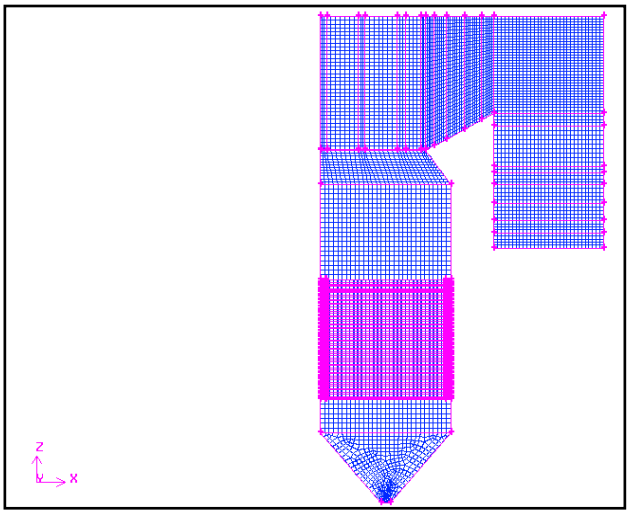


Fig. 10.CFD Modeling and CAVT testing

None of the prior art methods work well due to poor model conformity and derisory fault tolerance. For example the acoustical method which finds the noise made by the leaking water must face the noisy environment present in the power house. Therefore, the result of the prior art methods furnish either frequent false alarms or real tube leaks that are not identified. These conventional methods may detect a tube leak, if it is big enough and could take as much as 72 hours for detection. There are many instances in which thermal power plants have been allowed to run for extended times with un-detected tube leaks due to confusion with absence of advanced monitoring system.

Proposed Techniques:
As shown in above figure the various parts of the boiler like RH, Pl, SH & div SH & economizer area comprise tube banks vulnerable to leakage. So common / general small scale experimental set up can be fabricated with required mountings and attachments having identical pressure temperature condition so that leakage can be arrested and further processed as thought in outline of proposal.

So in this paper it is proposed to get aid or adopt such technique whose reveled results are uninterrupted that alert at very early stage of inception of leak and propagation of the same before causing damage to adjacent parts. For that as proposed

earlier model/prototype can further be attached to some device which would arrest leakage signal and that could further be analyzed as shown in fig below.

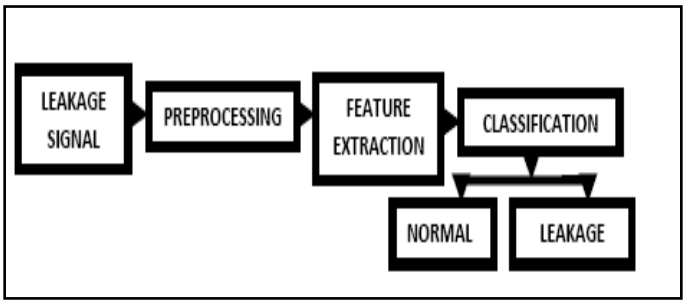


Fig. 11 Schematic of the diagnostic method

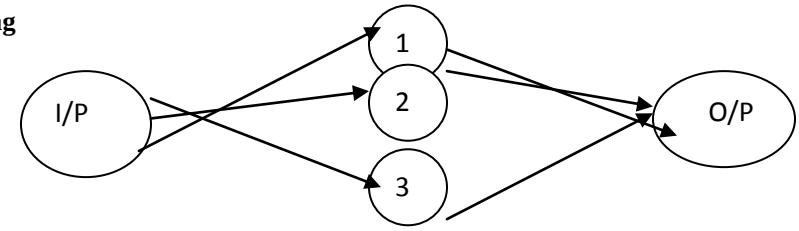
Fig. 12 Schematic of the diagnostic Model

METHODOLOGY

[1] ANN

In order to acquire the acoustic leakage signal, a lab setup model is designed in such a way that the air leakage from the tubes resembles the steam leakage in the boiler tube.

Data recording and preprocessing
Feature extraction
Energy
Entropy
Statistical features



Classification
The categorization of leakage or background is done by using artificial neural network. Neural networks are being used to analyze leakage signals for the detection of spikes. For identifying the leakage in boiler tubes, the features like Energy, entropy and statistical features like mean and minimum are given as input to ANN. Neural networks are a proven, widely used technology to solve such complex classification problems. In this work, it is proposed to find and use a neural network suitable for identifying boiler tube leakage.

METHODOLOGY

[2] FREQUENCY SHIFTING

As a leak develops in a boiler tube, turbulence by escaping fluid generates pressure waves within the contained fluid itself, throughout the flue gas into which the fluid is escaping, and within the container structure. These are commonly referred to as airborne, and structure-borne acoustic waves, respectively. To detect leaks, the energy associated with these mechanical waves are converted into electrical signals with a variety of dynamic pressure transducers (sensors) that are in contact with the medium of interest. Several methods of signal processing are available that allow the voltages generated by these sensors to be evaluated for the presence of a leak. As mentioned above, leaks in a boiler tube generate sound waves in three media. The decision regarding which types of acoustic waves are most reliably detected is important from both functional and economical considerations. This decision, in some cases, is not simple. Factors such as background noise level, sound attenuation within the medium, signal processing strategy, and installation costs play a role.

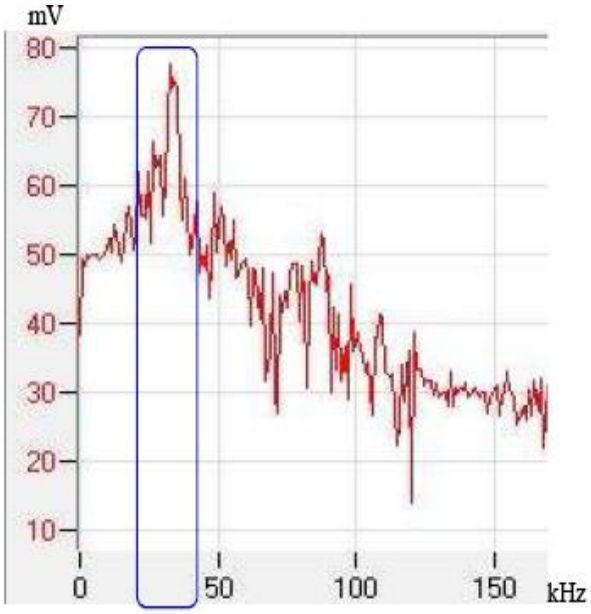


Fig 13 : Spectrum for Normal Operation

Fig 14 : Spectrum for Leak at pressure chamber

Frequency shifting has happened above 50kHz in pressure leak. Therefore, monitoring frequency band above 50kHz is essential to decide leaks. Applying frequency analysis function in tube leak detection system is important. Providing frequency figure in monitoring system can improve detection ability than monitoring noise intensity(dB). With checking out frequency shifting bands and RMS signals, we can confirm tube leaks.

An important part of this monitoring ability deals with early detection of leaks in boiler tubes. In utility boilers, early detection of leaks is primarily a financial issue. High pressure steam escaping from a tube leak can cause extensive damage to the adjacent tubes, which increases repair costs and outage length (hours).

CONCLUSION

In this study the features of the acquired signal from the prototype is extracted, filtered using a Gaussian filter and trained in a neural network and the following observations were done. When there is a leak the energy level of the acquired signal is higher compared to the background noise signals. From this we infer that the leak is present nearby. As the size of the leak increases the energy level of the signal decreases which shows that the leakage is present at a limited distance.

In airborne applications, microphones or low frequency resonant piezoelectric transducers are coupled by hollow waveguides to the gaseous furnace medium. Most leak detection system usually attach waveguides through penetrations in inspection doors, unused soot-blower ports or the casing. The structure-borne method of leak detection has found applications in valves and pressurized pipelines. Under a recent Electric Power Research Institute (EPRI) sponsored project, a high frequency structure-borne approach was found to be the best method for detecting leaks in feed-water heaters.

Some of the benefits that can be obtained by implementing these techniques are increased personnel safety, early warning small tube leak can prevent extensive damage, Increased availability and increase in plant efficiency, reduce repair time and safeguard your investment, planned and orderly shutdown by boiler, increased operating profits and saving of fuel due to planned and scheduled shutdown. In view of the foregoing we can find out the leakage using intelligent technique.

REFERENCES

[1] U.S. provisional patent application Ser. No. 60/511,998 filed on Oct. 16, 2003, entitled "A Method For Detecting Leaks In Tubes Of Steam Boilers" US 7113890 B2

[2] International Journal of Computer Applications (0975 – 8887) Volume 84 – No 16, December 2013 "Automatic Detection and Analysis of Boiler Tube Leakage System"

[3] Bjorn Widarsson, Erik Dotzauer, "Bayesian network-based early-warning for leakage in recovery boilers," Applied thermal Engg 2008, vol.28, pp. 754-760.

[4] Er Ashutosh Kumar Gupta , Lamar Stonecypher , "Boiler Tube Leakage detection by Acoustic Instrument in Thermal Power Plant", http://www.brighthubengineering.com, 2010

[5] Frequency Shifting Signal Detection And Analysis Of Boiler Tube Leaks. 18 th International Conference On Composite Materials

[6] EPRI, "Recent Advances in the Application of Acoustic Leak Detection to Process Recovery Boilers TAPPI Engineering Conference September, Vol. 1,pp 2-3, 1995.

[7] "L Zhanga, V Sazonova, J Kenta", Overview of steam generator tube degradation and integrity issues, Engineering and Design Volume 194, Issue 1, November 1999, Pages 19–30

[8] "Use of Cold Air Velocity Test (CAVT) to Locate Erosion Prone Zones in Pulverized Coal Fired Utility Boiler, P R Dhamangaonkar, S R Kajale, M R Nandgaonkar, 2011 Vol III WCE 2011, July 6 - 8, 2011, London, U.K.

[9] A Brief Description of NDT Techniques A Paper By Mark Willcox & George Downes

