COMPARISON BETWEEN CREEP FAILURE ANALYSIS AND MAGNETIC BARKAHUSEN NOISE RESULTS

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Abstract:

On this work we compared the results obtained after a conventional creep failure analysis and magnetic Barkhausen noise. We chose one region without creep damage that was named as standard. Two other regions with creep damage were named as T1 and T2. The sample T1 after optical metallographic analysis has presented level A and B of creep damage according the method of Neubauer[1] to estimate the rest life of creeping by replicas. The sample T2 after optical metallographic analysis has presented level C and D of creep damage according the same method. After the above failure analysis we procedure the MBR analysis and compared the results.

Keywords: Creep, failure, Barkhausen, rest life.

1. Introduction

Creep damage is the root causes of many failure equipments on heavy industries that work at non conventional temperature, specially boilers and furnaces. It's very difficult detect regions with creep damage by others conventional NDT methods. Replicas are the most used NDT technique to detect creep damage but this technique is statistics, superficial and do not cover the entire surface of tubes. The electromagnetic techniques are sensible to micro structural change that modifies the magnetic permeability of the material. As example of these promising techniques we can note remote field and magnetic Barkausen noise.

2. Procedure

We received one water wall tube sample from one boiler to determine its failure causes. After visual examination we took three cross sections to procedure metallurgical examination. We took one sample were on the visual examination the tube shows no damage, far from the damaged area, figure 1. We took two others samples in areas were the visual exams shows indications of the start and the end of failure, figure 2. The sample without any damage we call "standard". The sample we took at the start of the failure we call 'T1" and the sample we took at the end of failure we call "T2". The chemical analysis shows a chemical composition similar to a carbon steel ASTM SA-210.

Figure 1: Region without any damage.

Figure 2: Regions after visual exams shows the start and end point of failure.

As expected the "standard" shows a characteristic micro structure for carbon steel, figure 3. The sample "T2" shows a typical micro structure of final step of creep damage and level "C" and "D" of damage according Neubauer[1] classification, figures 4 and 5. The sample "T2" shows the initial step of creep damage and level "A" and "B" of damage according Neubauer classification. The figure 6 shows the creep failure curve and the Neubauer[1] classification.

Figure 3: "Standard" microstructure.

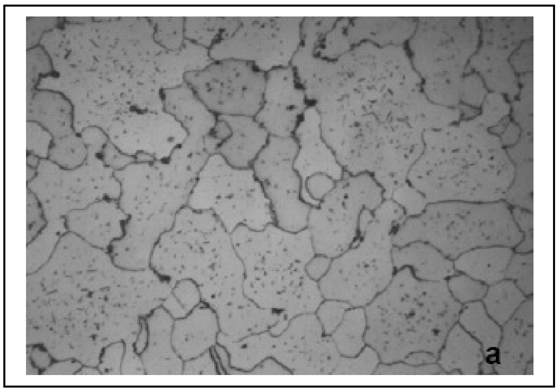

Figure 4: Sample T1 showing creep damage level "A" and "B" according Neubauer[1].

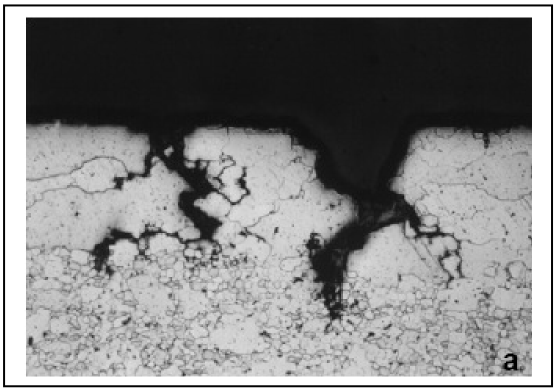

Figure 5: Sample T2 showing creep damage level "C" and "D" according Neubauer[1].

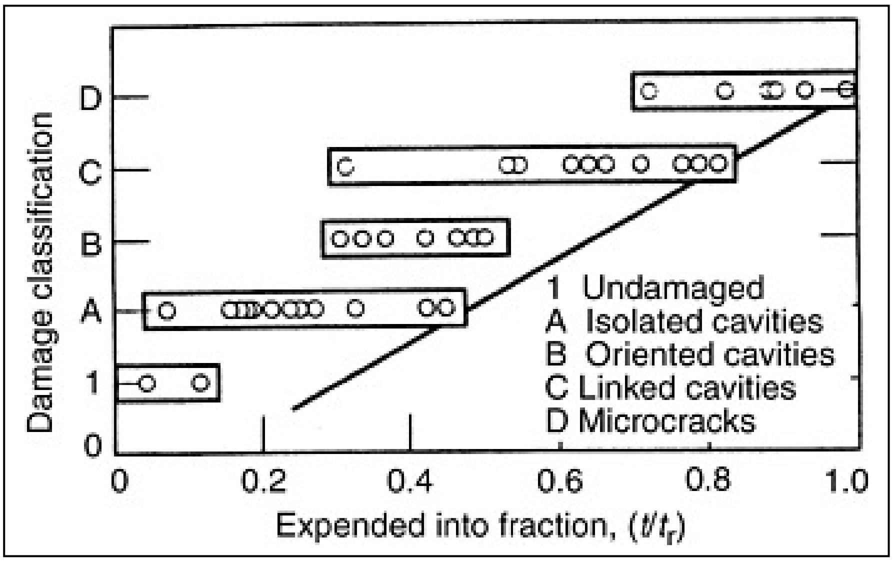

Figure 6 Creep failure curve and Neubauer[1] damage classification.

After metallurgical analysis to determine the root causes of failure we sent the samples to LADIN – Laboratório de Dinâmica, University of São Paulo to proceeding MBN investigations.

3. Results

The MBN results show a good correlation with metallurgical examination. We could verify that exist a signature for a non damaged sample and the start and end point of the creep damage. As the creep damage increase the energy associated to MBN decreases, figure 6.

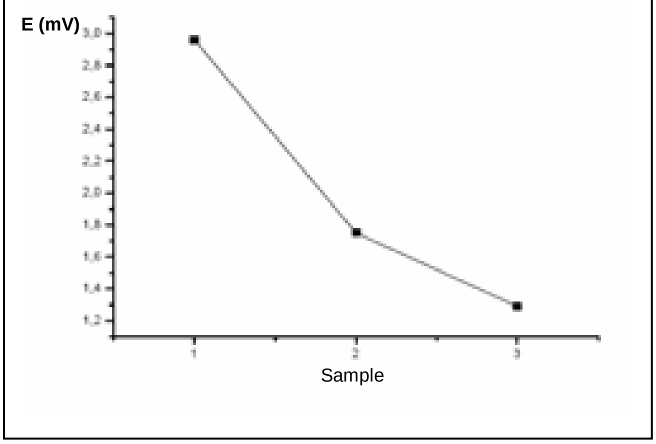

Figure 7: Creep failure curve and Neubauer[1] damage classification.

The loop shape is often associated with the material properties as strength, hardness and microstructure. Narrow loop indicates high permeability, low retentivity and low coercivity. Wide loop indicates low permeability, high retentivity and high coercivity. When we analyze the results isolated we can see clearly the changes in the MBN signal, such as a microstructure changes signature, figures 8, 9 and 10.

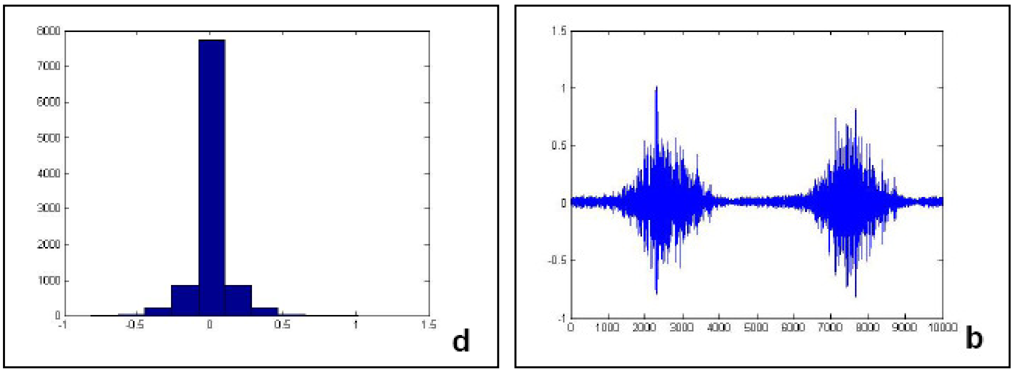

Figure 8: Statistical analyses and MBN signal for the "standard".

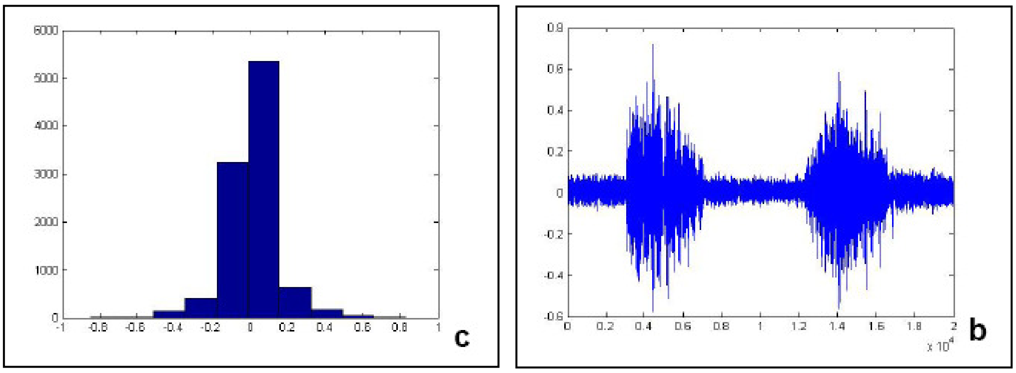

Figure 9: Statistical analyses and MBN signal for the sample "T1".

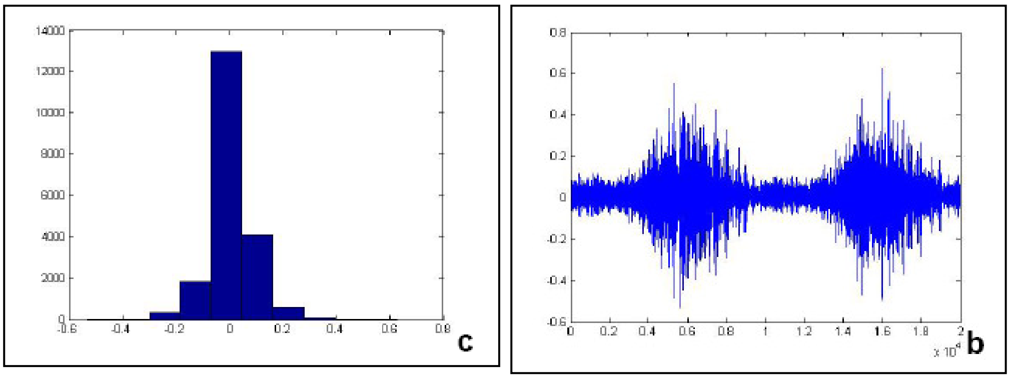

Figure 10: Statistical analyses and MBN signal for the sample "T2".

4. Conclusions

The MBN shows as promising NDT method for creep damage evaluation due his high sensitivity, simplicity of measurements and real time monitoring despite we have used a field sample were the creep damage levels, according Neubauer[1], could not be separated. The MBN signal shows it clearly when we treat statistically the results.

[1] Neubauer B. and Wedel U., ***"Restlife Estimation of Creeping by Means of Replicas"***, Advances in Life Prediction Methods, D. A. Woodford and J.R. Whitehead, Ed., American Society of Mechanical Engineers, New York, 1983, p 307 – 314.