ABSTRACT

Acoustic Emission Technique (AET) has significant merits and capability to characterize the dynamic phenomenon such as plastic deformation, oxidation and crack growth etc. This technique can also detect and characterize the process of spalling in oxide scales. In the present work an attempt has been made to characterize the acoustic emission signal generated during the high temperature oxidation of 2.25Cr 1Mo ferritic steel, which is an industrially important alloy used in high temperature heat-exchanger tubes and pressure vessels. Various parameters of acoustic emission signals obtained during breakaway oxidation, isothermal oxidation and in-situ spalling of this steel at various temperatures have been studied and results are discussed in relation to thermogravimetry and microscopy.

The onset of breakaway oxidation and in-situ cracking of the oxide scale formed on 2.25Cr 1Mo steel in air at 1173 K has been detected by acoustic emission technique. AE parameters i.e Events, Ring down Counts (RDC), Rise time (RT) and Event duration (ED) show negligible increase during isothermal heating at this temperature, until a point, where a sudden increase in AE activity is found. This point corresponds to the onset of breakaway oxidation. An enormous increase in AE activity after the start of cooling has been attributed to the separation of the scale from matrix as a result of thermal stresses arising during cooling. Peak amplitude distribution is measured and b-parameter is calculated which helps in distinguishing the phenomenon of isothermal oxidation at 1173 K and internal cracking of oxide scale taking place during cooling from 1173 K in terms of the amplitudes of the acoustic emissions released.

Frequency spectrum analysis of AE signal obtained during breakaway oxidation and internal cracking of oxide scale of 2.25 Cr 1 Mo steel at 1173 K was carried out. Three regions namely pre-breakaway, post-breakaway and internal cracking were distinguished and confirmed by thermogravimetric analysis and Scanning Electron Microscopy (SEM) observations. It was observed
that three different regions showed three different characteristic patterns. Frequency spectra based upon predominant frequencies were correlated with the physical phenomena happening during the course of oxidation.

The parabolic rate constants measured by plotting the square of the weight gain as a function of time shows increasing values of the constant with the increase in the temperature of isothermal oxidation. In addition, as the temperature of isothermal oxidation increases the AE event rate increases resulting in an increase in the total number of AE events generated. There is a non linear relationship between total AE events generated and parabolic rate constants. Variation in the temperatures of oxidation does not show any variation in the RMS level of AE signal and in the b-parameter obtained from logarithmic cumulative peak amplitude distribution plot. Different event rates and subsequently the differences in total number of AE events generated are indicative of the increased rate of energy release with the growth of oxide layer formed at higher temperatures. Rate of energy release being higher for higher temperature oxidation and vice versa.

Amplitude distribution analysis for characterising the AE signal is utilised to study the phenomenon of spalling taking place when specimen is cooled from higher temperatures. The b-parameter obtained from logarithmic cumulative amplitude distribution plot differentiated the phenomenon of spalling in terms of its severity. A small value of 'b' corresponds more intense spalling and vice versa.