TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

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The mechanism of fatigue failures

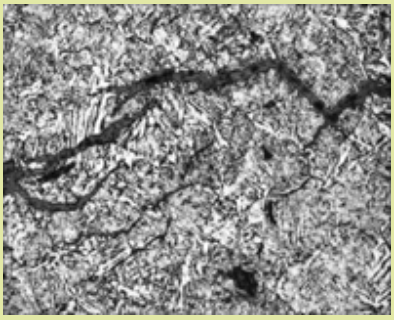
An insight.

Mechanical components satisfying mechanical strength criteria may fail at significantly low strength under the influence of phenomenon called fatigue. Historically many design disasters have happened by neglecting effect of fatigue. This article will highlight the prominent mechanism of fatigue failure.

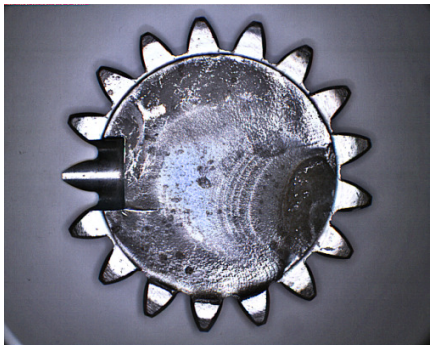
Fatigue damage results in progressive localized permanent structural change and occurs in materials subjected to fluctuation stresses and strain. It may result in cracks for fracture after a sufficient numbers of fluctuation. Fatigue fractures are caused by the simultaneous action of cyclic stress, tensile stress and plastic strain. With any one of these three is not present, fatigue crack will not initiate and propagate. The cyclic stress and strain start the crack, the tensile stress produces crack growth.

The normally fatigue fracture is identified by low magnification view and SEM examination. In low magnification view, the fracture looks relatively flat with no deformation at the contours. Presence of ratchet marks as shown in Fig below indicate the location of fatigue crack initiation which is normally between two consecutive ratchet marks. Often beach marks are also visible. Their nature and configuration along with the extent of fatigue fracture surface tells about extent of stress concentration and overall conditions depending upon the ductility of the material. The orientation of the fast fracture surface indicates the nature in which the fluctuating stresses are acting. SEM indicates presence of fatigue striations on fracture surface which are cured, parallel lines along with fairly zigzag nature as shown below.

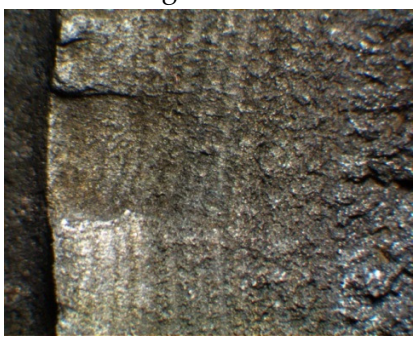
Microstructure of the Month



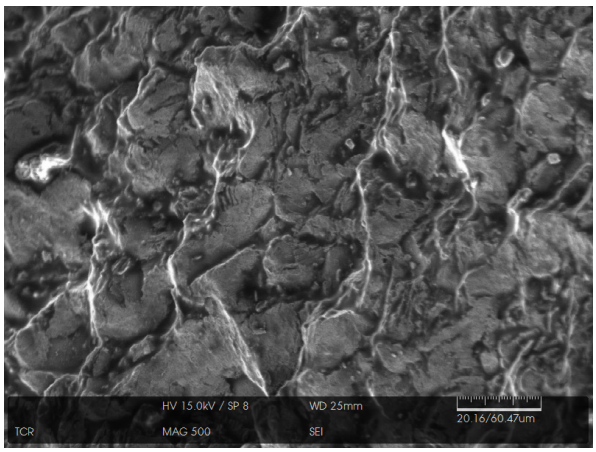
Magnification: *400X*
MOC: *ASTM A 516 Gr 70*
Component: *weld joint of nozzel and pipe or reboiler*
Observation: *Optical microscope image of weld indicates typical SCC filled with oxide scales.*
Cause: *The cracking at weld and HAZ region is on account of caustic stress corrosion cracking; substantiated by higher amount of sodium found in EDS analysis.*
Useful hint: *inadequate cleaning of component before the plating process can lead to poor adhesion in metallic coatings. It is advised to carry out precise hardness evaluation on weld and HAZ areas to find susceptibility of SCC. Areas having significant difference in hardness values between base metal to HAZ or weld should be subjected PWHT at an available opportunity.*

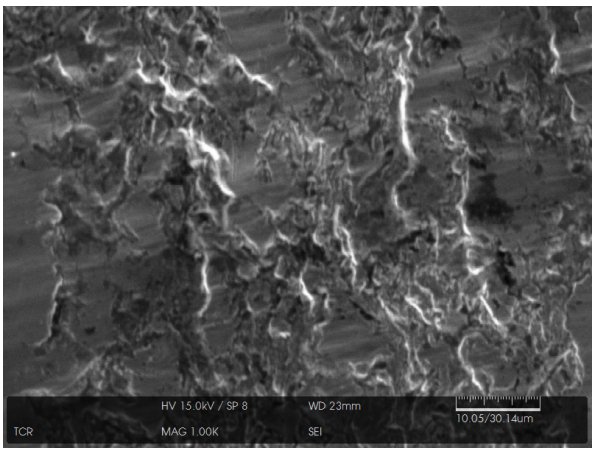


Low magnification view showing convex beach marks on fracture surface.



Low magnification view showing ratchet marks at fracture edge





SEM images of fracture surface showing fatigue striations

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