CATEGORY: ROLL SURFACE INDICATIONS

TYPE: LADDER TYPE FIRECRACKS

AFFECTS: WORK ROLL (HOT MILLS)

CHARACTERISTICS

Ladder cracking is characterized as a series of longitudinally aligned heavy cracks contained in a circumferential band typically present around the full barrel diameter. Ladder firecracks are mostly oriented in the longitudinal direction, however some degree of circumferential cracking may also be present connecting between adjacent longitudinal cracks. The cracks will be significantly larger and deeper (radially) than the normal fire crazing (section II.A) that will also be present. If the cracks are large and open enough, they can generate repetitive surface indications on the rolled product that correspond to the effected area of the roll surface.

EXAMPLES

Example 1

Longitudinally aligned cracks contained in a circumferential band at the barrel surface of a work roll. The cracks are aligned like the rungs of a ladder.

Example 2

Longitudinally aligned ladder cracks at the surface of a high chrome iron work roll. Cracks in this instance are tightly closed and only become readily visible with the use of magnetic particle testing.

MECHANISM

The mechanism for the formation of ladder type firecracks is similar to what was described for fire crazing, but to a much more significant degree and in a different orientation (see section II.A – Fire Crazing). During mill operation, a localized lack of or an interruption in coolant at the barrel surface results in localized and circumferentially oriented heating of the roll surface. As a result of this circumferential heating event, the temperature of the roll surface within the affected area will attain a much higher temperature and to a greater depth of penetration than that of the surrounding material. The higher temperature within the affected area results in an excessive degree of localized expansion of the roll material. Due to the restriction of this expansion by the surrounding cooler roll material, a large degree of compressive stress will be generated within the affected area.

If the affected area is then exposed to water from the roll coolant system while still significantly hotter than the surrounding roll material, rapid cooling and contraction of the heated surface layer will occur resulting in the formation of fire cracks.

The severity of the cracks that form for a given roll material are dependant on the localized increase in temperature, the tempering temperature used during manufacturing, rate of cooling and depth of heat penetration (this being determined by how long the affected area was exposed to a lack of or an ineffective spray during rolling) and the rate of cooling there after. Extended exposure times without any coolant spray followed by rapid water cooling afterwards will result in a larger crack size that extends to a greater depth (radially).

PREVENTION

Localized lack of roll coolant typically results from blocked coolant nozzles or an incorrect spray pattern. Typically ladder cracks will form with greater depth than that of stall band firecracks.

- If ladder cracks are observed then the spray header assembly should be inspected for correct alignment, pressure and volume. The sprays should be inspected to ensure that no blockages or heavy wear of the nozzle is present.

- It is strongly recommended that this type of cracking be entirely removed before further mill service. Due to the size, orientation and depth, ladder cracks are more affected by the shear and contact stresses generated during mill operation than fire crazing or stall band fire cracking. If not completely removed, ladder firecracks are therefore more likely to propagate at a rapid rate via fatigue deeper into the rolls cross section with continued mill service until eventual spalling occurs.