Resulfurized Billet Round Cracks

Question

In as cast rounds of 220 mm diameter we are facing sub-surface cracks in medium carbon resulphurised steel grades i.e. with Sulphur up to 0.035 %. The crack is located 10 to 15 mm below the surface. Casting speed range is 1.1. to 1.2 m/min. What needs to be done to overcome the crack problem. Please advise. SSK, India

Answer

The depth of the crack below the round surface is one indicator as to the source of the cracks. Cracks cannot occur in liquid steel. So your cracks must be forming sometime after solidification. Cracks occurring 10 to 15 mm below the surface indicate that the crack formed in the round billet in the bottom half of the mold or just below the mold. Examine a deep macro etch to determine if the crack ends in the chill zone. If the crack does not stop in the mold chill zone then the crack formed after the billet round left the mold. Look for additional smaller cracks. A sulfur print may be useful but not as good as looking at a deep macro etch. A comprehensive failure analysis study including surface fractography helps to determine the nature of the crack.

A factor pointing to the source of the crack is orientation. Cracks can be longitudinal, transverse, crazed or random. The orientation of the crack indicates the vector of stress application. At high temperatures, cracks normally occur due to an applied tensile stress rather than compressive force.

There have been numerous studies of mold and sub mold solidification in cast sections so that quantitative data is available to determine the shell thickness at various points below the mold. Various factors influence the shell thickness: liquid steel tundish temperature, cast speed, steel chemistry, type of mold powder or lubricant in use and spray water pressure, flow, distribution and atomization. Shell thickness can be used as a tool to determine if spray water flow conditions are causing crack formation.

Sometimes a simple change in tundish temperature, spray water conditions or caster speed may help to eliminate subsurface cracks. Other sources or the cracks may relate to the strand alignment, strand support, mold alignment or mold wear. A mold

gregdressel@dresseltech.com

with extensive wear at the bottom indicates a strand alignment or strand guide problem.

An operator always needs to make sure that a billet encounters uniform cooling just below the mold. Inspect the spray ring and first zone to make sure there are no clogged nor missing spray nozzles. One trial would be to reduce to spray cooling at the top of the spray ring and let the billet surface go to a higher temperature. This is usually accomplished by changing to lower flow spray nozzles rather than just reducing the flow at a valve. Lower tundish temperatures will also help reduce the chances for internal crack formation.

In general, to eliminate subsurface cracks, one can either remove the source of the stress or improve the high temperature strength of the material to better resist crack formation. A 0.035 % S level adds to the chances for internal crack formation. While changing the level of sulfur or further modifying the grade specification may not be permitted, looking for and eliminating sources of internal stress will help to eliminate internal cracks. The simplest steps are to reduce the tundish temperature and then change the spray ring and first zone flows and pressures.

gregdressel@dresseltech.com