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A VIEW FROM THE PENTHOUSE: USEFUL INFORMATION FOR THE WORLD OF BOILERS

DYNAMITE DAMAGE

In a coal-fired boiler, the combustion characteristics (heat content, % volatiles, etc.) and the ash content and composition (especially the ash-fusion temperature) determine the size of the furnace. The chemical make-up of the ash, often the amount of sodium and potassium, defines the melting or softening temperature. Usually the higher the sodium and potassium, the lower the ash-fusion temperature. To prevent fouling, fly ash should be "cold enough" as it enters the superheater and reheater so it does not stick to the steam-cooled tubes. Thus, the height is adjusted so that the temperature of the gas exiting the furnace is less than the ash-fusion temperature. Under these temperature conditions, the fly ash is delivered to the convection pass as fine solid particles. The deposit build-up remains friable and easily removed. Periodic use of sootblowers can then maintain the heating surface free of ash deposits and keep heat-transfer within the design range. The furnace is uniquely designed for a particular coal.

A change in fuel, especially to one with a lower ash-fusion temperature can lead to slag and clinker formations within the superheater and/or reheater. When the temperature of the gas exiting the furnace is higher than the melting point of the ash, the fly ash is deposited as molten droplets onto the tubes in the convection-pass. When the droplets freeze on the steam-cooled surfaces, the resultant sintered deposit is hard, glassy, and cannot be removed by sootblower use. Large clinkers may then develop.

Control of clinker formation and removal of these slag masses becomes an on-going problem. The use of shotguns is a frequent method for destruction of clinkers. Under most circumstances, damage to the pressure parts by this slag-removal technique is minimal. Occasionally a lead pellet will lead to a steam leak, especially in the thinner tubes of the reheater. Thicker tubes of waterwalls and superheaters are seldom damaged beyond a slight dent. However, the use of deer slugs for the removal of particularly stubborn slag accumulations can lead to sizeable holes if the slug scores a direct hit on a relatively clean tube. The development of these leaks then forces the unit off-line for a repair. Damage from projectiles is often neat, nearly round holes. Traces of lead from the slug can be detected on the rim of the hole by careful energy dispersive x-ray (EDX) analysis.

The use of dynamite to remove particularly large or stubborn clinker formations is also a common practice. Damage to the superheater or reheater is usually limited to distortion of the tube bundles. Any gross distortion will compound the clinker-formation problem by changing the bundle spacing, however. The change in spacing may lead to lanes and fly-ash erosion; as the more closely spaced pendants fill with ash. Occasionally steam leaks develop at broken alignment clips or other attachments.

Distortion of bundles from dynamite damage is usually obvious, and leaks become obvious during hydrostatic testing or shortly after start-up when the steam leaks are visible. A more subtle, and certainly less obvious, form of dynamite damage occurs in the microstructure of the ferritic steel.

A typical microstructure for a carbon or low-alloy steel after some years of elevated-temperature service is ferrite and spheroidized carbides, similar to that shown in Figure 1.

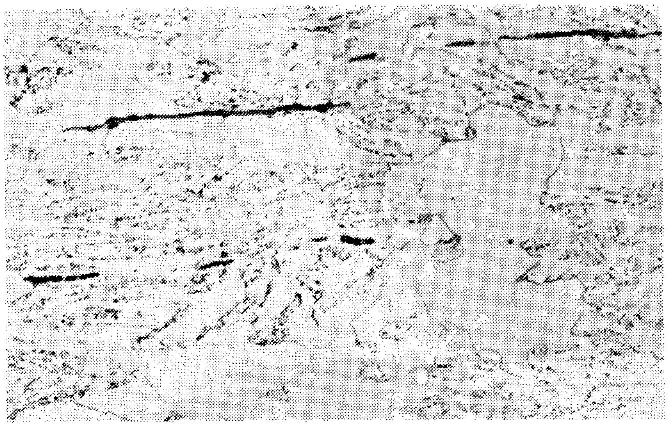

Figure 1

Here the microstructure is a mixture of ferrite and spheroidized carbides with occasional large carbide-free ferrite grains. In older boiler tubes where the sulfur content tends to be higher than the modern steel-making practice, microstructures will contain the long, manganese-sulfide stringers, see Figure 1.

The impact from the shock wave of a dynamite blast leads to two types of microstructural damage. First, the formation of deformation twins within the ferrite; and secondly, the development of cracks at the manganese-sulfide stringers. Figure 2 shows the deformation twins, the nearly straight lines across the individual ferrite grains. The presence of these deformation twins is proof of the impact onto the ferritic tube. Deformation twins are fairly common in austenitic stainless steels and are readily formed by simple plastic deformation. In ferritic steels similar to carbon steel, T-11 or T-22, deformation twins do not form by simple plastic deformation but require a severe or harsh impact. The presence of these deformation twins is proof of impact damage.

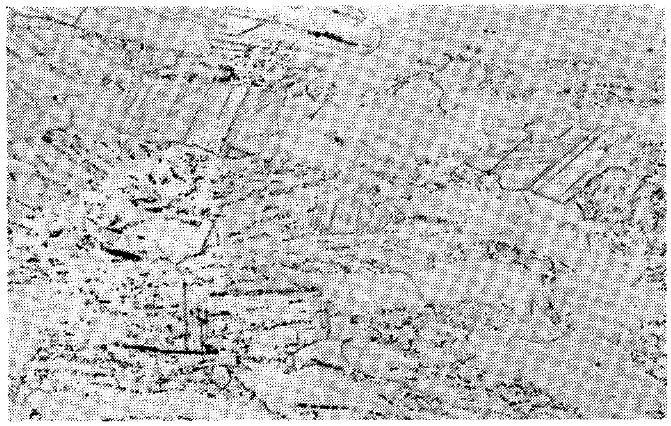

Figure 2

The shock waves running through the steel form cracks at and around the manganese-sulfide stringers, see Figure 3. While this damage may not lead to an immediate steam leak; the presence of internal cracks can propagate as fatigue or creep-fatigue damage later on and lead to a steam leak.

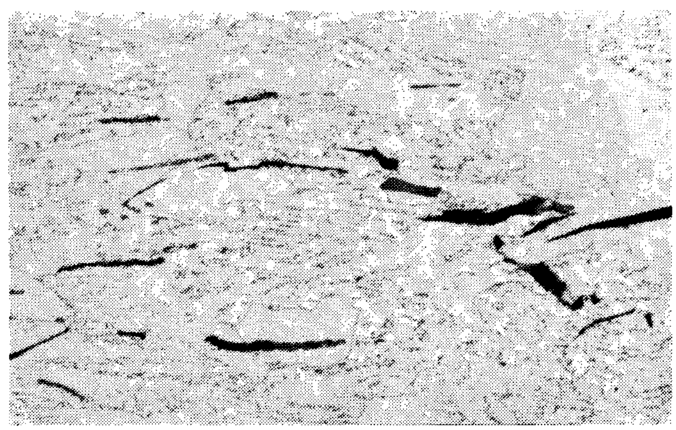

Figure 3

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