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Corrosion evaluation of one dry desulfurization equipment – Circulating fluidized bed boiler

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ABSTRACT

As a clean fuel combustion technology, circulating fluidized bed (CFB) possesses various advantages. Among them, flexibility in fuels and superiority in desulfurization are the two prominent ones and can hereby facilitate sufficient utilization of high-sulfur fuels. But unfortunately, these low-grade fuels always introduce harsh service environment within the CFB boilers and consequently result in severe degradation extent on relevant equipments, especially the high-temperature sulfur corrosion. In this event, by nearly ten characterization methods, comprehensive investigation was carried out on a whole CFB boiler during downtime, and special emphasis was particularly laid on the failure components including one perforated nozzle along with its fractured inlet tube for primary air, and one perforated manhole door of refeed valve. Finally, countermeasure and suggestion was put forward, which can provide instructive significance in corrosion prevention for the CFB boilers, even other desulfurization equipments, running under similar aggressive conditions in engineering practice.

1. Introduction

With the increasing demand for energy conservation and environmental protection, higher utilization of fossil fuels and lower emission of air pollution are presently the two prior concerns to fossil power plants. As for the former one, popularization of new-generation ultra-supercritical (USC) boilers is the most effective and attractive approach, and our previous work carried out an integrity evaluation of the dissimilar steels welded joints that are often encountered in these USC boilers [1]. With respect to the latter one (air pollution), the sulfur pollution, which commonly refers to the sulfur dioxide, is actually the most hazardous factor resulting in acid rain. So as to relieve the extent of this kind of pollution, there currently exist two common ways of desulfurization, one is the fluidized bed combustion (FBC) technology and the other is the flue gas desulfurization (FGD) process. FBC is virtually a type of dry desulfurization and desulfurizes simultaneously with combustion under dry condition in furnace, while FGD is a sort of wet desulfurization and needs specific exteriorized FGD equipments for desulfurizing amid wet condition. In fact, compared with the conventional fossil power plants, the most distinct advantage of FBC and FGD is their supreme flexibility in fuels, such as coal, oil, biomass, peat, petrol coke and so on, particularly for those low-grade fuels with high sulfur content [2,3]. Consequently, these two kinds of world-widely used desulfurization technologies are especially popularized in China in order to satisfy her natural condition of high reserves of low-grade coals [4]. Statistically, in the year 2008 over three quarters of total installed capacity of China was fossil power, and among which 66% (379 million kW) was from those plants installed with desulfurization equipments [5]. Hence, normal and safe operation of these FBC and FGD equipments is of critical importance for China [6].

Only in terms of the FBC, three variants have been evolved since its introduction in 1970s, including bubbling fluidized bed (BFB), circulating fluidized bed (CFB) and a hybrid type between BFB and CFB [7]. Among them, CFB is presently the most universal FBC technology thanks to its relatively higher combustion efficiency than BFB. Also for China, she now owns the largest amount and thermal capacity of CFB boilers in the world as well [8]. The unique feature of a CFB boiler compared with the conventional boilers is the added equipment called cyclone, which is used to refeed the incompletely combusted fuel particles and ashes back into the furnace for re-firing, i.e. the *circulating* function. As a result, fuels can be fully utilized and the sulfur in them can be sufficiently eliminated before being exhausted. In addition, configurations of CFB boilers usually vary according to different companies' designs, and the two leading ones are from Foster Wheeler (FW, USA/Finland) and GEC-Alstom (France) [4]. However in fact, high desulfurization efficiency commonly brings about harsh service environment for the CFB boilers at the same time, especially for those fire high-sulfur fuels like the petrol coke, and will consequently result in degradations on relevant equipments [9–15]. But actually, large amount of the past researches mainly focused on the heat transfer efficiency [16–19],

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