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SPECIAL SECTION: IMPACTS OF FUEL QUALITY ON POWER PRODUCTION AND THE ENVIRONMENT

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Impacts of Fuel Quality on Power Production and the Environment

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share of green electricity for the EU25 from 14 to 21% in 2010. Later, in 2005, the EU Biomass Action Plan was launched,

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Impacts of Fuel Quality on Power Production and the Environment

The history of fossil-fuel-based electricity generation shows that technology development, optimization of the steam-raising cycle, and fuel utilization were major aspects of concern up to about the middle of the last century (~1950). These efforts led to a serious reduction in specific fuel consumption, from 3.5 tons of coal equivalent (TCE)/MW_{th} in 1885 to less than 0.3 TCE/MW_{th} today, which, in turn, has resulted in a corresponding increase of total plant efficiency.[1]

The rapid growth of the economies after World War II and the following increase in the demand for electricity led to new areas of concern, e.g., increasing unit size and capacity, plant upscaling, and availability improvements, in particular when utilizing local fuels of variable quality. From 1960 to 1975, public electricity demand caused upscaling of unit capacities, and as a consequence, frequent unexpected outages of the boilers occurred. The major cause for this was the formation of ash deposits on heat-transfer surfaces. Other problems frequently encountered in utility boilers at that time were erosion and corrosion of heat-transfer equipment.[1]

The U.S. Clean Air Act Amendment of 1990 changed the utilization of coal for heat and power production. After 1990, utilities introduced scrubbers, low-NO_x burners, fuel switching, and fuel blending.[2] The Clean Air Act Amendments also changed the way utilities did business, because they were now looking to buy and sell emission credits, which could be tied to fuel purchases and fuel contracts. Fuel engineers were now not only focused on how to burn the fuel but also deeply concerned about slagging, fouling, corrosion, and erosion in boilers. Utilities looked not only at the heating value (MJ/kg) of a fuel but also the ash chemistry, grindability, and proximate and ultimate analyses, especially the contents of N, S, and Cl in a fuel.[2]

In addition to the changes in boiler operation caused by increasing demands, a liberalization of the energy market was suggested in the mid-1990s. Utility operations up to that time placed major focus on the reliability of thermal fuel conversion systems. Government regulatory boards and utilities cooperated closely to establish practices that best served the public, and in many cases, both bodies identified reliability as a more important consideration than economy. However, after 1995, many governments worldwide believed that electrical power rates could be lowered if the utility-monopoly structure was replaced by a deregulated, free-market structure of power generation. The U.K. first demonstrated such price reductions, and the State of California was leading the U.S. into similar practices.[2]

At the United Nations (UN) Change of Global Climate Conference in Kyoto, Japan, in December 1997, the environmental aspect of power production also came into focus, because emission of greenhouse gases was the major issue. For the first time ever, legally binding emission reduction target levels for greenhouse gases were established worldwide. According to the Kyoto Agreement, total emissions must be reduced by 5.2% by the year 2012. The European Union (EU) launched its RES-e directive in 2001, aiming at increasing the share of green electricity for the EU25 from 14 to 21% in 2010. Later, in 2005, the EU Biomass Action Plan was launched, aiming specifically at doubling biomass utilization for heat and power production by 2010.

Thus, several energy political changes have caused increased focus on utilization of cheap, low-quality CO_2-neutral fuels.

Utilizing cheap and low-quality, CO_2-neutral fuels may be problematic because of a number of potential operational and emission problems, including slagging/fouling of heat-transfer surfaces, corrosion, reuse of fly ash, formation and emission of sub-micrometer ash particles, etc. The main route between a burning fuel particle and troublesome deposits on a heat-transfer surface inside a utility boiler may be principally divided into a number of subsequent steps:[3] (i) release of critical ash-forming elements (mainly K, S, and Cl) during heating, pyrolysis, ignition, and subsequent char burnout of the straw, (ii) formation of aerosols by nucleation and eventual coagulation of flame-volatilized elements and formation and entrainment of residual ash (during char burnout), (iii) transport of ash-forming species, such as gases, liquids (droplets), and solids (particles), from the bulk gas to heat-transfer surfaces and adhesion of these ash species to the heat-transfer surfaces, and (iv) spatial buildup, sintering (maturation and consolidation), and shedding of deposits.

During more than 40 years, regular conferences on ash and corrosion research have been organized worldwide, addressing these ash-related issues, in the beginning, within the framework of the United Engineering Foundation (UEF).[2] The first conference was held in Marchwood, just outside Southampton in the U.K., in 1963. The last Impacts of Fuel Quality Conference on "Power Production and the Environment", was held in Puchberg, Austria, Sept 23–27, 2012, with Professor Franz Winter, Vienna University of Technology, as the chairman.

This special issue contains a number of high-quality papers selected by the Organizing Committee from that conference.

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Notes

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