Proceedings of the 10th World Congress on Civil, Structural, and Environmental Engineering (CSEE 2025)
Barcelona, Spain - April, 2025
Paper No. ICEPTP 124
DOI: 10.11159/iceptp24.124

Characterization of Fly Ash from Boilers Co-combusting Waste-derived Fuels and Coal for Utilization in Blended Cement

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Extended Abstract

In recent years, environmental issues brought about by climate change have been continuously evolving, leading industries to propose environmental measures aimed at reducing carbon emissions. Under the strategic promotion by the government, along with the benefits in reduction of carbon emission, waste-derived fuels have gradually become a popular and viable option for partial replacement of fossil fuels used in industrial boilers. However, the ashes produced from co-combusting waste-derived fuels and coal in industrial boilers poses difficulties for their utilization. This is because the physical and chemical characteristics of these ashes remain unclear, which in turn impacts the potential utilization of these co-combusted ashes. Current waste-derived fuels are mainly produced by dealers in waste paper, textile manufacturing wastes, and crumb rubber, with the majority coming from waste paper industry. The supplies of waste-derived fuels from these dealers vary, resulting in variations in the properties of the ashes produced. This study surveyed the current status of waste-derived fuel as alternative fuels for industrial boilers and investigated the characteristics of fly ash produced by co-combustion of waste-derived fuel and coal, with an emphasis on the potential of utilization as supplementary cementitious materials in blended cement.

Two fly ashes generated from circulating fluidized bed (CFB) boilers co-combusting coal and paper mill wastes were collected and evaluated for their chemical, physical, and thermal characteristics using X-ray fluorescence, X-ray diffraction, thermogravimetry, and scanning electron microscope. It was found that, comparing to the pulverized coal fly ash (PCFA) produced from power plants burning coal only, the varying operating variables in the co-combustion of waste-derived fuels with coal cause significant changes in the characteristics of the fly ashes produced. The particle size of co-combustion fly ash (CCFA) falls in the range of about 4 to 100 μm, and most particles of CCFA, in contrast to the spherical shape of PCFA, are granular and irregularly shaped, with a rough and porous surface texture. Then, the co-combustion fly ash (CCFA) was used as a partial substitute for cement (20% by mass) in preparing cement mortar for comparison with that made of the control (PCFA). The effects of CCFA utilization on the fresh and hardened properties of the prepared cement mortars were analyzed and their contribution to strength development assessed. Laboratory investigations including setting time, water requirement, soundness, and compressive strength were conducted. It was noted that CCFA produced by CFB boilers contained some amount of sulfate, resulting from the flue gas desulfurization process for reducing sulfur dioxide emission, and tended to delay the setting time of cement mortar. Also, the compressive strength of cement mortar containing 20% CCFA exhibited a relatively slower strength development with curing time, when compared with PCFA. The strength activity index of the CCFAs was found to be in the range of 68-75% of the control cement mortar at 28 days and increase with curing time, showing the characteristic of pozzolanic reaction. The results demonstrated that fly ash from the co-combustion of waste-derived fuel and coal has the potential to be utilized as supplementary cementitious materials in partial replacement of cement in making concrete.