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Air Toxics Emissions from Cogeneration Boilers by Applying Multiple Fuels in Taiwan

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Reducing the consumption of coal as fuel is a key strategy for net-zero carbon emissions policy in Taiwan. The government plan to reduce the consumption of coal in cogeneration and industrial boilers at first. Cogeneration units consumed 21.5 million metric tons of coal annually, which accounted for approximate 36 % of total consumption. There are 53 cogeneration boilers using coal as fuel, and 14 facilities using multi-fuels for many years. The multi-fuels included waste rubber, pulp and paper sludge, waste plastic, and RDF/SRF. However, the air toxics issue causes public concern while increasing the use of industrial waste as fuel in these boilers. This study investigated the variation in air toxics emissions, including heavy metals (As, Cd, Pb) and Dioxins, from cogeneration units in Taiwan while introducing industrial waste derived fuels to replace part of coal usage.

Based on the data among 2019 ~ 2021, the coal-fired cogeneration units contributed most emissions of target air toxics in cogeneration sector due to their great amount use of coal. But the emission factors showed a different profile. The emission factors (emission based on the input heat value of multi-fuels) of these four target air toxics are 5.5 g/Tcal (As), 1.1 g/Tcal (Cd), 12.1 g/Tcal (Pb), and 20.7 μg I-TEQ /Tcal (Dioxins), respectively, from coal-fired cogeneration units. The emission factors of multi-fuels cogeneration facilities were 9.7 g/Tcal, 2.7 g/Tcal, 35.3 g/Tcal, and 99.7 μg I-TEQ /Tcal, respectively. The results indicated that these four target air toxics emission factors of multi-fuels facilities are higher than those of coal-fired facilities. The ratios of emission factors for multi-fuels to coal-fired units are 1.76 times for Arsenic, 2.45 times for Cadmium, 2.92 times for Lead, and 4.82 times for Dioxins. Research shows that higher emission factors of air toxics in multi-fuels units could be attributed to the complexity of industrial waste compositions and the emissions without effective control. The results also showed great variation of air toxics emission factors among multi-fuels units. It may be caused by the same reasons.

This study also investigated the emissions and air pollution control devices (APCDs) for two multi-fuels facilities. Process B uses solid derived fuel (SRF) as the major fuel (input heat value 79.2%) and uses waste rubber as minor fuel (input heat value 17.0%). The APCDs include bag filter and WFGD. The emission factors are 0.56 g/Tcal, 1.17 g/Tcal, 19.29 g/Tcal, and 58.3 μg I-TEQ /Tcal, respectively, which are 0.06, 3.08, 0.55, 0.58 times of the average emission factors of all multi-fuels systems. Process B has relatively high emission of cadmium. Process C has been designed to use various industrial waste as fuel. The input fuels are quite diverse, included RDF (73.8%), bituminous coal (14.1%), waste rubber (7.1 %), pulp and paper sludge (3.1%), and waste wood (0.7%). RDF made of waste from papermaking process, cartons, packaging paper, etc. The APCDs include LNB, bag filter, and WFGD. The emission factors are 6.73 g/Tcal, 6.12 g/Tcal, 8.18 g/Tcal, and 53.3 μg I-TEQ /Tcal, respectively, which are 0.69, 2.27, 0.23, and 0.53 times of the average emission factors

of all multi-fuels units. Process C also has relatively high emission of cadmium.

Research shows that cogeneration units use industrial waste as multiple fuels to reduce the consumption of coal will increase emissions of air toxics. The ratio of multiple fuels and the composition of alternative fuels influenced the emission profiles significantly. Potential impacts on environment and public health by air toxics in the neighborhood and effective emission control system should be further studied before adoption of the policy.

[1] Bureau of Energy, Ministry of Economic Affairs, Taiwan, R.O.C. **2022.**

[2] Y. M. Kuo, S. W. Huang, W. Y. Kuan, *AAQR*, **2021**, 21(11):210112