Determination of biomass-coal blending ratio by ^{14}C measurement in co-firing flue gas

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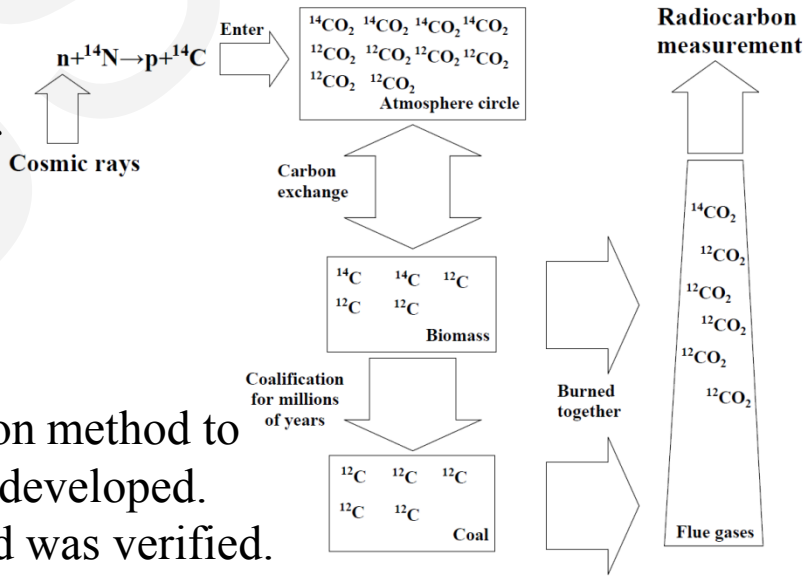
Background

- Biomass-coal co-firing is an attractive technology for reducing carbon dioxide emissions from coal power plants.
- Government in China need a reliable method to measure the biomass blending ratio for regulating the economic subsidies for power station
- ^{14}C detection is a mature technique used to identify biogenic and fossil carbons. It has been widely used for the detection of ^{14}C activity in the atmosphere, biogenic industrial products, waste incineration power plants et.al.
- In this study, a ^{14}C analysis and calculation method to ascertain the biomass blending ratio was developed. The usability and accuracy of this method was verified.

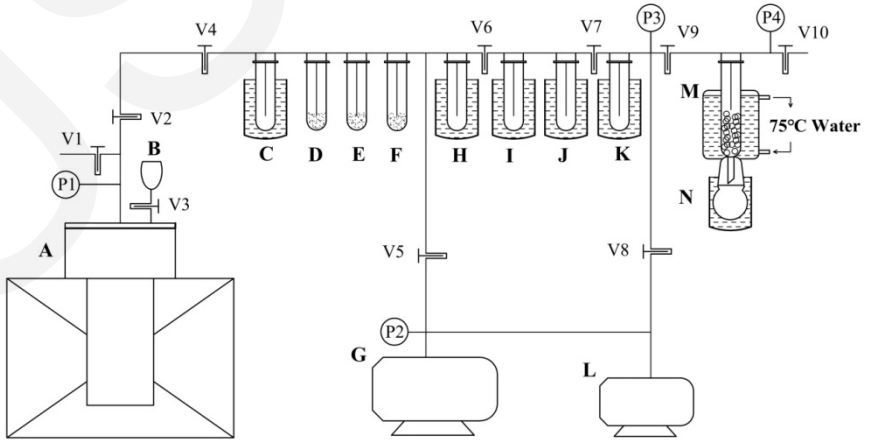


Method

- ASTM (2016) recommends three methods for sample preparation and measurement of ^{14}C activity: AMS, CO_2 absorption amine and benzene synthesis. .

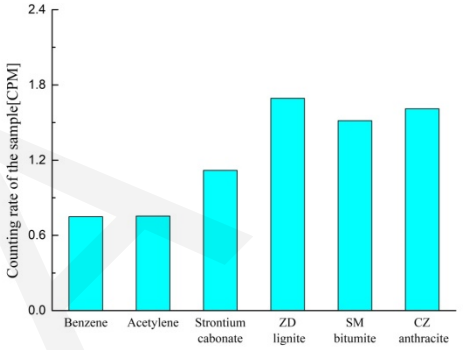
- Considering the accuracy and test cost, in this study benzene synthesis system was built to preparing the ^{14}C sample.

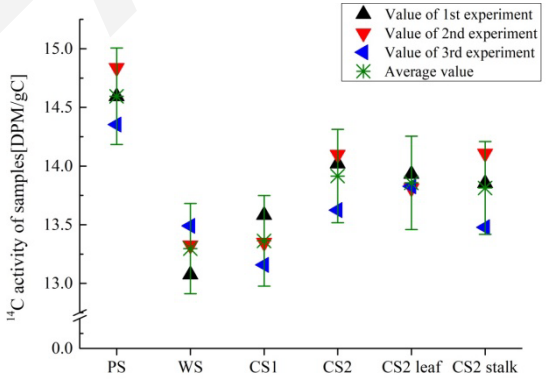
- Benzene synthesis system: A—reaction vessel and furnace; B—separating funnel; C, H—water traps; I, J, K—liquid nitrogen trap; L—diffusion pump; M—catalyzer heated in a water bath; N—benzene trap and a collection bottle; V1~V10—valves; P1~P4—vacuum pressure gauges

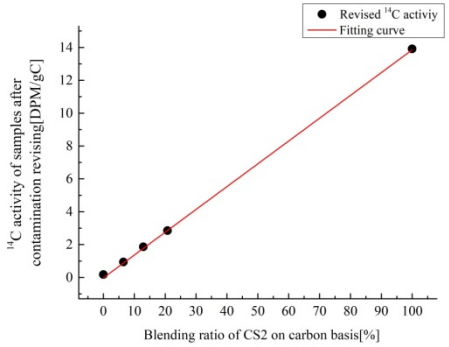


Results

- The ^{14}C test value of spectrum grade benzene is the instrument background, affecting all benzene samples. The ^{14}C test value of a benzene sample made from commercial $SrCO_3$ reveals the effects of contamination induced by the sample preparation process.
- Each biomass sample selected underwent three separate benzene synthesis and testing processes. The measurement points of each biomass sample fell within the error, suggesting that the ^{14}C measurement method built in our laboratory is reliable and accurate.
- The calculated values of the biomass-coal blending ratio obtained from the flue gas ^{14}C activity test are consistent with the given values.







Conclusion

- The ^{14}C value of spectrum grade benzene revealed the instrument background activity, and $SrCO_3$ revealed the contamination in the preparation process. The test ^{14}C activity of coal sample was not negligible when using the benzene method.

- The independent repetitive experiment proves the stability of the benzene synthesis and measurement system designed in this study. The difference in ^{14}C activity between plant types and between plants of the same type from different areas was significant, and would require more work in particular applications.

- A modified empirical expression based on ^{14}C activity measurement in the co-firing flue gas was proposed, considering the effects of coal ^{14}C activity. The absolute measurement error was about 1% for a typical biomass-coal co-firing application.