AMMONIA CARBONATION AND BIOMASS PYROLYSIS FOR CARBON MANAGEMENT

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The increasing anthropogenic CO_2 emission and global warming have challenged the United States and other countries to find new and better ways to meet the world's increasing needs for energy while reducing greenhouse gases. Here, we present an integrated technology concept for global CO_2 sequestration and environmental protection through ammonia carbonation and biomass pyrolysis. The systematic ammonia-carbonation-based approach invented at ORNL integrates fossil energy systems (such as a coal-fired power plant) with CO_2-sequestration by solidifying flue-gas CO_2 into solid NH_4HCO_3 products.[1, 2] Our recent experimental studies demonstrated that removal of flue-gas CO_2 can be achieved via formation of solid NH_4HCO_3 through ammonia carbonation in the gas phase.[3] In addition to solidification of CO_2, this process also has the potential capability to remove NO_x, and SO_x emissions. Therefore, the invention could simultaneously or selectively convert CO_2, NO_x, and SO_x emissions into valuable fertilizers [mainly, NH_4HCO_3] that can enhance sequestration of CO_2 into soil and subsoil earth layers, reduce NO_3^- contamination of groundwater, and stimulate photosynthetic fixation of CO_2 from the atmosphere.[4, 5] When this technology is in worldwide use because of its high efficiency and carbon credit, in addition to the benefit of clean air protection and stimulation of photosynthetic fixation of CO_2 from the atmosphere, maximally 300 million tons of CO_2 per year [equivalent to about 5% of the CO_2 emissions from coal–fired power plants in the world] from smokestacks can be placed into soil by the use of this technology.[6] An equally exciting and significant approach has been developed at Eprida and NREL. This approach applies a pyrolysis process to produce char and synthetic gas (containing mainly H_2, CO, and CO_2) from biomass which could come from farm and forestry sources. The hydrogen from this process could be used to create ammonia that can be used by the above ammonia-carbonation process to remove CO_2 in both the flue gas and the synthetic gas. The char materials produced from biomass pyrolysis contains a significant amount of non-digestible carbons such as the elementary carbons

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that can be stored in soils also as sequestered carbons. Furthermore, the carbon in the char is in a partially activated state and is highly absorbent. Combination of char, nitrogen compounds (such as NH_4HCO_3 or urea) and other plant nutrients could thus result in a slow-release fertilizer that is ideal for green plant growth. Since both HCO_3^- and char are non-digestible to soil bacteria, an NH_4HCO_3-char fertilizer can be an effective product that could maximally enhance storage (sequestration) of carbons into soils while providing ideal "organic slow-release" nutrients for plant growth. Therefore, the combination of these two novel approaches [7] will provide an opportunity for fossil energy systems, farmers, and the fertilizer industry infrastructure to become the largest contributor to meeting Kyoto greenhouse-gas reduction targets.

References

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