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Today's energy landscape is—sadly—dominated by fossil fuel-supplied systems. Although globally there is a growing movement to phase out these polluting resources with renewable energy technology, this transition has been sluggish for many political and economic reasons. Imagining a limited but continued utilization of fossil fuels like coal in the future, it is still important to actively monitor how this source of energy can be better handled to minimize unnecessary energy waste.

This is why I was astonished to learn that of the confirmed 1055 billion metric tons of coal stockpiled in the world in 2018 (Tan et al., 2020; https://doi.org/10.1038/s41598-020-63988-4), a large portion is lost to combustioneach year while in storage or in transit. Coal, which is a different form of thecarbon used in many separations processes such as in our Fixed Bed Gas Adsorption lab, still has a high affinity for oxygen. The physisorption of oxygen in the nanopores of coal is an exothermic process, and becauseoxygen is also an excellent combustion fuel source for that very material, coal fires result and are difficult to handle.

Since the macroscopic adsorptive properties of coal have been well studied,Tan et al.decided to study the coal nanopore structure-function relationship to better inform oxygen physisorption mechanisms and perhaps limit coal waste.Using Mercury Intrusion Porosimetry (MIP), SEM, and Coal Oxygen Adsorption (COA), Tan et al. investigated five coal samples, each with a different degree of development and processing from coke, to determine total pore volumes and pore morphologies. It was found that less developed lignite coals had higher averaged pore volumes and therefore reversibly adsorbed less oxygen in their minipores (3-10nm in diameter) than did the more developed anthracite and bituminous coals. In addition, fractal dimensions, or measures of nanopore structural complexity, were assigned to each coal sample. Although it is said that these values vary by sample for the same type of coal, the authors claim that increased structural complexities (as in the more processed coals) lead to higher adsorptive capacities due to increased tortuosity and pore connectivity. Hysteresis in oxygen adsorption-desorption in the more processed coal types was also observed: because these coal types had characteristic ink-and-bottle type pores, desorption in such oxygen-saturated pores was inhibited.

The implicit conclusion here is that less processed coals will generally adsorb less oxygen and lower risks for spontaneous coal combustion. This study (at least in spirit) employed much of the same Solute Movement Theory alongside Langmuir isotherms we used in the analysis of CO_2 flowing through an activated carbon-loaded column. What I would like to see in this research is a more rigorous investigation of the structure-property relationships instead of a catch-all using the fractal dimension measures. Then perhaps the conclusions regarding how to process coal to keep it from combusting would be more measurable. I suggest that the authors also provide potential solutions to limiting adsorption once the coal is already processed, with something like soaking the coal reserves in cheap, non-flammable gases to limit oxygen adsorption. It is quite interesting that a resource so critical to separations technologies and the current global energy economy can be so dangerous in its own handling!