LETTERS TO THE EDITOR

To the Editor:

In "A Superstructure-Based Optimal Synthesis of PSA Cycles for Post-Combustion CO_2 Capture", A. Agarwal et al. calculate an optimal energy consumption for CO_2 capture using PSA (see Agarwal's Table 7). Their number for 85% CO_2 capture is 465 kWh/metric ton (tonne) of CO_2 removed. This is better, they say, than absorption processes that use 765 to 950 kWh/tonne of CO_2. A reasonable question is what percentage of a coal-fired power plant might this be? I use an independent path for calculating this. The following gives an estimate for a low-sulfur Montana bituminous coal

Heating value 21,980 kJ/kg (9,540 Btu/#)

Carbon content, w% 72.0

A typical heating rate for a coal-fired power plant is about 10,230 kJ/kWh (9,700 Btu/kWh). Using these numbers we calculate the tonnes of CO_2 from a 500 MW plant with no CO_2 control.

$$500 \times 1000 \times 10,230 \times 0.72 \times (44/12)/(21,980 \times 1000) = 614 \text{ tonnes } CO_2/\text{hr}$$

At 85% CO_2 recovery this is 522 tonnes/h. Using Agarwal et al. numbers, the energy associated with this is

$$522 \times 465/1000 = 243 \text{ MW}$$

This says that 243/500 = 48.6% of the original 500 MW is spent removing CO_2. To get 500 net MW, we would need a plant 1/(1-0.486) = 1.94 times larger. Our CO_2 removal based on the original plant size is 1–1.94 × 0.15 = 0.709 or 71%, not 85%.

For the numbers cited for the absorption processes the power consumed would be

$$522 \times 765/1000 = 399 \text{ MW to } 522 \times 950/1000 = 496 \text{ MW}$$

This would be 79.8–99.2% of the original power output. This is only for CO_2 capture and does not include sequestration, e.g., compression to perhaps 2000 psig (138 bars). I believe the absorption costs quoted are erroneously high.

If instead of a low-sulfur western coal, we had used a high-sulfur eastern coal with a heating value of 29,170 kJ/kg (12,540 Btu/#), and 74 wt % C, the 500 MW plant would have emitted 476 tonnes CO_2/h. The attendant power requirement would have been 0.85 × 465 × 476/1000 = 188 MW. This is about 38% of the power plant output. This is somewhat better, but still probably unacceptably high, especially since this is before compression costs.

If these calculations are correct, these energy requirements are probably prohibitively high. In light of the apparent erroneous numbers for the absorption processes, I would appreciate the author's comments.

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