NPRE Tuesday February 15

History continued

Electricity direct from coal: current power plants from coal very inefficient (~40%) even before transmission. In electrochemical process you can extract electrons directly rather than burning which relies on the carnot cycle (efficiency: 1-Tc/Th). Carnot efficiency is limited by Th, which must be kept below the melting point of the furnace wall. Past designs for coal fuel cells have had carbonate electrolytes. An undesired side effect is the production of carbon dioxide.

Bar and Bruner: Developed mechanical device to prevent flooding of electrodes in a coal fuel cell using a magnesium oxide porous diaphragm to segregate the coal with an iron oxide electrolyte around the outside

Solid Oxide Fuel Cell: Advantage- no fluid electrolyte = no flooding. However, finding an electrolytyte with low resistance to ion conduction is very difficult. The polarization effect also limits the efficiency of solid oxide cells –at higher currents ions build up a space charge on the boundary of the electrolyte and cause higher resistance. Other issues include cost, durability, and availability. For instance, Westinghouse developed a tubular design that worked exceedingly well, but relied on platinum electrodes (too expensive)

Alkaline Fuel Cells: Early concern- alkaline electrolyte would degrade electrodes. Advantage- can use electrodes besides noble metals with less risk of corrosion than in acid solutions. Need electrode materials built into structures to prevent flooding. Thomas Bacon- worked on the principle that having a reversible reaction would help avoid irreversible heat loss. Pratton Whitney – developed fuel cell to power Apollo space missions. Space missions made fuel cells known in mainstream culture.

Fuel Cell Fundamentals – Energy is the integral of power. Gravimetric vs. volumetric energy densities can be very different.