SOLAR THERMAL RECYCLING OF SOLID WASTE MATERIALS

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Abstract - The treatment and recycling of complex solid waste materials require high-temperature energy-intensive processes that release vast amounts of greenhouse gases and other pollutants derived from the combustion of fossil fuels for heat and electricity generation. Alternatively, concentrated solar radiation can supply clean thermal energy at temperatures exceeding 1500 K for driving these highly endothermic processes. Waste materials containing carbonaceous compounds can be converted by thermal pyrolysis and gasification into synthesis gas and hydrocarbons, while waste materials containing metal oxides can be converted by carbothermal reduction into metals, metal nitrides, and metal carbides. Thus, the chemical products from such transformations can be used as feedstock for a variety of manufacturing processes, or can be used as clean fuels. Two important sources of wastes contaminated with heavy metals are considered: 1) EAF (electric arc furnace) dusts, and 2) automobile fluff. The chemical equilibrium composition of these complex materials and the energy required to process them, using carbon (from coke) or methane (from natural gas) as reducing agents, are computed for temperatures in the range 300–2000 K. The chemical boundary conditions for the solar reactor engineering design are determined. The use of concentrated solar energy as the source of process heat offers the possibility of converting waste materials into valuable commodities for processes in closed and sustainable materials cycles.