Enhanced Pyrolysis for Converting Polystyrene or Cellulose Polymers

Daniel J. Kathios

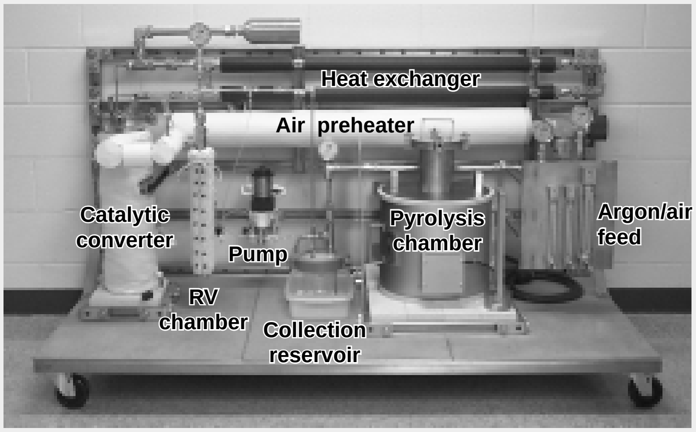
Enhanced pyrolysis results in substantial decomposition of solid polymeric materials. This technology was a direct outgrowth of 94-1 Research and Development, a part of which tasked TA-55 researchers to develop a non-incineration method for stabilizing almost two thousand plutonium- and uranium-impregnated polystyrene cubes ("polycubes") that are stored at the Hanford Site. The polycubes were manufactured during the early part of the Cold War for criticality studies. They now represent a legacy material that must be processed.

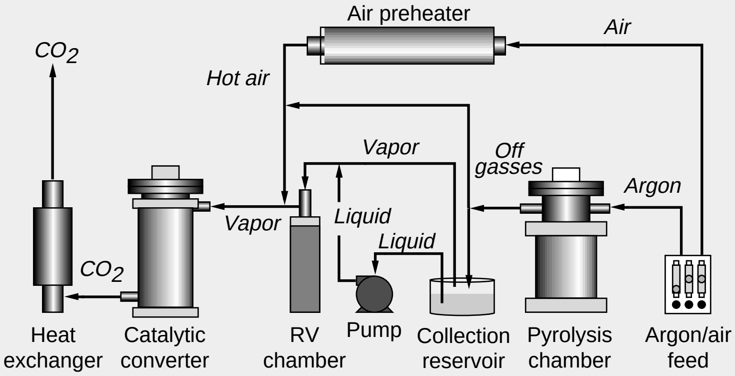
TA-55 personnel developed a system that converted more than 99 percent of the polycubes to carbon, carbon dioxide, and water, leaving behind a small mass of stable actinide material. Success of the pyrolysis system with polycubes made the potential application to TA-55 combustibles readily apparent.

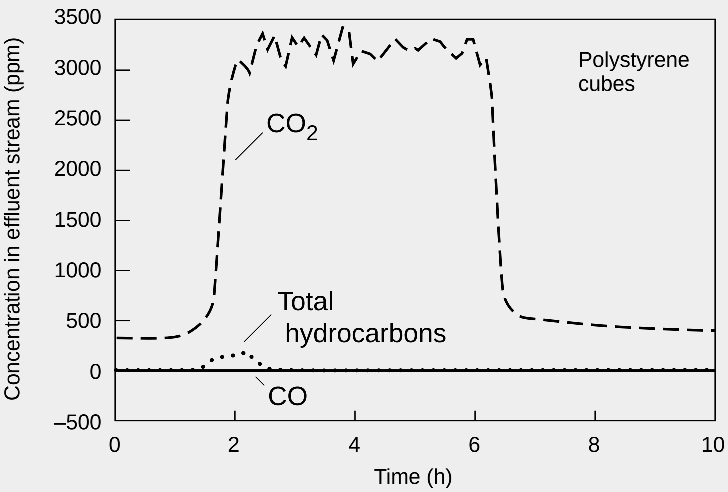
As seen in the photo, the prototype system consists of a pyrolysis (burning) chamber, a revaporization (RV) chamber, and a catalytic converter. The pyrolysis chamber is charged with polystyrene or cellulose combustible material and heated to 750°C in a flowing atmosphere of argon. The high temperature decomposes organic polymers into numerous liquid and gaseous constituents. A collection reservoir accumulates the liquid byproducts while volatile gases proceed directly to the RV chamber. A pump injects the collected liquids at a controlled rate into the gas stream in the RV chamber. The liquid constituents enter the gas phase, and the combined gas fractions are injected into the catalytic converter, where they are oxidized primarily to CO_2.

The totality of the polystyrene or cellulose conversion process is evident from the graph, which shows the composition of the effluent steam that leaves the catalytic converter. Actinide-impregnated polystyrene cubes are converted to carbon, CO_2, water, and a small amount of actinide-containing residue with greater than 99 percent efficiency. The process efficiency is greater than 93 percent for cellulose materials.

The system is controlled and monitored by computer, which improves the safety envelope of the process. The complete unit is also ergonomically friendly and requires minimal maintenance, so workers are at a reduced risk for exposure to radiation or caustic byproducts. Two identical systems are to be shipped to Hanford Site, while a third system is already installed in a glove box at TA-55.







An enhanced pyrolysis (burning) system, shown above, can convert polystyrene waste matrices to carbon, carbon dioxide, and water with greater than 99% efficiency. The graph shows the constituents of the effluent stream for polystyrene cubes. A system designed for cellulose has a process efficiency greater than 93%.