

Environmental Impact of the Degradation of Materials

Degradation of all materials, whether naturally occurring or man-made, necessarily produces chemicals as a result of the process. The degradation of polyethylene and candle wax can produce a variety of chemicals including formaldehyde (a key ingredient in embalming fluid), acrolein (a quite toxic chemical), along with hundreds of other chemicals. Recently, Ellis *et. al.* have claimed that the high temperature aerobic degradation of poly(tetrafluoroethylene) (PTFE) and other partially fluorinated polymers produces very large amounts of trifluoroacetic acid. The experimental approach employed by these authors did not allow for them to capture, let alone identify, the vast majority of the degradation products; furthermore, their proposed findings are at odds with the wealth of literature that has dealt with this subject for more than half a century.

The major thermo-oxidative degradation product of PTFE is carbonyl fluoride. Carbonyl fluoride was not detected by Ellis *et. al.* and only small amounts of tetrafluoroethene were detected due to the use of a thermal trapping methodology that was too warm (-78°C) relative to the boiling points of carbonyl fluoride (-85°C) and tetrafluoroethene (-76°C). This flaw in the experimental procedure raises serious questions as to the accuracy of the analysis of the evolved gasses and the ability to characterize either the types or amounts of degradation products.

While it has long been known that the thermal degradation of PTFE can produce trifluoroacetic acid (TFA), production of this chemical depends critically upon the details of the degradation variables. This is reflected by the fact that while some public health laboratories have reported detection of TFA, others have not. Previous reports of the degradation of fluoropolymers in air indicates that the amounts of TFA produced from copolymers of tetrafluoroethene, which are known to be less stable than polytetrafluoroethylene, were less than 0.2%. These amounts when compared to the 7.8% reported by Ellis *et. al.* again point to their inability to produce an accurate measure of the degradation products due to likely difficulties with the analytical procedures.

Release into the environment of chemical species that are long lived is an issue that is worthy of responsible discussion. In the case of TFA, there is evidence of substantial concentrations in the oceans and other bodies of water that seem to indicate accumulation over a period of several hundred years. The amount of TFA being produced from the thermolysis of PTFE and related polymers, while unknown, is undoubtedly a very small amount compared to that currently present in the environment and to that present in the pre-industrial environment. Apparently, there are natural sources of TFA which have not yet been identified. Furthermore, the environmental risk of TFA in rain water at the concentration (100 ng/l) suggested has been evaluated and concluded to not be an issue at this time. The detection of other fluorinated acids by Ellis *et. al.* is also brought into question by the lack of attention to detail evident in their experimental design and execution.