LONG TERM THERMAL STABILITY IN AIR OF IONIC LIQUID BASED ALTERNATIVE HEAT TRANSFER FLUIDS FOR CLEAN ENERGY PRODUCTION

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Abstract

The purpose of this study was to investigate the effect of long-term aging on the thermal stability and chemical structure of seven different ILs so as to explore their suitability for use as a heat transfer fluid. This was accomplished by heating the ILs for 15 weeks at 200°C in an oxidizing environment and performing subsequent analyses on the aged chemicals.

Experimental

All TGA experiments were conducted under a N_2 atmosphere using a Netzsch 209 F1 thermal gravimetric analyzer with single use Al crucibles at a ramp rate of 20°C/minute. The thermal analysis software (Proteus V5.2.0) calculates the thermal onset temperature based on the intersection of the baseline with the tangent, at the inflection point, of the decomposition rate.

The head gas off the TGA was continually sampled by a direct inlet mass spectrometer. Using chemical knowledge, the MS was set to rasterred between the logical decomposition products measuring the intensity of any product with the m/z (mass to ion charge) ratio

Results and Discussion

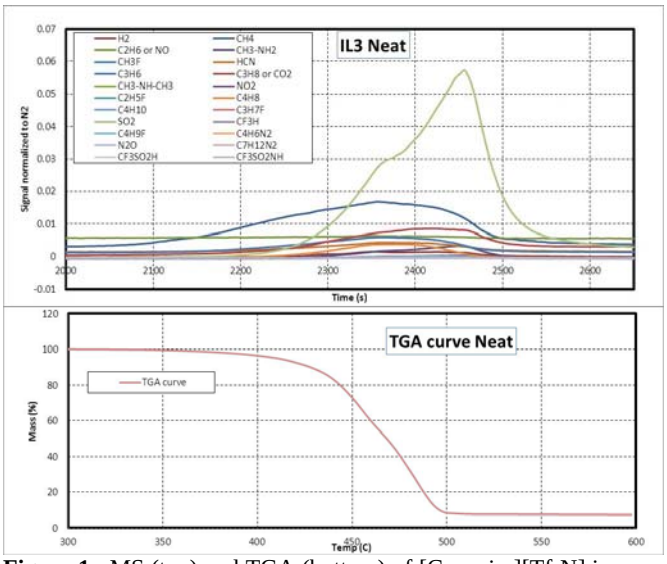

Figure 1. MS (top) and TGA (bottom) of [C_4mmim][Tf_2N] in a neat condition.

Several ionic liquids were compared in the TGA-MS in aged and unaged conditions under a N_2 atmosphere with a 20 C/min heating rate. The head gas was continually sampled by a direct inlet mass spectrometer. Using chemical knowledge, the MS was set to rasterred between the logical decomposition products measuring the intensity of any product with the m/z (mass to ion charge) ratio, see Figures 1 and 2. Table 1 summarizes the area under the curves of the major off-gas constituents during the thermal heating process. It is only at temperatures greater than 400 °C that the release of H_2 gas occurs. The first off-gases observed occur around 300 °C at a m/z of 42 and 44.

The most likely compounds are N_2O, CO_2, and C_3H_6. Though the mechanism for the release of these compounds is unknown, it is assumed that the N_2O and the CO_2 are products of the anion decomposition and the C_3H_6 propyl group is from decomposition of the butyl chain attached to the cation. At 350 °C, the release of SO_2 (m/z = 64) and C_4H_8 (m/z = 56) are observed. The SO_2 is assumed to come from further decomposition of the anion while the C_4H_8 is a different decomposition mechanism for the cation and also release of the side chain from the imidazolium.

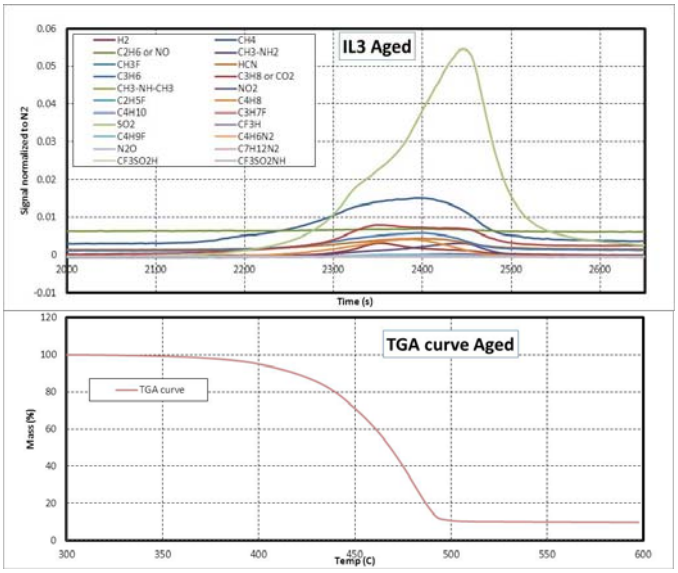

Figure 2. MS (top) and TGA (bottom) of [C_4mmim][Tf_2N] after aging for 15 weeks at 200°C in air.

Table 1: Relative area under the curves for several generated gas species during decomposition.

	Neat	Aged
Gas species		
H_2	1.1	1.0
CH_4	10.3	8.6
NO_2	4.0	4.2
SO_2	14.3	12.4
CO_2	4.8	6.3

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