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Is it possible to measure safety performance of nitrocellulose by the conventional stability evaluation methods? Comparison between the conventional methods and heat flow calorimetry

Nitric acid esters like nitrocellulose (NC) can undergo spontaneous decomposition even at room temperature and can ignite due to accumulation of the decomposition heat. In a previous study, it was considered that thermal bond scission of the O–NO₂ group and hydrolysis by atmospheric moisture participate in the initial NC decomposition, and NO_x derived from these reactions further accelerates the decomposition. Thus, as a stability evaluation method for nitric acid esters, the explosives control law in Japan prescribes the Abel test, and NATO countries proposed Methyl Violet test (MV test). Both methods measure the NO_x generation degree derived from heated samples by observing the time required for color-changing of test paper deployed at the upper side of the sample. However, the heating temperature is largely different; Abel test is conducted at 65 °C while MV test usually performed at a higher temperature like 120 or 134.5 °C.

In this study, to verify whether the Abel test and the MV test correctly measure the stability, the test results for raw NC and NC-containing explosives were compared with the thermal stability at an actual storage condition predicted by heat flow calorimetry (C80 calorimeter, SETARAM Inc.). As the result, no correlation was observed between the exothermic peak time observed by C80 and the NOx generation behaviour observed by Abel test, suggesting that the Abel test does not measure the physical hazard during storage. On the other hand, the results of MV test had a comparatively higher correlation. These results suggested that in some cases, Abel test did not measure the amount of NOx continuously generated by decomposition because of its low measurement temperature, but measured only the NOx amount physically adsorbed to the sample, which is possibly one of the reasons for the inconsistency in thermal stabilities.