

Abstract

Lubricating oil is essential for machines and automobiles to operate properly and is an important component to achieve high performance and energy efficiency. Since lubricating oil contains various additives to improve function, analysis of those additives is frequently required. However, analysis of additives in lubricating oil is not easily carried out because of complicated pretreatment requirements. This application shows an example of analyzing an organo-molybdenum compound (a friction modifier for lubricating oils) using the ionRocket, showing that additive information can be obtained quickly and without any pretreatment.

Samples

Organo-molybdenum compound (Fig. 1, commercial product)

*Safety Data Sheet information: contains mineral oil, polyolefin amide alkene amine and Molybdic acid special mixed amine salt.

Methods

The ionRocket combined with quadrupole time-of-flight mass spectrometry (QTOF-MS) equipped with Direct Analysis in Real Time (DART®) was used as the analytical system for this application (Fig. 2). The sample (a few μL) was placed into the ionRocket sample POT. A temperature gradient of $100^\circ\text{C}/\text{min}$. from room temperature to 600°C was applied (total run time 7 min.).



Fig. 1. sample

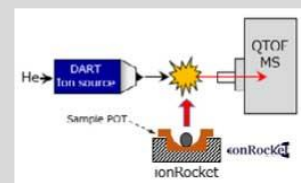


Fig. 2. ionRocket DART®-MS system

Results

Observed species were submitted to an industrial additives mass spec database (Compound Search, BioChromato) and resulting matches are shown in Fig.3. This result implies that the sample also contains antioxidants and lubricants which are not listed on the SDS.

For species m/z 382.43 and m/z 564.63, there was no match in the additives database. Further analysis of the MS/MS spectra suggested the presence of a quaternary ammonium compound (Fig.4). In order to confirm the presence of the molybdic acid ion, measurement in DART® negative mode was carried out. The characteristic spectral pattern observed at $500\sim 600^\circ\text{C}$ (Fig. 5) was compared with the theoretical spectral pattern of molybdic acid (Fig.6), suggesting the presence of molybdic acid. As demonstrated above, ionRocket DART®-MS analysis is an effective means for rapid analysis of various additives in lubricating oils without any pretreatment.

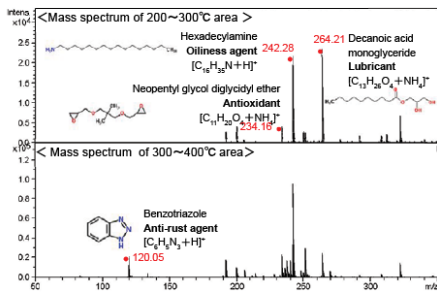


Fig. 3 Mass Spectrum
(Top: $200\sim 300^\circ\text{C}$ Bottom: $300\sim 400^\circ\text{C}$
DART positive ion mode

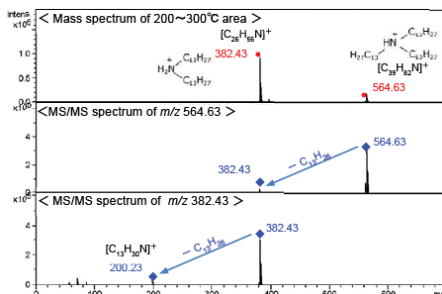


Fig. 4 Mass Spectrum and MS/MS Spectrum
 $200\sim 300^\circ\text{C}$ DART positive ion mode

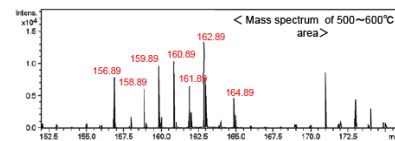


Fig. 5 Mass Spectrum
 $500\sim 600^\circ\text{C}$ DART negative ion mode

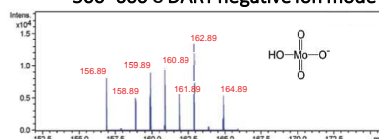


Fig. 6 Theoretical Spectral Pattern of
Molybdic Acid (HMoO_4^-)