

## Mitigating Problems in Measuring Hypergolic Fuels



Propellant Loading/  
Servicing/Storage

To monitor hydrazine concentrations accurately and safely, hydrazine is converted into a stable derivative that will be monitored and correlated to the actual hydrazine concentration. The hydrazine's reactivity is harnessed to produce a chemical reaction that will form a stable gas-phase derivative which will not react or decompose before it reaches the detector.

Hydrazine, monomethylhydrazine, and unsymmetrical dimethylhydrazine belong to a class of compounds known as hypergolic fuels. These fuels self-ignite upon mixing with hypergolic oxidizer (dinitrogen tetroxide), without need of a spark or other ignition source. The resulting reaction produces thrust with exceptionally high energy, making these compounds particularly useful as rocket propellants.

Hydrazines are also highly toxic and corrosive. The combined properties of reactivity, corrosivity, and toxicity present the potential for a leak, a disastrous situation in a hypergol-loaded system. Consequently, leak detection is of the utmost importance in protecting equipment and personnel.

Hydrazine vapor quantification presents many challenges in addition to the safety concerns. The reactivity of these compounds causes thermal and catalytic decomposition, which results in significant losses. Further complications arise from the "sticky" nature of hydrazine. Molecules adsorb irreversibly to virtually any surface they make contact with before detection, which results in instrument drift. These properties make it difficult to accurately quantify hydrazines. Current analytical methods seek to minimize these interactions.

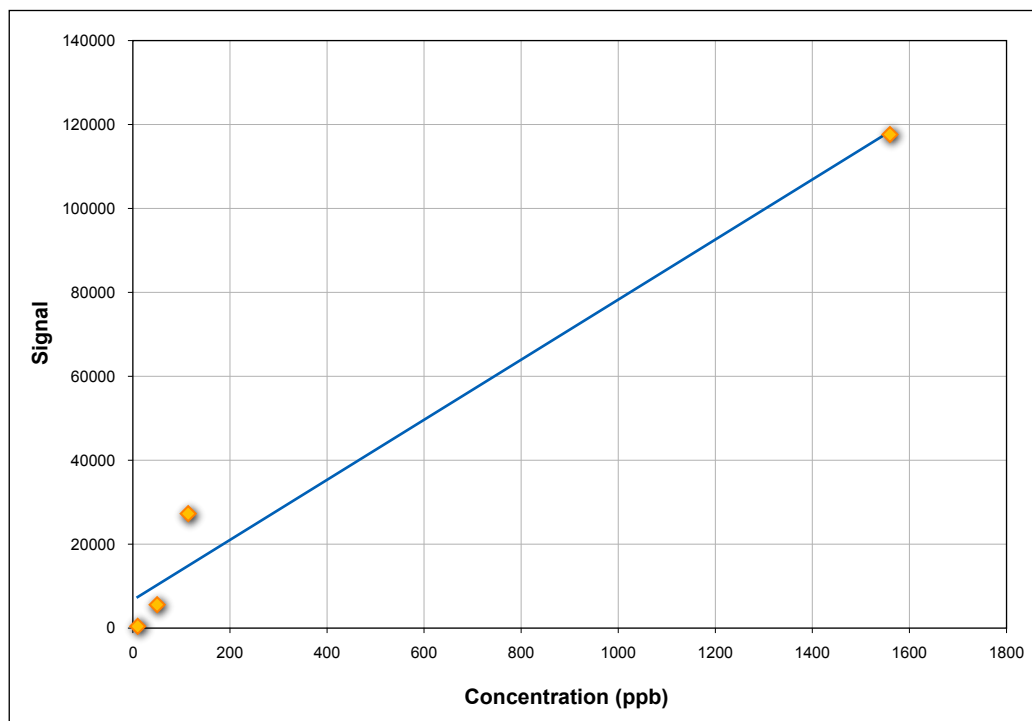
After an extensive literature search to determine appropriate chemical reactions, a method was devised to quantify hydrazines, without the limitations of monitoring hydrazines. In these experiments, we used the recently developed Desorption Electrospray Ionization (DESI) to ionize at ambient pressure a stabilized hydrazine derivative formed on a surface. To form the stabilized derivative, we exposed glass wool impregnated with a complexing reagent to hydrazine vapors at varying concentrations. We then used DESI to analyze the surface derivative, providing an indirect avenue for quantifying hydrazines. This approach harnesses, rather than limits, the reactivity of these hydrazines for more accurate quantification.

Our work successfully identified and characterized a gas-phase hydrazine reaction that formed a stabilized gas-phase hydrazine derivative which could be detected in place of the hydrazine. The work included using DESI to demonstrate the concept. The figure shows the results of the experiments.

Work continues in investigating and characterizing the current chemical reaction and in examining different chemical reactions and monitoring techniques. These tasks will be geared toward improving detection limits and producing a working prototype.

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*DESI response to hydrazine derivative.*