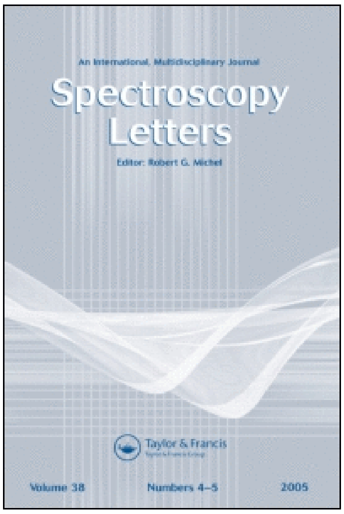

Spectroscopy Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597299

The Use of Organic Liquids as Fuels in Flame Spectroscopy

B. W. Bailey[a]; J. M. Rankin[a]
[a] Department of Health, Division of Laboratories and Research New York State, Albany, New York

To cite this Article Bailey, B. W. and Rankin, J. M.(1969) 'The Use of Organic Liquids as Fuels in Flame Spectroscopy', Spectroscopy Letters, 2: 6, 159 — 164
To link to this Article: DOI: 10.1080/00387016908050035
URL: http://dx.doi.org/10.1080/00387016908050035

SPECTROSCOPY LETTERS, 2(6), 159-164 (1969)

THE USE OF ORGANIC LIQUIDS AS FUELS IN FLAME SPECTROSCOPY

by

B. W. Bailey and J. M. Rankin
Division of Laboratories and Research
New York State Department of Health
New Scotland Avenue
Albany, New York 12201

INTRODUCTION

Until the present time the use of organic fuels in flame spectroscopy has been restricted to those fuels which could be presented to the burner in the vapor phase. The possibility of introducing organic liquids directly into a burner system allows simple access to a broad range of fuels which hitherto have not been investigated.

The purpose of this communication is to report the results of a preliminary study in which a variety of organic liquids have been examined with respect to their ability to produce self-supporting flames and to the applicability of such flames in atomic absorption spectroscopy.

The method of production of flames using organic liquids is relatively simple. The organic liquid is aspirated using a standard nebulizer system with air as the aspirating gas, the organic liquid aerosol is introduced into a conventional burner system and ignited in the normal manner. However, in order to introduce a sample into the flames so produced an additional nebulizer is needed. To accomplish this a dual nebulizer system was developed in which the organic liquid is aspirated through one nebulizer and the sample to be analyzed through the other.

EXPERIMENTAL

Instrumentation - The basic instrument used throughout these investigations was the Perkin-Elmer Model 303 atomic absorption spectrophotometer. The standard Model 303 nebulizer endcap was removed and replaced with a dual nebulizer attachment (Fig. 1 and 2) which was fitted with two Perkin-Elmer nebulizers. One of the nebulizers was employed to aspirate the organic liquid under investigation, the other to aspirate standard metal solutions. A Boling three-slot burner head was used throughout because it was found that the air-fuel mixture required for self-supporting flames was less critical with this design than with the single-slot burner.

RESULTS

Preliminary investigations were accomplished by aspirating the organic liquid under consideration through one of the nebulizers and

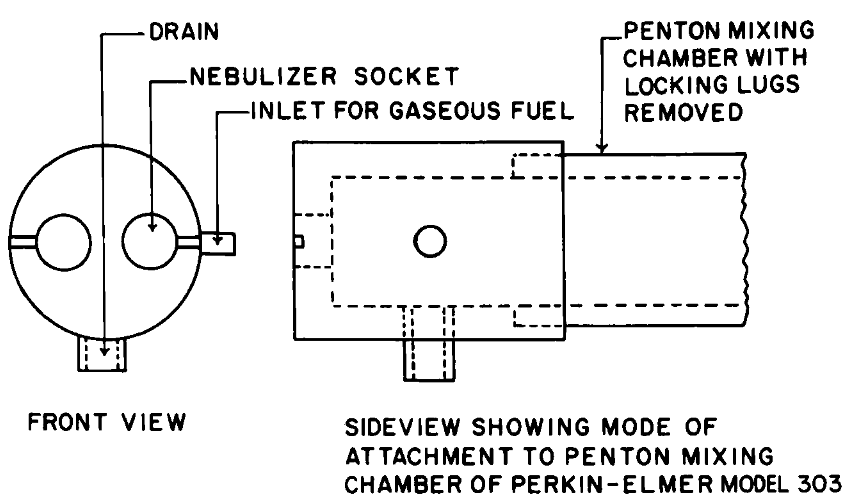

FIG. 1

Dual nebulizer attachment.

deionized water through the other. The resulting mixture was ignited by holding a flame near the edge of the burner face. Observations were then made on the flame produced. The rate at which the organic liquid was aspirated was controlled by regulating the airflow through the nebulizer. The rate of water aspiration was maintained at a constant 3.4 ml/min. Extinguishing the flame was accomplished by either removing the aspirator tube from the fuel supply or by cutting off the air supply to the fuel nebulizer. The organic liquids investigated fell into five categories, alcohols, ketones, esters, aliphatic hydrocarbons and aromatic hydrocarbons. The results obtained are summarized below.

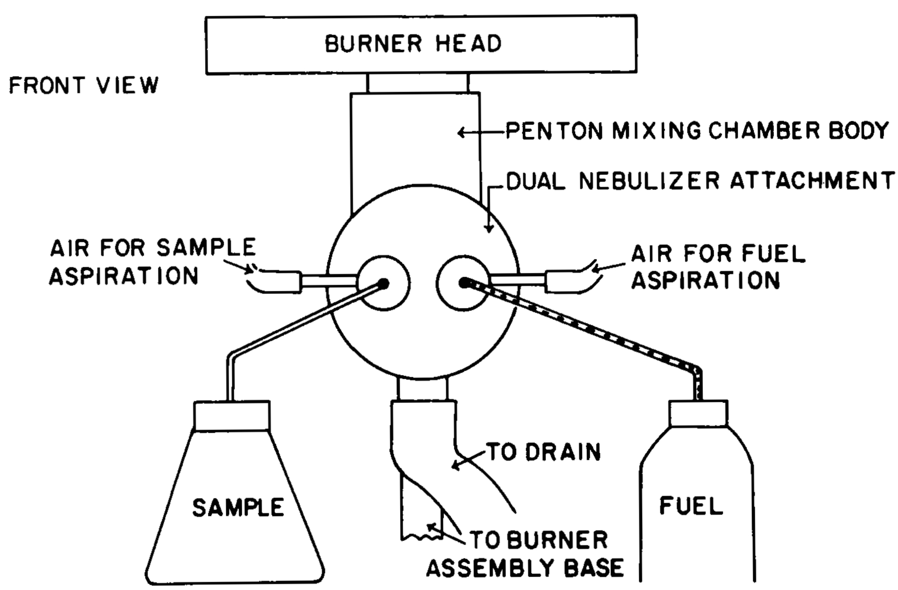

FIG. 2

Dual nebulizer attachment assembled for operation.

Alcohols: It was found that none of the alcohols investigated, including methanol, ethanol, n-butanol, n-amyl alcohol, were capable of producing self-supporting flames under the conditions described.

Ketones: Acetone produced a quiet, lean, self-supporting flame; but it was found that with methyl isobutyl ketone, the only other ketone investigated, that the flame lifted off shortly after ignition.

Esters: Neither ethyl acetate nor amyl acetate produced self-supporting flames.

Aliphatic hydrocarbons: n-pentane, n-hexane, and iso-octane were investigated. All of those gave quiet self-supporting flames. It was found that pentane, due to its large negative heat of vaporization, froze in the nebulizer tip after periods of extended aspiration, blocking the nebulizer and causing the flame to extinguish. Attempts at alleviating this problem by heating the nebulizer air supply were not sufficiently successful to warrant using pentane in further investigations.

Aromatic hydrocarbons: Benzene, toluene, and xylene were investigated. Benzene produced a quiet, self-supporting flame but both toluene and xylene showed a tendency to lift off after burning erratically for short periods of time.

On the basis of the above results, acetone, benzene, n-hexane, and iso-octane were selected for further evaluation. As mentioned previously, acetone produced a clear, lean, nonluminous flame. With the latter three fuels, the type of flame produced could be varied from fuel-lean to fuel-rich by controlling the rate of aspiration.

The applicability of the flames obtained with these fuels to atomic absorption spectroscopy was ascertained by comparing results obtained for the determination of copper in the various flames with those obtained using air/acetylene. All measurements were made at the 3247Å resonance line of copper utilizing a slit width of 1 millimeter. The instrument output was displayed on a 0-10 millivolt recorder. The rate of aspiration of the various fuels was adjusted by varying the flow rate of the nebulizing air to give a nonluminous flame. Zero absorbance (100%T) was set with distilled water being aspirated and then the absorbance of a series of standard copper solutions (1-5 ppm) was determined. The calibration curves so produced were all linear and passed through the origin. The experimental results and the conditions under which they were obtained are summarized in Table 1. Due to differences in the geometry between the standard single nebulizer and the experimental dual nebulizer system, valid comparisons can only be made between results obtained with the same system. However, for reference purposes results obtained using an air/acetylene flame are given for both systems.

TABLE 1

Analytical Sensitivities of Copper in Air/Organic Liquid Fuel Flames

Fuel	Fuel Aspiration Rate ml/min	Sample Aspiration Rate ml/min	μg Cu/ml	Absorbance	Sensitivity*
Hexane	2.4	3.4	5	0.37	0.06
Acetone	4.0	3.4	5	0.33	0.07
Benzene	2.1	3.4	5	0.32	0.07
Iso-octane	2.5	3.4	5	0.29	0.08
Acetylene	-	3.4	5	0.15	0.13
Acetylene**	-	3.4	5	0.19	0.10

*Defined as the concentration of copper in μg/ml necessary to produce 1% absorption

**Single nebulizer system

DISCUSSION

From the preliminary data obtained it appears that analytically useful flames can be obtained using common organic liquids. It is further seen that these flames are capable of producing sensitivities, with certain elements, that are comparable to or greater than those obtained with air/acetylene flames.

One of the major advantages of being able to use organic liquids directly as fuels in flame spectroscopy lies in the freedom it gives in fuel selection without the attendant problem of bulky fuel tanks and the ancillary regulators and flow meters they require. In our investigations the fuels were contained in plastic bottles and a rotometer was used to monitor aspiration rates.

In being freed from the bulky accessories normally associated with flame spectroscopy, portable atomic absorption spectrophotometers requiring only a small compressor to provide aspirating air become a realizable possibility.

Further investigations covering the analysis of a number of other metals by atomic absorption spectroscopy in air/organic liquid flames are presently being undertaken and the results will be published at a later date.

Received June 19, 1969