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STORAGE STABILITY OF HIGH TEMPERATURE FUELS

Part III. The Effect of Storage Upon Thermally Induced Deposition of Selected Fuel Components and Additives

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BUREAU OF MINES
U. S. DEPARTMENT OF THE INTERIOR
BARTLESVILLE, OKLA.

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FOREWORD

This report was prepared by the Bartlesville Petroleum Research Center, Bureau of Mines, Bartlesville, Oklahoma 74003, under USAF Contract No. F33615-67-M-5003. The contract was initiated under Project No. 3048, "Aviation Fuels," Task No. 304805, "Hydrocarbon Fuels," and was administered under the direction of the Air Force Aero Propulsion Laboratory (APFL), Air Force Systems Command, with Greg Gandee acting as project engineer.

This report covers work conducted from March 1969 to March 1970, the third year's effort of a 3-year contract.

The report was submitted by the authors in May 1970.

This technical report has been reviewed and is approved.

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ABSTRACT

The Bureau of Mines investigated the contribution of selected components and additives of high-temperature aircraft fuels to thermally induced deposits before and after 52 weeks of storage at 130° F. Of particular concern was the influence of fuel constituents on thermal stability quality of jet fuels during storage. A microfuel coker test apparatus was used to measure the thermal stability of test fuels and blends. The contribution of selected fuel components, labeled with carbon-14, to deposit-forming mechanisms was determined by radioactive-counting techniques.

Twenty-eight blends of the five test fuels with carbon-14-labeled fuel additives or components reached the final stage of storage at 130° F and received final analyses for deposit forming tendency. These additives included an amine-type antioxidant, a metal deactivator, and a corrosion inhibitor. Also included in this study group were oleic acid and 1,5-hexadiene. All three additives showed a marked tendency to degrade and react during storage and thermal stress. Oleic acid was found to interact with cadmium present in aircraft fuel systems and produce deleterious effects upon the thermal stability quality of the fuel.

Sixteen blends of the five test fuels with nonradioactive components were prepared as part of a special study. Six of these blends contained 1 percent of selected aromatic compounds, five blends contained an anti-icing additive, and five blends contained an organic sulfur compound. Results showed changes in thermal stability quality of many of the blends containing sulfur compounds.

Four additional special studies were performed as preliminary investigations to continued research of jet fuel stability characteristics. Both were designed to improve procedures or develop new, improved procedures for thermal stability tests.

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SECTION I

INTRODUCTION

This report presents results of Bureau of Mines research performed from March 1969 to March 1970, as the third year's work under a 3-year contract with the Air Force. The major objectives of this contract are summarized as follows:

1. Utilize a microfuel coker test apparatus to evaluate the effect of storage upon thermal stability characteristics of selected high-temperature, hydrocarbon jet fuels.

2. Study the effect of storage on deposit-forming tendencies of selected fuel components in a variety of fuel environments with contractor-developed, radiotracer techniques.

3. Extend the study initiated under item 2 to include blends prepared with fuels depolarized by gel percolation and fuels purposely contaminated with red iron oxide (Fe_2O_3) and water.

4. With previous findings on thermal degradation of a jet fuel antioxidant in a fuel environment, extend the study to include two antioxidants, one metal deactivator, a corrosion inhibitor, and one experimental additive. Determine the extent and rate of loss of these additives in several fuel environments at high temperatures with additional effort to identify thermally induced degradation products of these additives.

Experimental work during the first year was divided among the four objectives listed. The first objective was completed during the first year; and the others during the last 2 years of this contract period. Test fuels and special fuel treatment used in this program are described in Appendix I.

SECTION II

MICROFUEL COKER THERMAL STABILITY DEPOSITS

1 BACKGROUND

The U S Bureau of Mines, through a previous contract with the Air Force, evaluated various methods of measuring with radiotracers the contributions of individual fuel compounds to deposit formation in a variety of high-temperature, hydrocarbon jet fuels (1,2,3,4) These evaluations indicated that some of the procedures could be extended for determining, predicting, and possibly understanding the thermal stability phenomena associated with high-temperature fuels In the previous program, a radiotracer method was developed that extended the sensitivity of determinations to the parts-per-billion range, and the techniques were applied, with excellent results, to test blends that were thermally stressed in a static 5-ml bomb Because the results obtained in the static-test-condition system did not always correlate with those from a dynamic system, some of the techniques developed were modified and extended for use in microfuel coker test apparatus, so that results would more closely simulate results obtained from a standard coker apparatus These operational procedures have been described (5).

With these new test procedures, 68 blends were prepared, tested, and stored at 130° F during the first year of this contract The radiotracers used in these blends included one paraffinic hydrocarbon, seven aromatic fuel components, and one fuel antioxidant of the cresol type Initial thermal stability tests showed little or no contribution to deposits by these selected compounds, but significant changes in many of these test blends were anticipated in post-storage analyses

During the second year of this contract, the blends which had been prepared in the first year were retested after 1 year of storage at 130° F And 23 new blends were prepared, tested, and stored The radiotracers used in these new blends included a diolefin, an amine-type antioxidant, and a fatty acid

The preparation and storage of test blends have been described in detail (5,6)

2 SUMMARY OF PREVIOUS TEST DATA

Initial and final tests were completed on 68 test blends during the first 2 years of this program. These blends were combinations of the five test fuels and a group of selected fuel components labeled with carbon-14: n-hendecane-1-^{14}C, 1-methylindan-3-^{14}C 1-methylindene-3-^{14}C, 1-ethylindan-3-^{14}C,

1-ethylindene-3-^{14}C, 2-methyl-^{14}C-naphthalene, and tetralin-^{14}C. Also included were blends with a fuel antioxidant, 2,6-di-t-butyl-^{14}C-p-cresol.

The test data for these blends are summarized in Appendix II, tables 11-15. The initial thermal stability tests generally showed little or no contribution to deposits by these selected compounds; however, after storage for 52 weeks at 130° F, several of the blends showed definite reaction and considerable contribution of the radiotracer to the deposits.

The largest extent of reaction was observed in blends of the two substituted indenes with fuel designated 4-65-2, a JP-6 type fuel. Smaller, although still significant, increases in deposit contribution as a result of storage were noted for some blends that contained the substituted indans or tetralin.

The test blends that contained the radiotracers, 2-methyl-^{14}C-naphthalene or n-hendecane-^{14}C, showed only a slight contribution of the radiotracer to total deposits, either before or after storage. Similarly, the test blends that contained the labeled antioxidant, 2,6-di-t-butyl-^{14}C-p-cresol, showed very little participation of the antioxidant in deposit forming reactions, even after 52 weeks of storage at 130° F.

3. CURRENT STORAGE AND THERMAL STABILITY TESTS WITH RADIOACTIVE BLENDS

a. Blends Containing N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine

Eleven blends that contained N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine, an amine-type antioxidant, had been prepared, given the initial thermal stability test, and placed in storage during the second year of this program (6). In the final year, these blends were removed from storage, after 52 weeks at 130° F, and the final, thermal stability test was performed on each blend.

The before- and after-storage test data for these blends are summarized in table 1, and the detailed data are tabulated in Appendix II, tables 16-26. Very large amounts of radioactivity from the labeled additive were found in the deposits formed by thermal stress of the blends at the threshold failure temperature of the neat fuel. Apparently, from the data, the deposit forming tendency of this compound depends greatly upon the fuel environment since the percentage of radiotracer that went into deposits ranged from 1 to 56 percent in the different fuels.

TABLE 1. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING N,N'-di-sec-Butyl-4-^{14}C-p-PHENYLENE-DIAMINE

Fuel	Treatment	Radiotracer conc., ppm	Contribution of radiotracer to total deposits, percent: Before storage	Contribution of radiotracer to total deposits, percent: After 52 wks at 130° F	Radioactivity recovery, percent
1-65-2	Neat	5	40.06	16.60	1/ 56.8
	Contaminated	2	42.47	16.92	1/ 59.5
	Depolarized	3	35.04	0.92	2/ 17.3
2-65-2	Neat	2.5	2.20	1.60	90.5
	Contaminated	2.5	1.21	1.79	92.7
	Depolarized	2.5	7.16	6.64	73.2
3-65-2	Neat	3	10.49	4.68	77.1
4-65-2	Neat	2.5	17.99	21.43	62.3
5-65-2	Neat	3	49.88	44.15	3/ 70.9
	Contaminated	3	53.03	56.75	3/ 80.8
	Depolarized	2.5	15.11	6.60	3/ 65.4

1/ Approximately one-fourth of the loss of radioactivity occurred during storage.
2/ One-half of the loss occurred during storage.
3/ Approximately one-tenth of the loss occurred during storage.

A surprising feature of many of these blends is the apparent improvement of thermal stability quality during storage. This was most noticeable in the blends with 1-65-2, a JP-5 fuel. Many of the blends show poor radioactive material balances. Loss of radioactivity occurred during both the initial and final microfuel coker thermal stability test. In addition, those blends with fuel 1-65-2 showed a large loss of radioactivity during storage, and blends of fuel 5-65-2 showed a smaller but significant loss of radioactivity during storage. The poorest radioactivity balance was exhibited by the blend of depolarized fuel 1-65-2; approximately 40 percent of the initial radioactivity was lost during storage, and another 40 percent was lost in the final thermal stability test Very little radiotracer could be recovered from the storage bottle by the technique previously described (6) for recovering adherent deposits. The butyl group, which contains the radioactive carbon-14 atom, is apparently fragmented from the parent molecule and lost through volatility Depending on the fuel environment, this thermal degradation of the antioxidant can apparently occur, to some extent, at the relatively low temperature of storage as well as at the high temperature of the thermal stability test.

Contamination of the fuel with iron oxide and water barely affected the reaction and fragmentation of this labeled antioxidant. Results from test fuel 1-neat and 1-contaminated were similar, as were those of pairs 2-neat and 2-contaminated and fuel 5, both neat and contaminated This probably indicates the precision of the method.

Depolarization was less consistent in its total effect. Depolarized blends with fuels 1-65-2 and 2-65-2 consumed more antioxidant during storing and testing than did the neat fuel blends; this indicated a less stable environment after depolarization. Another blend, with depolarized fuel 5-65-2, contributed less antioxidant to deposits formed in the thermal stability test than did the neat fuel; this indicated an improvement in fuel quality as a result of depolarization

b. Blends Containing Oleic-1-^{14}C Acid

Discussions with other investigators have disclosed possible deleterious effects of trace quantities of oleic acid in jet fuels Extensive deposit formation and filter plugging reportedly results from an interaction between the oleic acid and cadmium parts of the fuel tanks and plumbing systems.

Blends that contained 250 ppm oleic acid labeled with carbon-14 were prepared with each of the five test fuels and tested in the microfuel coker before and after storage for 52 weeks at 130° F. One blend with each fuel consisted of the neat fuel and the oleic acid; a second blend was identical except three cadmium plated screws were placed in the bottle to simulate the environment that apparently produces troublesome deposits in aircraft fuel systems.

Table 2 summarizes the results obtained on these blends, while the detailed data are shown in tables 27-36.

Fuels 3-65-2, 4-65-2, and 5-65-2 showed some initial contribution of the oleic-^{14}C acid to total deposits. With only 24 hours' contact at room temperature, the reaction of oleic acid-cadmium metal was too small to be measured in the initial tests.

When tested after storage, all five blends which were stored in contact with cadmium showed a significantly greater contribution of oleic-^{14}C acid to total deposits than the neat fuel blends. The blend of fuel 4-65-2, without cadmium, showed a large increase in deposits as a result of storage, but the blend with cadmium produced an even larger increase. These results indicate that oleic acid in a fuel does indeed interact with the cadmium to produce deleterious effects on the thermal stability quality of fuel stored in contact with cadmium.

c. Blends Containing 1,5-Hexadiene-1,6-^{14}C

Two blends were prepared with a carbon-14-labeled 1,5-hexadiene since there was not enough of the compound available for a more complete study. The test data are summarized in table 3 and shown in detail in tables 37-38, Appendix II.

About 0.2 percent of the initial radiotracer was found in the deposits formed in the initial microfuel coker test, and about double that amount was found in the deposits from the final test.

The radioactivity balance was poor, with a significant part of the loss of radioactivity having occurred during the 52 weeks of storage. This loss can probably be attributed to volatility or fragmentation of the hexadiene, or both.

d. Blends Containing N,N'-disalicylidene-1,2-Diaminopropane-1-^{14}C

Five blends, one with each of the five test fuels, were prepared with a carbon-14-labeled metal deactivator, N,N'-disalicylidene-1,2-diaminopropane, as the radiotracer. The concentration of metal deactivator in each blend was approximately 10 ppm.

These blends were tested in the microfuel coker both before and after storage at 130° F. The N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C was received so late in this program that the blends prepared with it could be stored for only 26 weeks instead of 52 weeks. The test data for these blends are summarized in table 4 and shown in detail in tables 39-43, Appendix II.

TABLE 2. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 250 PPM OLEIC-1-^{14}C ACID

Fuel	Treatment	Contribution of radiotracer to total deposits, percent: Before storage	Contribution of radiotracer to total deposits, percent: After 52 wks at 130° F	Radioactivity recovery, percent
1-65-2	Neat	0.004	0.339	96.8
1-65-2	With cadmium	.001	1.687	1/ 92.0
2-65-2	Neat	.002	.258	1/ 91.5
2-65-2	With cadmium	.116	1.184	88.9
3-65-2	Neat	.529	.341	1/ 91.0
3-65-2	With cadmium	.414	.982	90.9
4-65-2	Neat	.433	2.218	1/ 90.5
4-65-2	With cadmium	.527	2.721	1/ 88.8
5-65-2	Neat	.679	.312	1/ 92.8
5-65-2	With cadmium	.885	1.284	1/ 88.9

1/ About half of the loss of radioactivity occurred during storage.

TABLE 3. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 2 PPM 1,5-HEXADIENE-1,6-^{14}C

Fuel (neat)	Contribution of radiotracer to total deposits, percent: Before storage	Contribution of radiotracer to total deposits, percent: After 52 wks at 130° F	Radioactivity recovery, percent
1-65-2	0.214	0.484	1/ 39.7
2-65-2	.253	.438	1/ 50.1

1/ About one-third of the loss of radioactivity occurred during storage.

TABLE 4. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 10 PPM N,N'-DISALICYLIDENE-1,2-DIAMINOPROPANE-1-^{14}C

Fuel (neat)	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
	Before storage	After 26 wks at 130° F	
1-65-2	7.71	13.40	98.3
2-65-2	2.11	0.79	1/ 87.2
3-65-2	3.46	1.95	93.1
4-65-2	5.55	19.42	2/ 30.0
5-65-2	20.26	21.14	86.1

1/ One-half of the loss of radioactivity occurred during storage.
2/ Approximately three-fourths of the loss of radioactivity occurred during storage.

With the exception of the least stable fuel blend, fuel 4-65-2 (JP-6), the results of the thermal stability tests after storage were similar to the results before storage; from 1 to 20 percent of the carbon-14 was recovered in filterable deposits, and a small amount of the radioactivity was lost by fragmentation and volatilization during the coker test. The blend with fuel 4-65-2 behaved differently; more than 50 percent of the original radioactivity was lost during storage, and about 35 percent of the remaining radioactivity was lost during the final thermal stability test in the microfuel coker. The filterable deposits collected after storage amounted to 19 percent of the radioactivity that remained after storage, compared to 5 percent filterable deposits before storage.

Because the blend with fuel 4-65-2 lost so much radioactivity during storage, the deposits inside the storage bottle were dissolved in a solvent comprised of equal parts of acetone, toluene, and 2-propanol, and the radioactivity was measured. The radioactivity recovered from the bottle in this way represented 22 percent of the original radioactivity. The other 30 percent lost in storage apparently resulted from fragmentation of the molecule with volatilization of the fragment that contained the carbon-14.

e. Blends Containing Dilinoleic-^{14}C Acid

Dilinoleic acid, the active ingredient of a corrosion inhibitor was also investigated in this project. A small quantity of dilinoleic acid labeled with carbon-14 was obtained from a commercial supplier. The dilinoleic-^{14}C acid, as received, was diluted with the commercial inhibitor and the resulting solution was blended with each of the five test fuels in the proper quantities to produce final blends that contained the equivalent of 20 pounds of active ingredient in 1,000 barrels of fuel.

Initial microfuel coker tests were performed on the blends, and aliquots of each blend were also stored at 130° F. However, the carbon-14-labeled dilinoleic acid was received so late in the 3-year program that the blends could be stored for only 24 weeks instead of the usual 52 weeks.

The test data for these blends are summarized in table 5, with the detailed data in tables 44-48, Appendix II All five of these blends showed some deterioration during storage, as evidenced by radioactivity associated with filterable deposits, as well as by the visual ratings of the preheater tubes. Between 10 and 20 percent of the total radioactivity of each blend was lost during storage, apparently through fragmentation and volatilization of the additive, since no radioactive deposits could be recovered from the storage bottles.

TABLE 5. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING DILINOLEIC ACID-^{14}C

Fuel (neat)	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
	Before storage	After 24 wks at 130° F	
1-65-2	1.050	1.288	1/ 76.9
2-65-2	1.141	2.316	1/ 74.5
3-65-2	0.666	1.163	1/ 71.5
4-65-2	.526	1.198	1/ 81.1
5-65-2	1.074	3.756	1/ 69.9

1/ About one-half of the loss of radioactivity occurred during the storage period

Radioactive material balances disclosed that another 12 to 16 percent of the labeled corrosion inhibitor was lost during the thermal stability test in the coker. These tests indicated that this corrosion inhibitor contributed to loss of thermal stability quality during storage, and showed some contribution to preheater and filterable deposits during thermal stress both before and after storage.

SECTION III

SPECIAL STUDIES

1. THERMAL STABILITY TESTS WITH NONRADIOACTIVE BLENDS

As a result of these findings from the use of trace amounts of carbon-14-labeled components to study jet fuel thermal stability, Bureau scientists decided to extend these investigations by storing some blends containing a similar nonradioactive component at a higher concentration level. Radiotracer studies showed as much as 5 to 6 percent reaction of some radioactive components with little or no change in the overall thermal stability of the fuel. The radiotracer levels were purposely held low, usually less than 20 ppm, to avoid changes in fuel characteristics However, knowledge of the effect of larger than trace quantities of some fuel components, such as aromatic compounds, was needed. For that purpose, a few blends were selected for further study at higher concentrations.

Six blends were prepared, with 1 percent of an unlabeled component added to each one, as follows: 1 percent 2-methylnaphthalene in fuel 1-65-2, 1 percent 1-methyl-1-indene in fuel 4-65-2, 1 percent 1-methyl-1-indene in fuel 5-65-2, 1 percent 1-ethyl-1-indene in fuel 4-65-2, 1 percent 1-ethyl-1-indene in depolarized fuel 5-65-2, and 1 percent 1-ethylindan in depolarized fuel 5-65-2.

The results of the microfuel coker tests, before and after storage, of these nonradioactive blends are listed in table 6. Test results indicated that 1 percent 2-methylnaphthalene had no effect on the thermal stability quality of fuel 1-65-2, even after 1 year of storage. However, the substituted indenes and the ethylindan, at this concentration, apparently caused some immediate deterioration of the fuel as evidenced by the initial tube deposits being heavier than normal. And, after the storage at 130° F, the tube deposits in the final microfuel coker test were generally much heavier than the initial deposits, which indicated extensive degradation of the thermal stability of the fuel blend.

In addition to the compounds previously discussed, two other nonradioactive compounds were blended with the test fuels Five blends were prepared with the five test fuels and an anti-icing additive, 2-methoxyethanol. The concentration of 2-methoxyethanol in each blend was 0.1 vol pct. An aliquot of each blend was tested in the microfuel coker immediately after preparation, and the remainder was stored at 130° F for 26 weeks, then retested. A blend with fuel 2-65-2 produced a heavier than normal tube deposit in the initial test, with no change after storage, and blends with fuels 3-65-2 and 5-65-2,

TABLE 6. -- TEST DATA FOR NONRADIOACTIVE BLENDS

Added component (conc)	Fuel No. and treatment	Test temperature, °F tube/fuel-out	Tube deposit rating		Length of storage at 130° F, weeks
			Before storage	After storage	
2-Methylnaphthalene (1 wt pct)	1-65-2, neat	480/290	2	1	52
1-Methyl-1-indene (1 wt pct)	4-65-2, neat	575/338	4	8	52
	5-65-2, neat	725/412	5	8	52
1-Ethyl-1-indene (1 wt pct)	4-65-2, neat	575/338	2	4	46
	5-65-2, depolar.	725/412	8	8	40
1-Ethylindan (1 wt pct)	5-65-2, depolar.	725/412	5	8	37
2-Methoxyethanol (0.1 vol pct)	1-65-2, neat	480/290	1	1	26
	2-65-2, neat	625/362	5	5	26
	3-65-2, neat	675/388	2	4	26
	4-65-2, neat	575/338	2	1	26
	5-65-2, neat	725/412	3	4	26
n-Butyl sulfide (0.3 vol pct)	1-65-2, neat	480/290	1	2	24
	2-65-2, neat	625/362	4	5	24
	3-65-2, neat	675/388	2	3	24
	4-65-2, neat	575/338	2	7	24
	5-65-2, neat	725/412	2	3	24

showed a slight deterioration of the thermal stability during storage.

The final nonradioactive compound investigated was a sulfur compound, n-butyl sulfide, blended with the five test fuels at a concentration level of 0.3 vol pct The sulfide did not appear to cause an immediate change in the thermal stability of the fuel, but after only 24 weeks at 130° F, all five fuel blends showed some deterioration as measured by preheater tube deposit. The largest change was produced in the blend of fuel 4-65-2, with the tube deposit rating having changed from 2 before storage to 7 after storage.

2. TESTS WITH ELECTROPOLISHED PREHEATER TUBES

The standard technique of cleaning the microfuel coker preheater tubes is to polish the tube with "A-1"* metal polish and to rinse with acetone and hexane. That the tube cleaning procedure affects the test results has been reported; consequently, an alternate cleaning procedure, electropolishing, was investigated.

The technique for electropolishing the aluminum preheater tubes was adapted from a method originally developed for electropolishing the 5-ml stainless steel bombs used in a previous investigation (1,7). The preheater tube was the anode in an electrolyte of 2.5 percent fluoboric acid solution. The container, which also served as the cathode, was simply a 6-inch length of 5/8-inch aluminum tubing closed at one end. The tube was electropolished for 5 minutes at an applied voltage of 15 volts. After electropolishing, it was rinsed thoroughly with water, acetone, and hexane. The tube was then installed in the microfuel coker, and a standard test was run using one of the five test fuels.

The tube deposit ratings obtained with the electropolished tubes are listed in table 7; representative tube ratings of tubes cleaned with A-1 polish are included for comparison. It can be seen from the data that the effect of using an electropolished tube is not the same for all fuels. Fuels 3-65-2 and 5-65-2 produced much heavier deposits on electropolished tubes than on tubes cleaned with A-1 polish, fuels 2-65-2 and 4-65-2 produced slightly heavier deposits on the electropolished tubes, while fuel 1-65-2 gave practically the same deposits on electropolished tubes as on the tubes cleaned with A-1 polish.

The results of the standard microfuel coker test, using preheater tubes cleaned with A-1 polish, were widely different for the five test fuels, with the

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* The mention of brand names is for identification only and does not imply endorsement by the Bureau of Mines.

TABLE 7. - COMPARISON OF ELECTROPOLISHING WITH A-1 POLISH

Fuel No.	Tube polished with A-1		Tube electropolished	
	Test temperature, °F tube/fuel-out	Tube deposit rating	Test temperature, °F tube/fuel-out	Tube deposit rating
1-65-2	450/275	1	400/250	1
	475/287	2	450/275	2
	480/290	3	480/290	3
	500/300	4	500/300	3 1/2
	500/300	5	600/350	6
			650/375	7
			700/400	8
2-65-2	575/338	1	575/338	2
	600/350	2	600/350	3
	625/362	3	625/362	6
			650/375	6
			700/400	8
3-65-2	600/350	1	550/325	2
	650/375	2	575/338	4
	675/388	2	600/350	5
	675/388	3	675/388	8
	700/400	3	675/388	8
4-65-2	550/325	0	530/315	2
	575/338	3	550/325	2
	575/338	4	550/325	4
	600/350	5	560/330	4
			575/338	4
			600/350	6
			625/362	7
			650/375	8
5-65-2	600/350	0	550/325	2
	675/388	2	575/338	4
	700/400	2	625/362	6
	725/412	3	650/375	7
	750/425	4	680/390	8

threshold failure temperatures of the fuels ranging from 480° F to 725° F However, when electropolished tubes were used, the estimated failure temperature ranged from 480° to 600° F using a No. 3 rating as the failure level or from 550° to 600° F if a No. 5 rating was selected. There was an indication that electropolished tube ratings compared better with the 5-ml bomb ratings at 25 percent ΔT than with microfuel coker ratings.

3. QUANTITATIVE DETERMINATION OF TOTAL CARBON ON PREHEATER TUBES

Preliminary data were obtained for comparing visual preheater coker tube ratings and the quantity of carbon obtained by combustion of the microfuel coker deposits over CuO The CO_2 obtained from combustion was quantitatively measured by gas chromatographic analysis Conventional visual rating of coker preheater tubes is based upon the darkest spot on the test section, and this spot is not always representative of the entire deposition. Some coker test conditions result in large areas of light-colored deposits on the preheater tube; others give small areas of deposits of a dark nature. Therefore, a direct comparison of total carbon with visual ratings shows poor correlation. However, a method was found that compensated for these differences and is discussed below.

A series of hand-coated tubes was used to establish a calibration curve for rating of preheater tubes from actual test samples These calibration tubes were coated with a uniform film of gasoline gum obtained from air-jet gum apparatus. The gum was dissolved in a trisolvent and painted on the preheater tube to cover a section exactly 25.4 mm in length. The solvent then was removed and the coating fixed by baking in a dynamic helium atmosphere for 15 minutes at 300° C. Film thickness was varied by the dilution control of gum in solvent. Visual ratings ranging from 2 to 8 were obtained with good uniformity of color over the painted area. Each finished tube was combusted by inserting the preheater tube into a quartz combustion tube packed with 4 inches of CuO at 625° C. Oxygen was passed over the tube to sweep the resultant CO_2 into a plastic collection bag. The total volume collected was recorded prior to analyzing a 26-cm^3 aliquot in a gas chromatographic (23 feet x 1/8-inch Porapak Q) column operated at room temperature, using helium carrier gas at 30 cm^3/min and a heated filament detector for total CO_2. Total weight of carbon on the preheater tube was calculated with dilution factors and chromatographic calibration data. The results obtained from the calibration tubes were plotted against the visual rating for each tube as shown in figure 1. A regression analysis was used to determine the best line through the data. The correlation was excellent and this curve was used to rate tubes from actual jet-fuel microfuel coker thermal stability tests. Table 8 shows a comparison

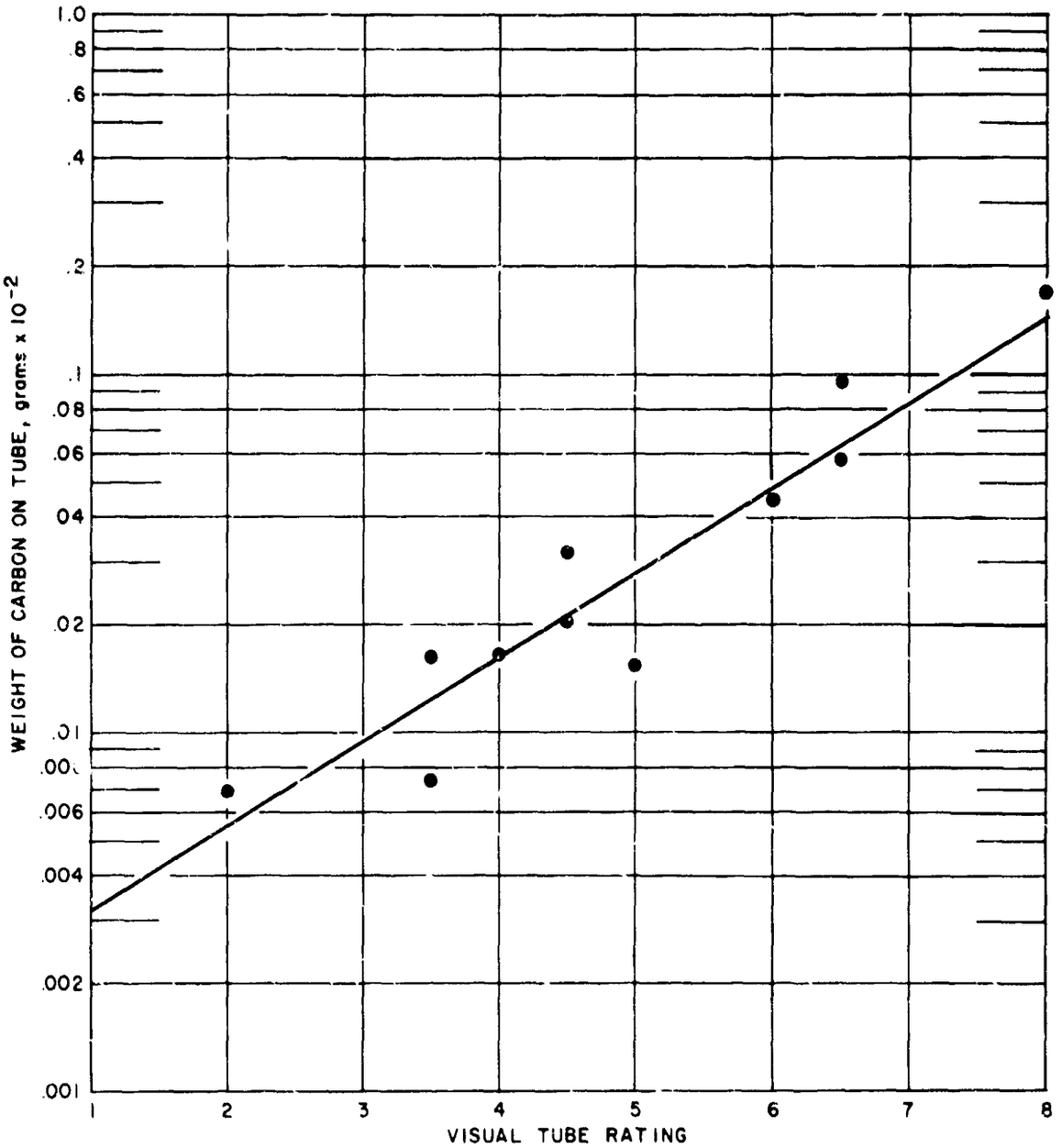

FIGURE 1.-Combustion of Deposits on Hand-Coated Preheater Tubes.

TABLE 8. - COMPARISON OF VISUAL RATINGS WITH RATINGS BASED UPON TOTAL CARBON FOR FIVE JET FUELS

Fuel or tube no.	Temp., °F	Wt of carbon deposit, g	Tube rating (from graph), no.	Visual tube rating, no.
3-6-67	575/337	0.000166	4	3
1-65-2	480/290	.000186	4	4
4-65-2	575/338	.000075	2.5	2
4-65-2	600/350	.000351	5.5	7
3-65-2	675/388	.000329	5.5	8
IN26-1361	480/290	.000937	7	1
3NO-1375	675/388	.000074	2.5	3
3-65-2	675/388	.000078	2.5	4
3NO-1375	675/388	.000057	2	3
2-65-2	480/290	.000128	3.5	1
1-65-2	480/290	.000063	2.5	4
4-65-2	575/338	.000148	4	8
5D52-1% Ethylindene	725/412	.001025	7.5	8
5D52-1% Ethylindan	725/412	.001050	7.5	8
1-65-2	600/350	.000508	6	8

of these data with conventional visual ratings. Note that the ratings by visual and weight of carbon methods are similar. The weight of carbon ratings provides a more reliable measure of the deposit-forming characteristics since it is a precise analytical measurement of the total deposition, whereas the visual tube is based upon the darkest area on the tube.

A problem encountered in these investigations was that of residual fuel contamination of preheater tubes and its effect upon total carbon determination. This problem was minimized by rinsing the preheater tube that contained the deposit with n-hexane, followed by evacuation at 100 micron's pressure. The rinsings were repeated, and the tube was again evacuated. Far fewer wild results were observed after incorporation of this precleaning.

As the windup of these preliminary investigations, a series of six additional jet fuels was obtained. Each was tested in the microfuel coker for thermal stability quality. The preheater tube from each determination was rated both visually and by the combustion technique described. The threshold failure temperature was calculated by regression analysis of the data. The completed ratings are summarized as follows:

	Threshold failure temp, °F	
Fuel	Visual ratings	Wt of carbon ratings
JP-4	536/318	546/323
RAF-159-64	823/462	691/395
Blend 7	536/318	518/309
AFFB-3-64	598/349	573/337
RAF-163-60	720/410	674/387
RAF-178-64	428/264	505/303

4. HYDROGEN-BONDING OF JET FUELS

Another preliminary study to develop a new and unique method of determining the thermal stability quality of aircraft turbine fuels was begun as a prelude to further cooperative studies on jet fuels. This effort was aimed at developing a correlation between hydrogen bonding and the thermal stability quality of the fuel. The first technique used to study hydrogen bonding employed a tritiated acid complex of phosphoric acid -- $TH_2PO_4 \cdot BF_3$ -- to promote a tritium exchange reaction in the fuel. Although exchange was achieved with this reagent, the rate and extent of exchange were functions

of both the labile hydrogen and hydrocarbon unsaturation and/or aromaticity. It therefore seemed necessary to seek less severe conditions of exchange in order to minimize the effect of olefins and aromatics in the reaction.

Yavorsky and Gorin (8) used tritiated phosphoric acid for labeling organic compounds with labile hydrogen. The reaction rate induced by this reagent was estimated to be less than 1 percent of that observed with the corresponding BF_3 complex. The tritiated acid was easily prepared by combining stoichiometric quantities of tritium oxide and phosphorus pentoxide. The resulting reagent was too viscous to be pipetted; assay of the reagent was, therefore, calculated on a mass basis, and the exchange reaction with organic materials was investigated by combining a mass ratio of 2 to 1, fuel to reagent. Studies with some pure compounds revealed that olefins and aromatics did not exchange or react with this reagent to any appreciable degree in periods to 1 hour at room temperature. However, cresol, which contains a labile hydrogen, exchanged to the extent of 55 percent with 2 1/2 hour's contact with the reagent. Sample recovery from this reagent presented a difficulty not previously encountered. Oxygenated compounds such as cresol, as well as the acid reagent, are soluble in water. However, a washing procedure with benzene was developed that satisfactorily recovered the sample from the acid reagent. Liquid scintillation radioassay techniques were used to determine the total exchange of tritium from the reagent with the labile hydrogen of the sample.

First data with the hydrogen bonding method described above showed evidence of a good correlation between the abundance of active hydrogen sites and the thermal stability quality of five jet fuels. The data are as follows:

Tritium Incorporation as a Measure of the Thermal Stability Quality of Five Jet Fuels

Jet fuel	Microfuel coker threshold failure temperature, °F	Exchange, percent of initial (avg of 2)
1-65-2	480	0.067
2-65-2	625	.033
3-65-2	675	.029
4-65-2	575	.020
5-65-2	725	.031

Jet fuel 3-65-2 averaged 0.023 percent tritiation for 10 replicate runs with a standard deviation of 0.009 percent. Five replicate runs made on jet fuel 3-65-2 with 1 percent cresol added averaged 1.441 percent and showed even better repeatability, probably due to the larger percentage of tritium incorporation.

Another set of eight jet fuels was treated in the same manner as the above group of five jet fuels. They are listed below by their code designation and the 5-ml bomb failure temperatures. Coker data were not available for these samples.

Fuel	5-ml bomb failure temperature, °F	Exchange, percent of initial
AFFB-8-67	362	0.023
AFFB-4-64	343	.062
AFFB-10-67	484	.011
RAF-174-63	381	.090
AFFB-3-64	488	.011
AFFB-9-67	354	.073
AFFB-12-68	551	.014
AFFB-11-68	555	.005

5. OXYGEN CONSUMPTION DURING THERMAL STABILITY TESTS IN A 5-ML BOMB

Although storage stability is not presently considered a serious problem for high-temperature fuels, such as SST turbine fuels, thermal stability is of concern, and improvement in precision of existing methods for measuring thermal stability is highly desirable. Along these lines, the standard 5-ml-bomb thermal stability test developed by Phillips Petroleum Co. (9) was modified to permit the measurement of oxygen consumption during heating a fuel sample with hopes of incorporating this value into a more precise determination of thermal stability quality. A silicone rubber septum was used on the upper structure of the 5-ml bomb apparatus so that at the end of the conventional heating period the gases above the sample could be sampled with a microliter syringe for oxygen analysis in a gas chromatograph.

A total of 20-30 runs on each of five fuels was obtained for this study. At least 10 of these runs were at a single test temperature: 400° F. These values were obtained to predict the threshold failure temperature of the fuel by

running a single determination in the 5-ml bomb apparatus. An acceptable correlation with microfuel coker information could not be found from these data; therefore, 10 to 20 more runs on each fuel were made at test temperatures selected to give 10 to 90 percent oxygen consumption. These latter data were then combined with the 400° F data for correlative efforts. In each test the loss in light transmittance was measured, as was the oxygen consumption.

Tables 49-53 contain the data falling between 5 and 35 units' loss of light transmittance for each fuel and the regression analysis of the light transmittance loss data for each of the five test fuels. These calculations were made by the method prescribed by Phillips Petroleum Co. Threshold failure temperatures were derived from this treatment of the data. These values do not correspond very well with microfuel coker data. Also included in these five tables are regression equations for the product of light transmittance loss and oxygen consumed. This product was felt to correspond roughly to the factor (MF_{16}) of Schwartz (10). The standard deviation of the estimated threshold failure temperature based solely upon light transmittance losses was calculated to be ±153° F, as shown in table 54. The standard deviation using a combined ΔLT-O_2 consumption factor was ±129° F. An analysis of equality of variance shows these values are not significantly different; therefore, no improvement in threshold failure temperature estimation was achieved by incorporation of the second parameter of oxygen consumption.

Other treatments of these data are included in tables 55-59. The grouping of data in these five tables shows a definite tendency to break sharply at nearly 400° F. A linear expression seems to fit the data points if they are divided into two groups and a straight line is fitted to each group. Therefore, tables 55 through 59 contain the regression analyses of these data grouped as indicated in terms of oxygen consumed. For instance, in table 55, the data are divided into two groups - the first contains all values between 0 and 60 percent oxygen consumption, and the other contains data for oxygen consumption higher than 60 percent. Although many data points could be assigned to either curve, each data point was used only once.

It was thought initially that some significance could be attached to the breakpoint shown in plots of oxygen consumption versus test temperature. However, the extrapolated breakpoint appears between 400° and 425° F for all five fuels, although the threshold failure temperature for these five ranges from 480° F on fuel No. 1 to 725° F on No. 5. Therefore, there seemed no correlation between these inflection points of oxygen consumption and thermal stability quality of the fuel as defined by the microfuel coker. The increase in oxygen consumption at this point is probably a function of bond strength in organic molecules.

An attempt at correlation between threshold failure temperature of the five fuels (as determined by microfuel coker) and the loss of light transmittance at 400° F in the 5-ml bomb was unsuccessful. However, a fair correlation does exist between 25 units light transmittance and the standard CRC coker test.

Further attempts to correlate oxygen consumption at 400° F in the 5-ml bomb with threshold failure temperature (by microfuel coker) were also unsatisfactory.

Finally, an attempt to correlate a factor composed of the product of light transmittance loss and oxygen consumption at 400° F with the threshold failure temperature (by microfuel coker) failed to establish any relationship.

Other attempts at correlation included comparison of slopes of least squares curves (ΔLT versus threshold failure temperature; percent O_2 consumed versus threshold failure temperature; and factor versus threshold failure temperature) for each of the five fuels with threshold failure temperature as well as comparison of y-intercepts with threshold failure temperature. No correlation was found for any of the parameters mentioned. This would suggest that thermal stability quality is only partially related to oxidation, with perhaps fragmentation and bond cleavage the controlling factor in deposition during thermal stress in the microfuel coker. The 5-ml bomb is probably more closely related to oxidation tendency than is the microfuel coker.

SECTION IV

CONCLUSIONS

1. MICROFUEL COKER-THERMAL STABILITY DEPOSITS

The greatest extent of reaction which was observed in the labeled fuel blends studied during the last year of this 3-year program was in those blends that contained the carbon-14-labeled antioxidant N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine. The amount of reaction or decomposition which formed filterable deposits varied greatly from fuel to fuel, with as much as 56 percent of the radiotracer recovered as filterable deposit from one fuel and only 1 percent filterable deposit in another fuel. Radioactivity losses which were large for these blends, both during storage and in the thermal stability tests, indicated fragmentation of the butyl group from the additive to give a volatile product, which was lost through vaporization.

The second greatest amount of reaction was observed with another labeled amine-type additive, N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C. The amount of radiotracer recovered as filterable deposits ranged from 1 to 20 percent. Again, some radiotracer was lost through fragmentation and vaporization of the volatile product, and the greatest loss occurred in fuel 4-65-2.

Oleic-^{14}C acid blended with a jet fuel was found to interact with cadmium during storage, with formation of more filterable deposits than when the blend was stored without cadmium.

There was a modest amount of reaction during storage in blends that contained a corrosion inhibitor, dilinoleic-^{14}C acid, along with some loss of radioactivity. The greatest reaction with dilinoleic-^{14}C acid was in fuel 5-65-2, the fuel which has the highest thermal stability threshold failure temperature.

2. SPECIAL STUDIES

From the test data for the nonradioactive blends, it was concluded that the substituted indenes and indan cause serious deterioration of the thermal stability quality of fuels when they are present at the 1-percent level. Also, 0.3 percent n-butyl sulfide caused a decrease in the thermal stability quality of all the test fuels after only a short storage period. The anti-icing additive, 2-methoxyethanol, was concluded to have only a slight effect on the thermal stability quality of the fuels, while 1 percent 2-methylnaphthalene had no effect on the thermal stability of the one fuel with which it was blended.

An investigation performed to compare electropolishing with A-1 polish as a means of cleaning the preheater tubes for the microfuel coker showed that when electropolished tubes were used a wider range of deposit ratings was obtained. However, the fuels with the highest thermal stability rating produced heavier deposits on electropolished tubes, and the fuel with the lowest thermal stability rating produced the same deposits on electropolished tubes as on tubes cleaned with A-1 polish. Consequently, it was concluded that electropolishing, although not correlating well with the standard cleaning procedure, might have some application in a thermal stability test requiring a wider range of sensitivity than the established coker procedures

A method was developed that showed merit as a substitute for visual ratings of preheater tubes. The modified rating method was based upon the total carbon dioxide obtained after combusting the deposit over CuO, in a combustion furnace. A series of seven fuels was rated by the conventional visual method and the described modification with good agreement. The modification was concluded to provide a more reliable measure of deposit-forming characteristics since it was a precise analytical measurement of the total deposit formation, whereas the tube rating based upon visual comparisons of the darkest deposit area does not consider the total deposition on the preheater tube.

Efforts to develop a new method of measuring thermal stability quality of fuels based upon a correlation between hydrogen bonding and threshold failure temperatures gave some encouragement from preliminary results. The method developed used tritiated phosphoric acid to promote an exchange between reactive hydrogen in the fuel and radioactive hydrogen. Studies with some pure compounds showed that olefins and aromatics did not exchange or react with the reagent to any appreciable extent. First data with the method showed evidence of a fair correlation between the abundance of active hydrogen sites and the thermal stability quality of five jet fuels as rated by the microfuel coker. Another set of eight fuels that were rated with the 5-ml bomb thermal stability test also showed good correlation.

A final special study was designed to measure oxygen consumption of a fuel during thermal stability stress in the 5-ml bomb test as a means of improving the correlation between this rating method and conventional coker rating methods. Improved correlations were not obtained from this study, and it was concluded that thermal stability quality is only partially related to oxidation, with fragmentation and bond cleavage the controlling factors in deposition during thermal stress in the 5-ml bomb test.

APPENDIX I

FUELS AND FUEL TREATMENT

1. FUELS

Five fuels were selected for study in this program. Three 5-gallon containers of each fuel were obtained from the Air Force and stored at 40° F under helium. Working samples were obtained by displacing from the desired container with low-pressure helium. Numbers assigned these fuels were unchanged from Air Force designations. Table 9 shows a summary of the microcoker data from these five fuels, and table 10 contains the inspection data for the same group. These unaltered fuels were referred to as neat in subsequent use.

2. FUEL TREATMENT

a. Depolarization

A portion of each of the five test fuels was depolarized by percolation through silica gel to remove 1 to 2 percent of the fuel that consisted of highly polar sulfur, nitrogen, and oxygen compounds. The bench-scale procedure used for this treatment is described as follows.

A 2-in-diameter glass column was filled with an appropriate amount of chemical-grade 925, 100/200-mesh silica gel. A ratio of 1 g of gel to 10 ml of fuel was more than adequate for the gross separations desired in this treatment; therefore, in the depolarization of 3.5 gal of fuel, about 2,150 ml of gel was used. A flowrate of 1 l/hr of fuel through the gel column was achieved by gravity and pressurization to 5 psig with nitrogen. The last of the fuel was eluted through the column with isopropyl alcohol. To detect the interface between alcohol and fuel, a portion of carbon-14-labeled isopropyl alcohol was introduced into the column and followed by a liter or more of unlabeled alcohol. Small fractions were collected from the zone between aromatics and colored polar materials, and each fraction was checked for radioactivity. Emergence of radioactive alcohol was used as a marker to define the interface between aromatics and polar materials. It was desirable to omit both radioactive and colored material from the depolarized fuel. In four of the treated fuels, about 1 percent of the fuel was discarded as polar material. More than 2 percent of the fifth fuel was removed by this treatment.

TABLE 9. - SUMMARY OF MICROCOKER DATA FROM FIVE TEST FUELS

Fuel	Test temperature, °F fuel-out/tube	Tube rating	BuMines breakpoint	Univ. of Dayton WPAFB breakpoint
1-65-2	275/450	1		
	300/500	5	480	475
	287/475	2		
	300/500	4		
2-65-2	350/600	2		
	337/575	1	625	625
	362/625	3		
3-65-2	350/600	1		
	375/650	2	675	700
	387/675	3		
	400/700	3		
	400/700	3		
	387/675	2		
4-65-2	350/500	0		
	350/600	5	575	600
	325/550	0		
	337/575	3		
	337/575	4		
	350/600	5		
5-65-2	350/600	0		
	400/700	2	725	675
	425/750	4		
	412/725	3		
	412/725	3		
	387/675	2		
	400/700	2		

TABLE 10. - INSPECTION DATA FOR FIVE HIGH-TEMPERATURE FUELS

	Fuel, Type, and Designation									
	1-65-2		2-65-2		3-65-2		4-65-2		5-65-2	
	Neat	Depolarized	Neat	Depol.	Neat	Depol	Neat	Depol	Neat	Depol.
Distillation:										
Initial boiling point, °F---	366	366	356	360	374	372	308	308	344	350
Fuel evap 10% at ------	384	392	372	374	396	396	330	330	364	364
Do. --- 20% at ------	390	396	374	374	402	400	334	334	368	368
Do. --- 50% at ------	402	408	380	380	416	414	346	346	380	380
Do --- 90% at ------	426	430	388	390	448	448	368	368	420	422
End point at ------	464	498	446	450	494	488	434	430	496	482
Residue, volume percent---	1 3	0 4	0.5	0.3	0 5	0 5	0.5	0.7	0.5	0.7
Distillation loss, ---do ---	.7	---	---	---	---	---	---	---	---	---
Specific gravity, 60° F/60° F	.807	.806	.783	.782	.792	.792	.782	.782	.772	.772
Sulfur, total weight-percent -	.016	.008	.001	.001	.001	.000	.006	.001	.000	.000
FIA hydrocarbon analysis, volume percent:										
P-N ----------	84	85	89	91	98	98	97	98	96	97
Olefin ----------	3	2	1	2	1	1	2	1	3	2
Aromatics ----------	13	13	8	7	1	1	1	1	1	1
Flash point, °F ----------	152	147	138	138	154	147	114	---	132	134
Freezing point, °C ---------	-52	-54	-62	-62	-52	-52	-68	-68	-63	-61
Viscosity at -30° F, centistokes	8.8	8.8	7 2	7.0	11.8	11.1	4 9	5.0	8.7	8.7
Thermal stability:										
MFC preheater deposit code 3, breakpoint temp, °F ---	480	540	625	560	675	640	575	640	725	750

After the depolarization was complete, each fuel was filtered through a 1.2μ cellulose ester filter. This filtration was considered necessary because of the detrimental catalytic effect of gel contamination in depolarized fuels. The filtered fuels were blanketed with an inert gas and stored at 40° F.

b. Contamination

Several test blends were contaminated by the addition of 20 ppm by weight of Fe_2O_3 (red iron oxide) and water in a ratio of 1 part to 5,000 parts fuel (vol).

APPENDIX II

TEST DATA OBTAINED FROM RADIOTRACER STUDIES WITH THE MICROFUEL COKER

TABLE 11. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 3 PPM 1-ETHYLINDAN-3-^{14}C

Fuel	Treatment	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
		Before storage	After 52 wks at 130° F	
1-65-2	Neat	0.060	0.037	98.5
	Contaminated	.000	.108	99.8
	Depolarized	.041	.075	100.4
2-65-2	Neat	.067	.015	99.8
	Contaminated	.015	.005	100.1
	Depolarized	.143	.029	99.2
3-65-2	Neat	.001	.027	100.0
4-65-2	Neat	.038	.988	99.2
5-65-2	Neat	.013	.083	101.4
	Contaminated	.048	.023	101.4
	Depolarized	.019	.654	96.7

TABLE 12. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 2 PPM 1-ETHYLINDENE-3-^{14}C

Fuel	Treatment	Contribution of radiotracer to total deposits, percent: Before storage	Contribution of radiotracer to total deposits, percent: After 52 wks at 130° F	Radioactivity recovery, percent
1-65-2	Neat	0.140	0.068	99.9
	Contaminated	.080	.137	99.5
	Depolarized	.018	.044	98.6
2-65-2	Neat	.026	.124	100.1
	Contaminated	.129	.085	99.9
	Depolarized	.004	.121	99.9
3-65-2	Neat	.122	.080	101.5
4-65-2	Neat	.155	5.317	1/ 95.9
5-65-2	Neat	.108	.560	102.4
	Contaminated	.096	.161	100.3
	Depolarized	.062	3.080	1/ 92.5

1/ Reflects a loss of radioactivity during storage period.

TABLE 13. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 1-METHYL INDAN-3-^{14}C, TETRALIN-^{14}C, 1,2,3,5-TETRAMETHYLBENZENE-^{14}C, 1-METHYLINDENE-3-^{14}C, AND n-HENDECANE-1-^{14}C

Fuel (neat)	Radiotracer	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
		Before storage	After 52 wks at 130° F	
1-65-2	1-Methyl-indan-3-^{14}C	0.012	0.088	100.8
2-65-2	--------do.---------	.007	.055	99.3
3-65-2	--------do.---------	.018	.057	99.9
4-65-2	--------do.---------	.027	1.310	96.7
5-65-2	--------do.---------	.062	.060	98.5
1-65-2	Tetralin-^{14}C---------	.038	.003	99.4
2-65-2	--------do.---------	.061	.094	101.0
3-65-2	--------do.---------	.001	.008	100.0
4-65-2	--------do.---------	.033	.773	96.6
5-65-2	--------do.---------	.037	.089	98.8
1-65-2	1,2,3,5-Tetramethyl-benzene-^{14}C	.010	.013	100.0
1-65-2	1-Methylindene-3-^{14}C	.013	.019	98.8
2-65-2	--------do.---------	.056	.105	99.6
3-65-2	--------do.---------	.105	.169	99.5
4-65-2	--------do.---------	.121	7.142	85.9
5-65-2	--------do.---------	.111	.268	98.6
1-65-2	n-Hendecane-1-^{14}C--	.033	.055	98.2
2-65-2	--------do.---------	.029	.036	101.9
3-65-2	--------do.---------	.060	.014	99.6
4-65-2	--------do.---------	.202	.373	101.6
5-65-2	--------do.---------	.143	.147	101.2

TABLE 14. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 0.7 PPM 2-METHYL-^{14}C-NAPHTHALENE

Fuel	Treatment	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
		Before storage	After 52 wks at 130° F	
1-65-2	Neat	0.021	0.096	99.7
	Contaminated	.020	.101	100.3
	Depolarized	.002	.025	98.8
2-65-2	Neat	.103	.033	99.2
	Contaminated	.056	.061	98.7
	Depolarized	.039	.038	100.4
3-65-2	Neat	.117	.029	100.2
	Contaminated	.070	.014	100.0
4-65-2	Neat	.087	.064	99.7
	Contaminated	.124	.122	99.8
	Depolarized	.088	.051	98.4
5-65-2	Neat	.166	.023	101.1
	Contaminated	.109	.031	99.3
	Depolarized	.049	.074	100.3

TABLE 15. - SUMMARY OF STORAGE-STABILITY TESTS OF BLENDS CONTAINING 8 PPM 2,6-di-t-BUTYL-^{14}C-p-CRESOL

Fuel	Treatment	Contribution of radiotracer to total deposits, percent		Radioactivity recovery, percent
		Before storage	After 52 wks at 130° F	
1-65-2	Neat	0.160	0.196	95.7
	Contaminated	.201	.261	99.5
	Depolarized	.000	.068	94.9
2-65-2	Neat	.038	.040	100.2
	Contaminated	.033	.036	98.7
	Depolarized	.037	.102	99.9
3-65-2	Neat	.044	.076	98.2
4-65-2	Neat	.078	.115	99.7
5-65-2	Neat	.107	.074	99.3
	Contaminated	.038	.085	98.0
	Depolarized	.048	.106	99.2

TABLE 16. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1N-1264

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2, Neat		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	5	5
Blend		
Initial sp. act., μCi/ml	0.03522	0.03049
Final sp. act., μCi/ml	0.01694	0.01495
Radioactivity balance, %	48.10	49.03
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating number	2	2
Radioactivity, total μCi	0.00699	0.00178
Percent of initial radiotracer	0.040	0.012
Filterable deposits		
450 mμ test filter, dpm	7,713,525	4,521,950
Blank 450 mμ prefilter, dpm	31,293	262,517
Net dpm on 450 mμ test filter	7,682,232	4,259,433
Percent of total radioactivity on 450 mμ test filter	19.65	12.59
300 mμ test filter, dpm	8,263,400	4,660,600
Blank 300 mμ filter, dpm	320,000	3,307,800
Net dpm on 300 mμ test filter	7,943,400	1,352,800
Percent of total radioactivity on 300 mμ test filter	20.32	4.00
10 mμ test filter, dpm	131,300	1,486,600
Blank 10 mμ filter, dpm	110,400	2,573,700
Net dpm on 10 mμ test filter	20,900	0
Percent of total radioactivity on 10 mμ test filter	0.05	0
Summary		
Summed filterable deposits, %	40.02	16.59
Total deposits, %	40.06	16.60

TABLE 17. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1C-1257

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2, Contaminated		
Radiotracer		
Compound N,N'-di-sec-buryl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2	2
Blend		
Initial sp. act., μCi/ml	0.01310	0.01188
Final sp. act., μCi/ml	0 00488	0.00579
Radioactivity balance, %	37.25	48.74
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	1	2
Radioactivity, total μCi	0 00387	0.00124
Percent of initial radiotracer	0 059	0.021
Filterable deposits		
450 mμ test filter, dpm	3,634,050	1.816,300
Blank 450 mμ prefilter, dpm	55,557	88,746
Net dpm on 450 mμ test filter	3,578 493	1,727,554
Percent of total radioactivity on 450 mμ test filter	24.61	13.10
300 mμ test filter, dpm	2.830,100	1,465,200
Blank 300 mμ filter, dpm	245,500	964,000
Net dpm on 300 mμ test filter	2.584,600	501.200
Percent of total radioactivity on 300 mμ test filter	17.80	3.80
10 mμ test filter, dpm	68.600	632,300
Blank 10 mμ filter, dpm	97,000	916,600
Net dpm on 10 mμ test filter	0	0
Percent of total radioactivity on 10 mμ test filter	0	0
Summary		
Summed filterable deposits, %	42.41	16.90
Total deposits, %	42 47	16.92

TABLE 18. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1D-1265

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2, Depolarized		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	3	3
Blend		
Initial sp. act., μCi/ml	0.01995	0.01167
Final sp. act., μCi/ml	0.00118	0.00336
Radioactivity balance, %	5.91	28.79
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	3	3
Radioactivity, total μCi	0.00924	0.000255
Percent of initial radiotracer	0.093	0.004
Filterable deposits		
450 mμ test filter, dpm	3,888,801	123,867
Blank 450 mμ prefilter, dpm	82,797	109,982
Net dpm on 450 mμ test filter	3,806,004	13,885
Percent of total radioactivity on 450 mμ test filter	17.19	0.11
300 mμ test filter, dpm	4,196,300	1,173,100
Blank 300 mμ filter, dpm	263,900	1,068,700
Net dpm on 300 mμ test filter	3,932,400	104.400
Percent of total radioactivity on 300 mμ test filter	17.76	0.81
10 mμ test filter, dpm	35,000	1,000,700
Blank 10 mμ filter, dpm	354,700	1,091,300
Net dpm on 10 mμ test filter	0	0
Percent of total radioactivity on 10 mμ test filter	0	0
Summary		
Summed filterable deposits, %	34.95	0.92
Total deposits, %	35.04	0.92

TABLE 19. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2N-1266

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, Neat		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2.5	2.5
Blend		
Initial sp. act., μCi/ml	0.01894	0.01890
Final sp. act., μCi/ml	0.01823	0.01681
Radioactivity balance, %	96.25	88.94
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	4	5
Radioactivity, total μCi	0.000202	0.000304
Percent of initial radiotracer	0.002	0.003
Filterable deposits		
450 mμ test filter, dpm	88,154	112,936
Blank 450 mμ prefilter, dpm	10,822	20,658
Net dpm on 450 mμ test filter	77,332	92,278
Percent of total radioactivity on 450 mμ test filter	0.37	0.44
300 mμ test filter, dpm	844,800	359,000
Blank 300 mμ filter, dpm	482,100	210,500
Net dpm on 300 mμ test filter	362,700	148,500
Percent of total radioactivity on 300 mμ test filter	1.72	0.71
10 mμ test filter, dpm	209,500	321,100
Blank 10 mμ filter, dpm	186,700	227,300
Net dpm on 10 mμ test filter	22,800	93,800
Percent of total radioactivity on 10 mμ test filter	0.11	0.45
Summary		
Summed filterable deposits, %	2.20	1.60
Total deposits, %	2.20	1.60

TABLE 20. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2C-1267

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, Contaminated		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2.5	2.5
Blend		
Initial sp. act., μCi/ml	0.01770	0.01764
Final sp. act., μCi/ml	0.01713	0.01603
Radioactivity balance, %	96.78	90.87
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	3	5
Radioactivity, total μCi	0.00040	0.000212
Percent of initial radiotracer	0.004	0.002
Filterable deposits		
450 mμ test filter, dpm	122,588	64,035
Blank 450 mμ prefilter, dpm	14,105	8,984
Net dpm on 450 mμ test filter	108,483	55,051
Percent of total radioactivity on 450 mμ test filter	0.55	0.28
300 mμ test filter, dpm	392,200	284,200
Blank 300 mμ filter, dpm	293,100	105,700
Net dpm on 300 mμ test filter	99,100	178,500
Percent of total radioactivity on 300 mμ test filter	0.50	0.91
10 mμ test filter, dpm	102,300	253,500
Blank 10 mμ filter, dpm	72,000	137,400
Net dpm on 10 mμ test filter	30,300	116,100
Percent of total radioactivity on 10 mμ test filter	0.15	0.59
Summary		
Summed filterable deposits, %	1.20	1.78
Total deposits, %	1 20	1.78

TABLE 21. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2D-1268

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, Depolarized		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2.5	2.5
Blend		
Initial sp. act., μCi/ml	0.01845	0.01842
Final sp. act., μCi/ml	0.01404	0.01226
Radioactivity balance, %	76.10	66.56
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	8(Est.)	4
Radioactivity, total μCi	0.00191	0.002348
Percent of initial radiotracer	0.021	0.025
Filterable deposits		
450 mμ test filter, dpm	946,786	666,966
Blank 450 mμ prefilter, dpm	41,455	62,924
Net dpm on 450 mμ test filter	905,331	604,042
Percent of total radioactivity on 450 mμ test filter	4.42	2.95
300 mμ test filter, dpm	887,400	816,500
Blank 300 mμ filter, dpm	336,600	259,300
Net dpm on 300 mμ test filter	550,800	557,200
Percent of total radioactivity on 300 mμ test filter	2 69	2.72
10 mμ test filter, dpm	106,900	571,300
Blank 10 mμ filter, dpm	100,800	381,000
Net dpm on 10 mμ test filter	6,100	190,300
Percent of total radioactivity on 10 mμ test filter	0.03	0.93
Summary		
Summed filterable deposits, %	7.14	6.60
Total deposits, %	7.16	6.63

TABLE 22. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 3N-1269

	Before Storage	After 52 wks. at 130° F
Fuel No. 3-65-2, Neat		
Radiotracer		
Compound N, N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	3	3
Blend		
Initial sp. act., μCi/ml	0.01970	0.01945
Final sp. act., μCi/ml	0.01491	0.01408
Radioactivity balance, %	75.68	72.39
Test Temperature		
Preheater tube, °F	675	675
Block, °F	388	388
Preheater tube deposits		
CRC tube rating, number	3	3
Radioactivity, total μCi	0.000403	0.000376
Percent of initial radiotracer	0.004	0.004
Filterable deposits		
450 mμ test filter, dpm	1,098,507	875,265
Blank 450 mμ prefilter, dpm	21,030	41,759
Net dpm on 450 mμ test filter	1,077,477	833,506
Percent of total radioactivity on 450 mμ test filter	4.93	3.86
300 mμ test filter, dpm	1,513,100	431,800
Blank 300 mμ filter, dpm	304,700	255,000
Net dpm on 300 mμ test filter	1,208,400	176,800
Percent of total radioactivity on 300 mμ test filter	5.53	0.82
10 mμ test filter, dpm	105,900	314,900
Blank 10 mμ filter, dpm	98,700	338,900
Net dpm on 10 mμ test filter	7,200	0
Percent of total radioactivity on 10 mμ test filter	0.03	0
Summary		
Summed filterable deposits, %	10.49	4.68
Total deposits, %	10.49	4.68

TABLE 23. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 4N-1270

	Before Storage	After 52 wks. at 130° F
Fuel No. 4-65-2, Neat		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2.5	2.5
Blend		
Initial sp. act., μCi/ml	0.01780	0.01782
Final sp. act., μCi/ml	0.00840	0.00728
Radioactivity balance, %	47.19	40.85
Test Temperature		
Preheater tube, °F	575	575
Block, °F	338	338
Preheater tube deposits		
CRC tube rating, number	3	2
Radioactivity, total μCi	0.00247	0.001754
Percent of initial radiotracer	0.028	0.020
Filterable deposits		
450 mμ test filter, dpm	3,570,429	262,103
Blank 450 mμ prefilter, dpm	72,471	155,495
Net dpm on 450 mμ test filter	3,497,958	106,608
Percent of total radioactivity on 450 mμ test filter	17.70	0.54
300 mμ test filter, dpm	670,900	4,861,100
Blank 300 mμ filter, dpm	661,100	732,000
Net dpm on 300 mμ test filter	9,800	4,129,100
Percent of total radioactivity on 300 mμ test filter	0.05	20.87
10 mμ test filter, dpm	150,000	586,800
Blank 10 mμ filter, dpm	108,000	598,300
Net dpm on 10 mμ test filter	42,000	0
Percent of total radioactivity on 10 mμ test filter	0.21	0
Summary		
Summed filterable deposits, %	17.96	21.41
Total deposits, %	17.99	21.43

TABLE 24. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5N-1271

	Before Storage	After 52 wks. at 130° F
Fuel No. 5-65-2, Neat		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	3	3
Blend		
Initial sp. act., μCi/ml	0.02053	0.02004
Final sp. act., μCi/ml	0.00710	0.00550
Radioactivity balance, %	34.58	27.45
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating number	4	4
Radioactivity, total μCi	0.000523	0.000515
Percent of initial radiotracer	0.005	0.005
Filterable deposits		
450 mμ test filter, dpm	2,537,757	1,854,766
Blank 450 mμ prefilter, dpm	136,263	105,612
Net dpm on 450 mμ test filter	2,401,494	1,749,154
Percent of total radioactivity on 450 mμ test filter	10.54	7.86
300 mμ test filter, dpm	9,748,700	8,763,300
Blank 300 mμ filter, dpm	783,900	696,000
Net dpm on 300 mμ test filter	8,964,800	8,067,300
Percent of total radioactivity on 300 mμ test filter	39.34	36.27
10 mμ test filter, dpm	74,000	211,100
Blank 10 mμ filter, dpm	175,500	556,700
Net dpm on 10 mμ test filter	0	0
Percent of total radioactivity on 10 mμ test filter	0	0
Summary		
Summed filterable deposits, %	49.88	44.13
Total deposits, %	49.8	44.1

TABLE 25. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5C-1272

	Before Storage	After 52 wks. at 130° F
Fuel No. 5-65-2, Contaminated		
Radiotracer		
Compound N, N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	2.5	2.5
Blend		
Initial sp. act., μCi/ml	0.01784	0.01728
Final sp. act., μCi/ml	0.00559	0.00429
Radioactivity balance, %	31.33	24.83
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating, number	3	3
Radioactivity, total μCi	0.000608	0.000700
Percent of initial radiotracer	0.007	0.008
Filterable deposits		
450 mμ test filter, dpm	2,449,175	1,785,628
Blank 450 mμ prefilter, dpm	91,060	51,518
Net dpm on 450 mμ test filter	2,358,115	1,734,110
Percent of total radioactivity on 450 mμ test filter	11.91	9.04
300 mμ test filter, dpm	8,478,400	9,520,000
Blank 300 mμ filter, dpm	337,900	370,600
Net dpm on 300 mμ test filter	8,140,500	9,149,400
Percent of total radioactivity on 300 mμ test filter	41.11	47.70
10 mμ test filter, dpm	80,100	178,000
Blank 10 mμ filter, dpm	156,100	380,200
Net dpm on 10 mμ test filter	0	0
Percent of total radioactivity on 10 mμ test filter	0	0
Summary		
Summed filterable deposits, %	53.02	56.74
Total deposits, %	53.03	56.75

TABLE 26. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5D-1273

	Before Storage	After 52 wks. at 130° F
Fuel No. 5-65-2, Depolarized		
Radiotracer		
Compound N,N'-di-sec-butyl-4-^{14}C-p-phenylenediamine		
Concentration in blend, ppm	3	3
Blend		
Initial sp. act., μCi/ml	0.02019	0.01955
Final sp. act., μCi/ml	0.01273	0.01187
Radioactivity balance, %	63.05	60.72
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating number	6(Est.)	2
Radioactivity, total μCi	0.00127	0.001094
Percent of initial radiotracer	0.013	0.011
Filterable deposits		
450 mμ test filter, dpm	1,905,700	1,124,802
Blank 450 mμ prefilter, dpm	121,311	198,105
Net dpm on 450 mμ test filter	1,784,389	926,697
Percent of total radioactivity on 450 mμ test filter	7.96	4.27
300 mμ test filter, dpm	2,497,400	1,419,800
Blank 300 mμ filter, dpm	906,400	1,004,500
Net dpm on 300 mμ test filter	1,591,000	415,300
Percent of total radioactivity on 300 mμ test filter	7.10	1.91
10 mμ test filter, dpm	155,500	516,500
Blank 10 mμ filter, dpm	147,500	427,500
Net dpm on 10 mμ test filter	8,000	89,000
Percent of total radioactivity on 10 mμ test filter	0.04	0.41
Summary		
Summed filterable deposits, %	15.10	6.59
Total deposits, %	15.11	6.60

TABLE 27 -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1N-1333

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2 Neat		
Radiotracer		
Compound Oleic-1-^{14}C-acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02231	0.02230
Final sp. act., μCi/ml	0 02091	0.02152
Radioactivity balance, %	93.7	96.5
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	2	2
Radioactivity, total μCi	0.000458	0.000069
Percent of initial radiotracer	0 0041	0.0006
Filterable deposits		
450 mμ test filter, dpm	38 442	20 314
Blank 450 mμ prefilter, dpm	45,261	10,532
Net dpm on 450 mμ test filter	0	9 782
Percent of total radioactivity on 450 mμ test filter	0	0 04
300 mμ test filter, dpm	310 900	215,200
Blank 300 mμ filter, dpm	363 300	196,000
Net dpm on 300 mμ test filter	0	19,200
Percent of total radioactivity on 300 mμ test filter	0	0 08
10 mμ test filter, dpm	150,700	265,600
Blank 10 mμ filter, dpm	166,400	210,800
Net dpm on 10 mμ test filter	0	54,800
Percent of total radioactivity on 10 mμ test filter	0	0 22
Summary		
Summed filterable deposits, %	0	0 34
Total deposits, %	0 00	0 34

TABLE 28. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1Cd-1334

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2, plus Cadmium		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02241	0.02180
Final sp. act., μCi/ml	0.02[illegible]4	0.02024
Radioactivity balance, %	96.1	92.8
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating number	2	3
Radioactivity, total μCi	0.000154	0.002609
Percent of initial radiotracer	0.0014	0.024
Filterable deposits		
450 mμ test filter, dpm	21,721	42,408
Blank 450 mμ prefilter, dpm	54,878	47,094
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	245,200	543,000
Blank 300 mμ filter, dpm	351,000	168,400
Net dpm on 300 mμ test filter	0	374,600
Percent of total radioactivity on 300 mμ test filter	0	1.55
10 mμ test filter, dpm	294,700	211,900
Blank 10 mμ filter, dpm	324,800	185,600
Net dpm on 10 mμ test filter	0	26,300
Percent of total radioactivity on 10 mμ test filter	0	0.11
Summary		
Summed filterable deposits, %	0	1.66
Total deposits, %	0.00	1.68

TABLE 29. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2N-1335

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, Neat		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.01533	0.01492
Final sp. act., μCi/ml	0.01493	0.01398
Radioactivity balance, %	97.4	93.7
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	4	3
Radioactivity, total μCi	0.000145	0.000144
Percent of initial radiotracer	0.0019	0.0019
Filterable deposits		
450 mμ test filter, dpm	45,820	38,538
Blank 450 mμ prefilter, dpm	53,521	119,447
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	155,900	117,500
Blank 300 mμ filter, dpm	333,600	96,100
Net dpm on 300 mμ test filter	0	21,400
Percent of total radioactivity on 300 mμ test filter	0	0.13
10 mμ test filter, dpm	244,300	110,400
Blank 10 mμ filter, dpm	247,000	89,300
Net dpm on 10 mμ test filter	0	21,100
Percent of total radioactivity on 10 mμ test filter	0	0.13
Summary		
Summed filterable deposits, %	0	0.26
Total deposits, %	0.00	0.26

TABLE 30. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2Cd-1336

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, plus Cadmium		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.01753	0.01755
Final sp. act., μCi/ml	0.01677	0.01539
Radioactivity balance, %	95.7	87.7
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating number	3	4
Radioactivity, total μCi	0.000224	0.000665
Percent of initial radiotracer	0.0025	0.008
Filterable deposits		
450 mμ test filter, dpm	43,555	142,220
Blank 450 mμ prefilter, dpm	64,545	141,225
Net dpm on 450 mμ test filter	0	998
Percent of total radioactivity on 450 mμ test filter	0	0.00
300 mμ test filter, dpm	159,400	294,200
Blank 300 mμ filter, dpm	358,100	135,200
Net dpm on 300 mμ test filter	0	159,000
Percent of total radioactivity on 300 mμ test filter	0	0.82
10 mμ test filter, dpm	317,200	153,400
Blank 10 mμ filter, dpm	295,000	84,200
Net dpm on 10 mμ test filter	22,200	69 200
Percent of total radioactivity on 10 mμ test filter	0.11	0.35
Summary		
Summed filterable deposits, %	0.11	1.17
Total deposits, %	0.11	1.18

TABLE 31. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 3N-1337

	Before Storage	After 52 wks. at 130° F
Fuel No. 3-65-2, Neat		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02281	0.02170
Final sp. act., μCi/ml	0.02168	0.02068
Radioactivity balance, %	95.0	95.3
Test Temperature		
Preheater tube, °F	675	675
Block, °F	388	388
Preheater tube deposits		
CRC tube rating, number	3	5
Radioactivity, total μCi	0.000089	0.000144
Percent of initial radiotracer	0.0008	0.0013
Filterable deposits		
450 mμ test filter, dpm	42,669	30,583
Blank 450 mμ prefilter, dpm	72,605	89,645
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	205,200	175,700
Blank 300 mμ filter, dpm	127,300	109,600
Net dpm on 300 mμ test filter	77,900	66,100
Percent of total radioactivity on 300 mμ test filter	0.31	0.27
10 mμ test filter, dpm	362,400	161,800
Blank 10 mμ filter, dpm	306,800	145,900
Net dpm on 10 mμ test filter	55,600	15,900
Percent of total radioactivity on 10 mμ test filter	0.22	0.07
Summary		
Summed filterable deposits, %	0.53	0.34
Total deposits, %	0.53	0.34

TABLE 32. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 3Cd-1338

	Before Storage	After 52 wks. at 130° F
Fuel No. 3-65-2, plus Cadmium		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02283	0.02303
Final sp. act., μCi/ml	0.02203	0.02070
Radioactivity balance, %	96.5	89.9
Test Temperature		
Preheater tube, °F	675	675
Block, °F	388	388
Preheater tube deposits		
CRC tube rating, number	3	6
Radioactivity, total μCi	0.000087	0.000779
Percent of initial radiotracer	0.0008	0.007
Filterable deposits		
450 mμ test filter, dpm	28,559	120,763
Blank 450 mμ prefilter, dpm	73,440	101,200
Net dpm on 450 mμ test filter	0	19,563
Percent of total radioactivity on 450 mμ test filter	0	0.08
300 mμ test filter, dpm	190,800	466,800
Blank 300 mμ filter, dpm	145,700	295,100
Net dpm on 300 mμ test filter	45,100	171,700
Percent of total radioactivity on 300 mμ test filter	0.18	0.67
10 mμ test filter, dpm	347,800	203,200
Blank 10 mμ filter, dpm	288,300	145,400
Net dpm on 10 mμ test filter	59,500	57,600
Percent of total radioactivity on 10 mμ test filter	0.23	0.23
Summary		
Summed filterable deposits, %	0.41	0.98
Total deposits, %	0.41	0.99

TABLE 33. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 4N-1339

	Before Storage	After 52 wks. at 130° F
Fuel No. 4-65-2, Neat		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02224	0.02130
Final sp. act., μCi/ml	0.02141	0.01967
Radioactivity balance, %	96.3	92.3
Test Temperature		
Preheater tube, °F	575	575
Block, °F	338	338
Preheater tube deposits		
CRC tube rating, number	3	1
Radioactivity, total μCi	0.000139	0.000018
Percent of initial radiotracer	0.0012	0.0002
Filterable deposits		
450 mμ test filter, dpm	64,829	310,546
Blank 450 mμ prefilter, dpm	75,756	32,048
Net dpm on 450 mμ test filter	0	278,498
Percent of total radioactivity on 450 mμ test filter	0	1.18
300 mμ test filter, dpm	225,000	389,600
Blank 300 mμ filter, dpm	196,900	266,700
Net dpm on 300 mμ test filter	28,100	122,900
Percent of total radioactivity on 300 mμ test filter	0.11	0.52
10 mμ test filter, dpm	353,600	1,285,000
Blank 10 mμ filter, dpm	275,100	1,162,000
Net dpm on 10 mμ test filter	78,500	123,000
Percent of total radioactivity on 10 mμ test filter	0.32	0.52
Summary		
Summed filterable deposits, %	0.43	2.22
Total deposits, %	0.43	2.22

TABLE 34. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 4Cd-1340

	Before Storage	After 52 wks. at 130° F
Fuel No. 4-65-2, plus Cadmium		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02171	0.02026
Final sp. act., μCi/ml	0.02066	0.01873
Radioactivity balance, %	95.2	92.4
Test Temperature		
Preheater tube, °F	575	575
Block, °F	338	338
Preheater tube deposits		
CRC tube rating, number	2	1
Radioactivity, total μCi	0.000108	0.000025
Percent of initial radiotracer	0.0010	0.0002
Filterable deposits		
450 mμ test filter, dpm	62,060	327,524
Blank 450 mμ prefilter, dpm	59,452	35,792
Net dpm on 450 mμ test filter	2,608	291,732
Percent of total radioactivity on 450 mμ test filter	0.01	1.30
300 mμ test filter, dpm	221,000	297,200
Blank 300 mμ filter, dpm	191,000	222,300
Net dpm on 300 mμ test filter	30,000	74,900
Percent of total radioactivity on 300 mμ test filter	0.12	0.33
10 mμ test filter, dpm	362,800	1,181,900
Blank 10 mμ filter, dpm	268,500	936,600
Net dpm on 10 mμ test filter	94,300	245,300
Percent of total radioactivity on 10 mμ test filter	0.39	1.09
Summary		
Summed filterable deposits, %	0.52	2.72
Total deposits, %	0.52	2.72

TABLE 35. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5N-1341

	Before Storage	After 52 wks. at 130° F
Fuel No. 5-65-2, Neat		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02234	0.02185
Final sp. act., μCi/ml	0.02129	0.02066
Radioactivity balance, %	95.3	94.6
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating, number	5	7
Radioactivity, total μCi	0.000017	0.000039
Percent of initial radiotracer	0.0001	0.0003
Filterable deposits		
450 mμ test filter, dpm	123,276	63,130
Blank 450 mμ prefilter, dpm	126,539	132,129
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	303,900	162,800
Blank 300 mμ filter, dpm	228,600	114,300
Net dpm on 300 mμ test filter	75,300	48,500
Percent of total radioactivity on 300 mμ test filter	0.30	0.20
10 mμ test filter, dpm	455,400	168,400
Blank 10 mμ filter, dpm	362,500	141,200
Net dpm on 10 mμ test filter	92,900	27,200
Percent of total radioactivity on 10 mμ test filter	0.37	0.11
Summary		
Summed filterable deposits, %	0.67	0.31
Total deposits, %	0.67	0.31

TABLE 36. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5Cd-1342

	Before Storage	After 52 wks. at 130° F
Fuel No. 5-65-2, plus Cadmium		
Radiotracer		
Compound Oleic-1-^{14}C acid		
Concentration in blend, ppm	250	250
Blend		
Initial sp. act., μCi/ml	0.02260	0.02184
Final sp. act., μCi/ml	0.02145	0.01979
Radioactivity balance, %	94.9	90.6
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating, number	3	8
Radioactivity, total μCi	0.000041	0.001269
Percent of initial radiotracer	0.0004	0.012
Filterable deposits		
450 mμ test filter, dpm	98,988	126,817
Blank 450 mμ prefilter, dpm	135,681	152,909
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	278,400	398,900
Blank 300 mμ filter, dpm	165,600	185,500
Net dpm on 300 mμ test filter	112,800	213,400
Percent of total radioactivity on 300 mμ test filter	0.45	0.88
10 mμ test filter, dpm	453,500	221,600
Blank 10 mμ filter, dpm	344,300	126,500
Net dpm on 10 mμ test filter	109,200	95,100
Percent of total radioactivity on 10 mμ test filter	0.43	0.39
Summary		
Summed filterable deposits, %	0.88	1.27
Total deposits, %	0.8[illegible]	1.28

TABLE 37. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1N-1282

	Before Storage	After 52 wks. at 130° F
Fuel No. 1-65-2, Neat		
Radiotracer		
Compound 1,5-Hexadiene-1,6-^{14}C		
Concentration in blend, ppm	2	2
Blend		
Initial sp. act., μCi/ml	0.01429	0.01218
Final sp. act., μCi/ml	0.01372	0.00561
Radioactivity balance, %	96.0	46.06
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	2	1
Radioactivity, total μCi	0.000063	0.000026
Percent of initial radiotracer	0.0009	0.0004
Filterable deposits		
450 mμ test filter, dpm	11,820	6,802
Blank 450 mμ prefilter, dpm	1,028	3,947
Net dpm on 450 mμ test filter	10,792	2,855
Percent of total radioactivity on 450 mμ test filter	0.07	0.02
300 mμ test filter, dpm	34,100	64,900
Blank 300 mμ filter, dpm	11,100	7,400
Net dpm on 300 mμ test filter	23,000	57,500
Percent of total radioactivity on 300 mμ test filter	0.14	0.42
10 mμ test filter, dpm	6,300	22,000
Blank 10 mμ filter, dpm	8,700	16,900
Net dpm on 10 mμ test filter	0	5,100
Percent of total radioactivity on 10 mμ test filter	0	0.04
Summary		
Summed filterable deposits, %	0.21	0.48
Total deposits, %	0.21	0.48

TABLE 38. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2N-1283

	Before Storage	After 52 wks. at 130° F
Fuel No. 2-65-2, Neat		
Radiotracer		
Compound 1,5-Hexadiene-1,6-^{14}C		
Concentration in blend, ppm	2	2
Blend		
Initial sp. act., μCi/ml	0.01416	0.01219
Final sp. act., μCi/ml	0.01358	0.00704
Radioactivity balance, %	95.9	57.75
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	4	6(Est.)
Radioactivity, total μCi	0.000063	0.000041
Percent of initial radiotracer	0.0009	0.0007
Filterable deposits		
450 mμ test filter, dpm	12,022	6,827
Blank 450 mμ prefilter, dpm	702	471
Net dpm on 450 mμ test filter	11,320	6,356
Percent of total radioactivity on 450 mμ test filter	0.07	0.05
300 mμ test filter, dpm	20,000	41,800
Blank 300 mμ filter, dpm	8,000	6,000
Net dpm on 300 mμ test filter	12,000	35,800
Percent of total radioactivity on 300 mμ test filter	0.08	0.26
10 mμ test filter, dpm	19,900	20,100
Blank 10 mμ filter, dpm	3,600	3,200
Net dpm on 10 mμ test filter	16,300	16,900
Percent of total radioactivity on 10 mμ test filter	0.10	0.12
Summary		
Summed filterable deposits, %	0.25	0.43
Total deposits, %	0.25	0.43

TABLE 39. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1N-1361

	Before Storage	After 26 wks. at 130° F
Fuel No. 1-65-2, Neat		
Radiotracer		
Compound N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C		
Concentration in blend, ppm	10	10
Blend		
Initial sp. act., μCi/ml	0.01700	0.01705
Final sp. act., μCi/ml	0.01551	0.01447
Radioactivity balance, %	91.2	84.9
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	1	1
Radioactivity, total μCi	0.004119	0.005593
Percent of initial radiotracer	0.048	0.066
Filterable deposits		
450 mμ test filter, dpm	1,293,150	2,267,546
Blank 450 mμ prefilter, dpm	69,161	151,002
Net dpm on 450 mμ test filter	1,223,989	2,116,544
Percent of total radioactivity on 450 mμ test filter	6.49	11.18
300 mμ test filter, dpm	315,300	603,200
Blank 300 mμ filter, dpm	93,800	195,800
Net dpm on 300 mμ test filter	221,500	407,400
Percent of total radioactivity on 300 mμ test filter	1.17	2.15
10 mμ test filter, dpm	90,400	118,100
Blank 10 mμ filter, dpm	105,100	171,300
Net dpm on 10 mμ test filter	0	0
Percent of total radioactivity on 10 mμ test filter	0	0
Summary		
Summed filterable deposits, %	7.66	13.33
Total deposits, %	7.71	13.40

TABLE 40. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2N-1362

	Before Storage	After 26 wks. at 130° F
Fuel No. 2-65-2, Neat		
Radiotracer		
Compound N, N'-disalicylidene-1,2-diaminopropane-1-^{14}C		
Concentration in blend, ppm	12	12
Blend		
Initial sp. act., μCi/ml	0.02306	0.02147
Final sp. act., μCi/ml	0.02060	0.01993
Radioactivity balance, %	89.3	92.8
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	3	4
Radioactivity, total μCi	0.000691	0.000507
Percent of initial radiotracer	0.006	0.005
Filterable deposits		
450 mμ test filter, dpm	364,276	331,488
Blank 450 mμ prefilter, dpm	151,859	160,946
Net dpm on 450 mμ test filter	212,417	170,542
Percent of total radioactivity on 450 mμ test filter	0.83	0.72
300 mμ test filter, dpm	400,000	503,500
Blank 300 mμ filter, dpm	205,600	610,900
Net dpm on 300 mμ test filter	194,400	0
Percent of total radioactivity on 300 mμ test filter	0.76	0
10 mμ test filter, dpm	382,200	296,200
Blank 10 mμ filter, dpm	250,600	279,500
Net dpm on 10 mμ test filter	131,600	16,700
Percent of total radioactivity on 10 mμ test filter	0.51	0.07
Summary		
Summed filterable deposits, %	2.10	0.79
Total deposits, %	2.11	0.80

TABLE 41. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 3N-1363

	Before Storage	After 26 wks. at 130° F
Fuel No. 3-65-2, Neat		
Radiotracer		
Compound N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C		
Concentration in blend, ppm	10	10
Blend		
Initial sp. act., μCi/ml	0.01861	0.01857
Final sp. act., μCi/ml	0.01672	0.01691
Radioactivity balance, %	89.8	91.1
Test Temperature		
Preheater tube, °F	675	675
Block, °F	388	388
Preheater tube deposits		
CRC tube rating, number	2	3
Radioactivity, total μCi	0.000939	0.000538
Percent of initial radiotracer	0.010	0.006
Filterable deposits		
450 mμ test filter, dpm	527,620	441,793
Blank 450 mμ prefilter, dpm	60,923	40,397
Net dpm on 450 mμ test filter	466,697	401,396
Percent of total radioactivity on 450 mμ test filter	2.26	1.95
300 mμ test filter, dpm	242,300	192,700
Blank 300 mμ filter, dpm	100,300	205,900
Net dpm on 300 mμ test filter	142,000	0
Percent of total radioactivity on 300 mμ test filter	0.69	0
10 mμ test filter, dpm	228,900	114,300
Blank 10 mμ filter, dpm	126,200	142,400
Net dpm on 10 mμ test filter	102,700	0
Percent of total radioactivity on 10 mμ test filter	0.50	0
Summary		
Summed filterable deposits, %	3.45	1.95
Total deposits, %	3.46	1.96

TABLE 42. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 4N-1364

	Before Storage	After 26 wks. at 130° F
Fuel No. 4-65-2, Neat		
Radiotracer		
Compound N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C		
Concentration in blend, ppm	11	5
Blend		
Initial sp. act., μCi/ml	0.02110	0.00951
Final sp. act., μCi/ml	0.01827	0.00450
Radioactivity balance, %	86.6	47.3
Test Temperature		
Preheater tube, °F	575	575
Block, °F	338	338
Preheater tube deposits		
CRC tube rating, number	1	1
Radioactivity, total μCi	0.002332	0.000277
Percent of initial radiotracer	0.022	0.006
Filterable deposits		
450 mμ test filter, dpm	1,313,894	1,909,758
Blank 450 mμ prefilter, dpm	124,931	289,112
Net dpm on 450 mμ test filter	1,188,963	1,620,646
Percent of total radioactivity on 450 mμ test filter	5.08	15.35
300 mμ test filter, dpm	281,700	1,153,100
Blank 300 mμ filter, dpm	174,800	898,300
Net dpm on 300 mμ test filter	106,900	254,800
Percent of total radioactivity on 300 mμ test filter	0.46	2.41
10 mμ test filter, dpm	234,600	1,320,800
Blank 10 mμ filter, dpm	319,500	1,147,100
Net dpm on 10 mμ test filter	0	173,700
Percent of total radioactivity on 10 mμ test filter	0	1.64
Summary		
Summed filterable deposits, %	5.54	19.40
Total deposits, %	5.56	19.41

TABLE 43. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5N-1365

	Before Storage	After 26 wks. at 130° F
Fuel No. 5-65-2, Neat		
Radiotracer		
Compound N,N'-disalicylidene-1,2-diaminopropane-1-^{14}C		
Concentration in blend, ppm	10	10
Blend		
Initial sp. act., μCi/ml	0.01947	0.01961
Final sp. act., μCi/ml	0.01398	0.01274
Radioactivity balance, %	71.8	65.0
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating, number	3	3
Radioactivity, total μCi	0.001224	0.000717
Percent of initial radiotracer	0.012	0.007
Filterable deposits		
450 mμ test filter, dpm	4,107,394	4,521,950
Blank 450 mμ prefilter, dpm	203,239	279,775
Net dpm on 450 mμ test filter	3,904,155	4,242,175
Percent of total radioactivity on 450 mμ test filter	18.06	19.49
300 mμ test filter, dpm	528,300	623,300
Blank 300 mμ filter, dpm	174,300	266,000
Net dpm on 300 mμ test filter	354,000	357,300
Percent of total radioactivity on 300 mμ test filter	1.64	1.64
10 mμ test filter, dpm	397,700	177,900
Blank 10 mμ filter, dpm	280,300	233,200
Net dpm on 10 mμ test filter	117,400	0
Percent of total radioactivity on 10 mμ test filter	0.54	0
Summary		
Summed filterable deposits, %	20.24	21.13
Total deposits, %	20.25	21.14

TABLE 44. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 1N-1368

	Before Storage	After 24 wks. at 130° F
Fuel No. 1-65-2, Neat		
Radiotracer		
Compound Dilinoleic acid-^{14}C		
Concentration in blend, ppm		
Blend		
Initial sp. act., μCi/ml	0.02177	0.01904
Final sp. act., μCi/ml	0.01931	0.01651
Radioactivity balance, %	86.7	86.7
Test Temperature		
Preheater tube, °F	480	480
Block, °F	290	290
Preheater tube deposits		
CRC tube rating, number	1	1
Radioactivity, total μCi	0.000160	0.000234
Percent of initial radiotracer	0.001	0.002
Filterable deposits		
450 mμ test filter, dpm	23,206	25,952
Blank 450 mμ prefilter, dpm	26,448	32,436
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	418,000	558,400
Blank 300 mμ filter, dpm	335,100	372,600
Net dpm on 300 mμ test filter	82,900	185,800
Percent of total radioactivity on 300 mμ test filter	0.34	0.88
10 mμ test filter, dpm	452,400	501,000
Blank 10 mμ filter, dpm	281,700	414,600
Net dpm on 10 mμ test filter	170,700	86,400
Percent of total radioactivity on 10 mμ test filter	0.71	0.41
Summary		
Summed filterable deposits, %	1.05	1.29
Total deposits, %	1.05	1.29

TABLE 45. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 2N-1369

	Before Storage	After 24 wks. at 130° F
Fuel No. 2-65-2, Neat		
Radiotracer		
Compound Dilinoleic acid-^{14}C		
Concentration in blend, ppm		
Blend		
Initial sp. act., μCi/ml	0.02207	0.01853
Final sp. act., μC /ml	0.01960	0.01602
Radioactivity balance, %	88.8	86.5
Test Temperature		
Preheater tube, °F	625	625
Block, °F	362	362
Preheater tube deposits		
CRC tube rating, number	2	4
Radioactivity, total μCi	0.000190	0.000280
Percent of initial radiotracer	0.002	0.003
Filterable deposits		
450 mμ test filter, dpm	41,305	36,176
Blank 450 mμ prefilter, dpm	98,265	63,689
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	527,300	783,700
Blank 300 mμ filter, dpm	373,500	399,500
Net dpm on 300 mμ test filter	153,800	384,200
Percent of total radioactivity on 300 mμ test filter	0.63	1.87
10 mμ test filter, dpm	461,000	361,700
Blank 10 mμ filter, dpm	337,000	270,200
Net dpm on 10 mμ test filter	124,000	91,500
Percent of total radioactivity on 10 mμ test filter	0.51	0.44
Summary		
Summed filterable deposits, %	1.14	2.31
Total deposits, %	1.14	2.31

TABLE 46. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 3N-1370

	Before Storage	After 24 wks. at 130° F
Fuel No. 3-65-2, Neat		
Radiotracer		
Compound Dilinoleic acid-^{14}C		
Concentration in blend, ppm		
Blend		
Initial sp. act., μCi/ml	0.02148	0.01715
Final sp. act., μCi/ml	0.01915	0.01516
Radioactivity balance, %	89.2	88.4
Test Temperature		
Preheater tube, °F	675	675
Block, °F	388	388
Preheater tube deposits		
CRC tube rating, number	4	5
Radioactivity, total μCi	0.000108	0.000185
Percent of initial radiotracer	0.001	0.002
Filterable deposits		
450 mμ test filter, dpm	37,970	38,210
Blank 450 mμ prefilter, dpm	38,365	71,478
Net dpm on 450 mμ test filter	0	0
Percent of total radioactivity on 450 mμ test filter	0	0
300 mμ test filter, dpm	356,800	318,400
Blank 300 mμ filter, dpm	203,600	180,500
Net dpm on 300 mμ test filter	153,200	137,900
Percent of total radioactivity on 300 mμ test filter	0.64	0.72
10 mμ test filter, dpm	387,200	287,400
Blank 10 mμ filter, dpm	381,600	204,300
Net dpm on 10 mμ test filter	5,600	83,100
Percent of total radioactivity on 10 mμ test filter	0.02	0.44
Summary		
Summed filterable deposits, %	0.66	1.16
Total deposits, %	0.66	1.16

TABLE 47. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 4N-1371

	Before Storage	After 24 wks. at 130° F
Fuel No. 4-65-2, Neat		
Radiotracer		
Compound Dilinoleic acid-^{14}C		
Concentration in blend, ppm		
Blend		
Initial sp. act., μCi/ml	0.02082	0.01861
Final sp. act., μCi/ml	0.01951	0.01666
Radioactivity balance, %	93.7	89.5
Test Temperature		
Preheater tube, °F	575	575
Block, °F	338	338
Preheater tube deposits		
CRC tube rating, number	4	5
Radioactivity, total μCi	0.000099	0.000272
Percent of initial radiotracer	0.001	0.003
Filterable deposits		
450 mμ test filter, dpm	61,616	42,560
Blank 450 mμ prefilter, dpm	34,222	53,369
Net dpm on 450 mμ test filter	27,394	0
Percent of total radioactivity on 450 mμ test filter	0.12	0
300 mμ test filter, dpm	377,700	658,500
Blank 300 mμ filter, dpm	421,800	411,600
Net dpm on 300 mμ test filter	0	246,900
Percent of total radioactivity on 300 mμ test filter	0	1.19
10 mμ test filter, dpm	434,200	423,100
Blank 10 mμ filter, dpm	340,100	478,900
Net dpm on 10 mμ test filter	94,100	0
Percent of total radioactivity on 10 mμ test filter	0.41	0
Summary		
Summed filterable deposits, %	0.53	1.19
Total deposits, %	0.53	1.19

TABLE 48. -
MICROFUEL COKER THERMAL STABILITY DATA FOR TEST BLEND 5N-1374

	Before Storage	After 24 wks. at 130° F
Fuel No. 5-65-2, Neat		
Radiotracer		
Compound Dilinoleic acid-^{14}C		
Concentration in blend, ppm		
Blend		
Initial sp. act., μCi/ml	0.02137	0.01710
Final sp. act., μCi/ml	0.01849	0.01430
Radioactivity balance, %	86.5	83.6
Test Temperature		
Preheater tube, °F	725	725
Block, °F	412	412
Preheater tube deposits		
CRC tube rating, number	4	6
Radioactivity, total μCi	0.000024	0 000111
Percent of initial radiotracer	0.0002	0.001
Filterable deposits		
450 mμ test filter, dpm	53,947	53,385
Blank 450 mμ prefilter, dpm	44,789	93,811
Net dpm on 450 mμ test filter	9,158	0
Percent of total radioactivity on 450 mμ test filter	0.04	0
300 mμ test filter, dpm	614,600	1,040,100
Blank 300 mμ filter, dpm	514,900	416,500
Net dpm on 300 mμ test filter	99,700	623,600
Percent of total radioactivity on 300 mμ test filter	0.42	3.28
10 mμ test filter, dpm	489,700	426,100
Blank 10 mμ filter, dpm	343,900	332,200
Net dpm on 10 mμ test filter	145,800	93,900
Percent of total radioactivity on 10 mμ test filter	0.61	0.47
Summary		
Summed filterable deposits, %	1.07	3.75
Total deposits, %	1.07	3.75

TABLE 49. - REGRESSION ANALYSIS OF DATA FOR FUEL 1-65-2
(TFT 480° F)

Y[1] °F	X,[2] ΔLT, percent	Oxygen consumed, percent	Z,[3] factor	Deviation of means y	x	z
398	18.1	20.70	374.670	1.5	-2.37	-142.411
401	22.2	19.34	429.348	4.5	1.73	- 87.733
403	24.4	13.15	320.860	6.5	3.93	-196.221
401	20.9	17.21	359.689	4.5	.43	-157.392
403	23.0	20.89	480.470	6.5	2.53	- 36.611
402	19.4	23.40	453.960	5.5	-1.07	- 63.121
406	17.0	17.41	295.970	9.5	-3.47	-221.111
401	23.2	6.38	148.016	4.5	2.73	-369.065
397	16.4	13.73	225.172	0.5	-4.07	-291.909
406	22.7	29.98	680.546	9.5	2.23	+163.465
350	6.4	0	0	-46.5	-14.07	-517.081
354	8.9	19.92	177.288	-42.5	-11.57	-339.793
415	31.9	49.71	1585.749	18.5	11.43	+1068.668
414	32.1	53.19	1707.399	17.5	11.63	+1190.318
$\bar{y}$=396.5	$\bar{x}$=20.47		$\bar{z}$=517.081			

Squares:
$\Sigma x^2 = 670.5486$
$\Sigma z^2 = 3,335,348.5185$

Products:
$\Sigma xy = 1601.700$
$\Sigma zy = 73,554.7555$

$b = \Sigma xy/\Sigma x^2 = 1601.700/670.5486 = 2.389$
$\hat{y} = \bar{y} + b\ (X - \bar{x}) = 396.5 + 2.389\ (X - 20.47)$
$\hat{y} = 347.60 + 2.389X$ for ΔLT

$b = \Sigma xy/\Sigma z^2 = 73,554.7555/3,335,348.5185 = 0.02205$
$\hat{y} = \bar{y} + b\ (Z - \bar{z}) = 396.5 + 0.02205\ (Z - 517.081)$
$\hat{y} = 385.10 + 0.02205\ (Z)$ for (% O_2 consumed x ΔLT)
Using 33.7% O_2 x 25 ΔLT = 842.5 for Z
Then TFT = 403.7 @ 25% LT (TFT by MFC = 480° F)

X - value 1 0.25 x 71.2 = 17.8
Substituting Y = 347.60 + 2.389 (17.8)
Y = 390.12 (when X = 17.8) represents TFT on basis of 25% ΔLT

X - value 2 0.15 x 71.2 = 10.7
Y = 347.60 + 2.389 (10.7)
Y = 373.16 represents TFT on basis of 15% ΔLT

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X = Loss in light transmittance units, values between 5 and 35 units.
3/ Z = ΔLT x O_2 consumed, percent.

TABLE 50.- REGRESSION ANALYSIS OF DATA FOR FUEL 2-65-2
(TFT 625° F)

Y[1] °F	X,[2] ΔLT, percent	Oxygen consumed, percent	Z,[3] factor	Deviation of means y	x	z
397	7.5	70.71	530.325	-42.05	-5.42	-390.246
404	8.0	61.33	490.640	-35.05	-4.92	-429.931
400	7.6	51.03	387.828	-39.05	-5.32	-532.743
399	6.5	56.06	364.390	-40.05	-6.42	-556.181
400	6.9	56.98	393.162	-39.05	-6.02	-527.409
401	7.3	53.78	392.594	-38.05	-5.62	-527.977
396	7.8	53.32	415.896	-43.05	-5.12	-504.675
401	6.8	59.04	401.472	-38.05	-6.12	-519.099
401	6.7	58.81	394.027	-38.05	-6.22	-526.544
405	6.9	59.73	412.137	-34.05	-6.02	-508.434
672	35.0	90.16	3155.600	232.95	22.08	2235.029
442	15.3	73.77	1128.681	2.95	2.38	208.110
373	6.0	26.64	159.840	-66.05	-6.92	-760.731
396	7.3	59.22	432.306	-43.05	-5.62	-488.265
390	5.9	62.09	366.331	-49.05	-7.02	-554.240
382	5.7	33.20	189.240	-57.05	-7.22	-731.331
436	14.7	69.26	1018.122	- 3.05	1.78	+ 97.551
438	12.3	80.94	995.562	- 1.05	- .62	+ 74.991
434	14.8	76.02	1125.096	- 5.05	1.88	264.525
565	31.9	79.51	2536.369	125.95	18.98	1615.798
565	31.6	78.28	2473.648	125.95	18.68	1553.077
562	31.8	78.28	2489.304	122.95	18.88	1568.733
$\bar{y}$=439.05	$\bar{x}$=12.92		$\bar{z}$=920.571			
n= 22						

Squares:
$\Sigma x^2 = 2076.3188$
$\Sigma z^2 = 16,785,699.9936$

Products:
$\Sigma xy = 15,667.0270$
$\Sigma zy = 1,446,091.9201$

$b = \Sigma xy/\Sigma x^2 = 15,667.0270/2076.3188 = 7.546$
$\hat{y} = \bar{y} + b(X - \bar{x}) = 439.05 + 7.546(X - 12.92)$
$\hat{y} = 341.56 + 7.546X$ for ΔLT

$b = \Sigma zy/\Sigma z^2 = 1,446,091.9201/16,785,669.9936 = 0.08615$
$\hat{y} = \bar{y} + b(Z - \bar{z}) = 439.05 + 0.08615(Z - 920.571)$
$\hat{y} = 359.74 + 0.08615Z$ for (% O_2 consumed × ΔLT)
Using 80.1% O_2 × 25ΔLT = 2002.5 for Z
Then TFT = 532.3 for 25% ΔLT (TFT by MFC = 625° F)

X - value 1 0.25 × 94.6 = 23.65
Substituting Y = 341.56 + 7.546(23.65)
Y = 520.02 represents TFT on basis of 25% ΔLT

X - value 2 0.15 × 94.6 = 14.19
Y = 341.56 + 7.546(14.19)
Y = 448.64 represents TFT on basis of 15% ΔLT

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X = Loss in light transmittance units, values between 5 and 35 units.
3/ Z = ΔLT × O_2 consumed, percent.

TABLE 51. - REGRESSION ANALYSIS OF DATA FOR FUEL 3-65-2
(TFT 675° F)

Y 1/ °F	X, 2/ ΔLT, percent	Oxygen consumed, percent	Z, 3/ factor	Deviation of means y	x	z
390	7.5	60.74	455.550	-29.97	-4.51	-394.828
401	8.4	77.56	651.504	-18.97	-3.61	-198.874
404	9.6	70.60	677.760	-15.97	-2.41	-172.618
408	11.0	63.64	700.040	-11.97	-1.01	-150.338
399	9.1	63.83	580.853	-20.97	-2.91	-269.525
397	8.7	60.74	528.438	-22.97	-3.31	-321.940
417	13.2	71.37	942.084	-2.97	+1.19	+91.706
408	10.0	67.70	677.000	-11.97	-2.01	-173.378
407	9.9	69.05	683.595	-12.97	-2.11	-166.783
408	9.3	78.92	733.956	-11.97	-2.71	-116.422
445	16.2	85.50	1385.100	+25.03	+4.19	+534.722
448	17.6	82.03	1443.728	+28.03	+5.59	+593.350
446	16.2	85.28	1381.536	+26.03	+4.19	+531.158
337	6.0	16.02	96.120	-82.97	-6.01	-754.258
355	7.1	20.56	145.976	-64.97	-4.91	-704.402
380	8.8	48.05	422.840	-39.97	-3.21	-427.538
380	9.9	47.40	469.260	-39.97	-2.11	-381.118
385	11.7	81.17	949.689	-34.97	-0.31	+99.311
396	12.8	58.44	748.032	-23.97	+0.79	-102.346
384	10.6	65.15	690.590	-35.97	-1.41	-159.788
380	9.4	56.06	526.964	-39.97	-2.61	-323.414
363	7.0	24.24	169.680	-56.97	-5.01	-680.698
366	6.9	23.16	159.804	-53.97	-5.11	-690.574
366	6.8	37.66	256.388	-53.97	-5.21	-594.290
392	10.2	67.75	691.050	-27.97	-1.81	-159.328
390	8.1	75.11	608.391	-29.97	-3.91	-241.987
481	16.6	83.37	1383.942	+61.03	+4.59	+533.564
513	19.6	84.16	1649.536	+93.03	+7.59	+799.158
556	21.8	85.94	1873.492	+136.03	+9.79	+1023.114
584	25.0	86.34	2158.500	+164.03	+12.99	+1308.122
633	27.2	92.67	2520.624	+213.03	+15.19	+1670.246
$\bar{y}$=419.97	$\bar{x}$=12.01		$\bar{z}$=850.378			

Squares:
$\Sigma x^2 = 898.6591$
$\Sigma z^2 = 10,816,059.1223$

Products:
$\Sigma xy = 10,714.3067$
$\Sigma zy = 1,177,032.0291$

$b = \Sigma xy/\Sigma x^2 = 10,714.3067/898.6591 = 11.923$
$\hat{y} = \bar{y} + b(X - \bar{x}) = 419.97 + 11.923(X - 12.01)$
$\hat{y} = 276.77 + 11.923X$ (for ΔLT)

$b = \Sigma zy/\Sigma z^2 = 1,177,032.0291/10,816,059.1223 = 0.10882$
$\hat{y} = \bar{y} + b(Z - \bar{z}) = 419.97 + 0.10882(Z - 850.378)$
$\hat{y} = 327.43 + 0.108827\ Z$
Using 88.9% O_2 consumed x 25 ΔLT = 2222.5 for Z
Then TFT = 569.3 (TFT by MFC = 675° F)

X value 1 = 0.25 x 76.5 = 19.13
Y = 276.77 + 11.923(19.13)
Y = 504.86 representing TFT on basis of 25% ΔLT

X value 2 = 0.15 x 76.5 = 11.46
Y = 413.65 representing TFT on basis of 15% ΔLT

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X = Loss in light transmittance units, values between 5 and 35 units.
3/ Z = ΔLT x O_2 consumed, percent.

TABLE 52. - REGRESSION ANALYSIS OF DATA FOR FUEL 4-65-2
(TFT 575° F)

Y 1/ °F	X, 2/ ΔLT, percent	Oxygen consumed, percent	Z, 3/ factor	Deviation of means y	x	z
405	13.5	74.04	999.540	-34.87	+1.10	33.006
401	11.6	76.67	889.372	-38.87	-0.80	-77.162
402	9.7	85.80	832.260	-37.87	-2.70	-134.274
408	8.2	86.00	705.200	-31.87	-4.20	-261.334
402	8.4	86.00	722.400	-37.87	-4.00	-244.134
404	9.5	82.96	788.120	-35.87	-2.90	-178.414
400	11.5	77.28	888.720	-39.87	-0.90	-77.814
403	8.0	85.80	686.400	-36.87	-4.40	-280.134
403	9.8	86.41	846.818	-36.87	-2.40	-119.716
400	12.1	78.70	952.270	-39.87	-0.30	-14.264
374	5.8	62.63	363.254	-65.87	-6.60	-603.280
372	5.0	61.84	309.200	-67.87	-7.40	-657.334
375	5.8	67.63	392.254	-64.87	-6.60	-574.280
385	9.0	68.68	618.120	-54.87	-3.40	-348.414
381	7.4	64.47	477.078	-58.87	-5.00	-489.456
390	9.0	70.53	634.770	-49.87	-3.40	-331.764
610	26.5	76.84	2036.260	+170.13	+14.10	+1069.726
610	26.3	76.78	2019.314	+170.13	+13.90	+1052.780
453	10.4	79.33	825.032	+13.13	-2.00	-141.502
480	15.9	81.65	1298.235	+40.13	+3.50	+331.701
516	17.3	81.65	1412.545	+76.13	+4.90	+446.011
559	21.4	77.00	1647.800	+119.13	+9.00	+681.266
584	23.0	81.97	1885.310	+144.13	+10.60	+918.776
$\bar{y}$=439.87	$\bar{x}$=12.40		$\bar{z}$=966.534			
n= 23						

Squares:
$\Sigma x^2 = 893.8500$
$\Sigma z^2 = 5,770,632.1944$

Products:
$\Sigma xy = 10,664.0870$
$\Sigma zy = 855,494.8067$

$b = \Sigma xy/\Sigma x^2 = 10,664.0870/893.8500 = 11.931$
$\hat{y} = \bar{y} + b(X - \bar{x}) = 439.87 + 11.931(X - 12.40)$
$\hat{y} = 291.93 + 11.931X$ (for ΔLT)

$b = \Sigma zy/\Sigma z^2 = 855,494.8067/5,770,632.1944 = 0.14824$
$\hat{y} = \bar{y} + b(Z - \bar{z}) = 439.87 + 0.14824(Z - 966.534)$
$\hat{y} = 296.59 + 0.14824\,Z$ (for % O_2 consumed x ΔLT)
Using 81.7% O_2 consumed x 25 ΔLT = 2042.5 for Z
Then TFT = 599.4 (TFT by MFC = 575° F)

X value 1 = 0.25 x 100 = 25.0
Y = 291.93 + 11.931 (25.0)
Y = 590.21 representing TFT on basis of 25% ΔLT

X value 2 = 0.15 x 100 = 15.0
Y = 291.93 + 11.931 (15.0)
Y = 470.90 representing TFT on basis of 15% ΔLT

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X = Loss in light transmittance units, values between 5 and 35 units.
3/ Z = ΔLT x O_2 consumed, percent.

TABLE 53. - REGRESSION ANALYSIS OF DATA FOR FUEL 5-65-2
(TFT 725° F)

Y 1/ °F	X, 2/ ΔLT, percent	Oxygen consumed, percent	Z, 3/ factor	Deviation of means y	x	z
399	12.5	60.70	758.750	-54.50	-4.98	-574.220
401	13.6	58.08	789.888	-52.50	-3.88	-543.082
405	12.2	60.70	740.540	-48.50	-5.28	-592.430
407	13.6	61.35	834.360	-46.50	-3.88	-498.610
401	10.9	57.42	625.878	-52.50	-6.58	-707.092
401	9.6	64.19	616.224	-52.50	-7.88	-716.746
406	12.2	58.52	713.944	-47.50	-5.28	-619.026
404	11.3	55.46	626.698	-49.50	-6.18	-706.272
402	11.5	68.56	788.440	-51.50	-5.98	-544.530
411	13.2	73.36	968.352	-42.50	-4.28	-364.618
388	8.6	58.77	505.422	-65.50	-8.88	-827.548
386	7.5	61.23	459.225	-67.50	-9.98	-873.745
379	6.3	48.42	305.046	-74.50	-11.18	-1027.924
419	14.7	75.79	1114.113	-34.50	-2.78	-218.857
416	13.7	74.74	1023.938	-37.50	-3.78	-309.032
421	15.6	79.82	1245.192	-32.50	-1.88	-87.778
449	16.2	88.60	1435.320	-4.50	-1.28	+102.350
452	16.4	82.11	1346.604	-1.50	-1.08	+13.634
458	22.0	81.58	1794.760	+4.50	+4.52	+461.790
483	25.4	82.63	2098.802	+29.50	+7.92	+765.832
497	27.8	84.74	2355.772	+43.50	+10.32	+1022.802
533	28.7	84.74	2432.038	+79.50	+11.22	+1099.068
563	29.4	86.49	2542.906	+109.50	+11.92	+1209.836
618	34.1	81.93	2793.813	+164.50	+16.62	+1460.843
623	34.8	85.44	2973.312	+169.50	+17.32	+1640.342
669	32.8	84.39	2767.992	+215.50	+15.32	+1435.022
$\bar{y}$=453.50	$\bar{x}$=17.48		$\bar{z}$=1332.970			
n=26						

Squares:
$\Sigma x^2 = 1908.6744$
$\Sigma z^2 = 17,617,686.1700$

Products:
$\Sigma xy = 16,983.0000$
$\Sigma zy = 1,622,262.6315$

$b = \Sigma xy/\Sigma x^2 = 16,983.00/1908.6744 = 8.898$
$\hat{y} = \bar{y} + b(X - \bar{x}) = 453.50 + 8.898(X - 17.48)$
$\hat{y} = 297.96 + 8.898X$ (for ΔLT)

$b = \Sigma zy/\Sigma z^2 = 1,622,262.6315/17,617,686.1700 = 0.09208$
$\hat{y} = \bar{y} + b(Z - \bar{z}) = 453.50 + 0.09208(Z - 1332.970)$
$\hat{y} = 330.76 + 0.09208Z$
Using 84.4% O_2 consumed x 25 ΔLT = 2110.0 for Z
Then TFT = 525.0 (TFT by MFC = 725° F)

X value 1 = 0.25 x 96.2 = 24.05
Y = 297.96 + 8.898(24.05)
Y = 511.96 representing TFT on basis of 25% ΔLT

X value 2 = 0.15 x 96.2 = 14.43
Y = 297.96 + 8.898(14.43)
Y = 426.36 representing TFT on basis of 15% ΔLT

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X = Loss in light transmittance units, values between 5 and 35 units.
3/ Z = ΔLT x O_2 consumed, percent.

TABLE 54. - COMPARISON OF ESTIMATED THRESHOLD FAILURE TEMPERATURE BASED ON LIGHT TRANSMITTANCE LOSSES (ΔLT) AND A COMBINING FACTOR OF ΔLT-O_2 CONSUMED

Fuel No.	5-ml Bomb: Microcoker TFT, °F	5-ml Bomb: Calc TFT (25% ΔLT)	5-ml Bomb: Calc TFT (15% ΔLT)	For 25% ΔLT: Deviation $(x_i - \bar{x})$	For 25% ΔLT: $(x_i - \bar{x})^2$	For 15% ΔLT: Deviation $(x_i - \bar{x})$	For 15% ΔLT: $(x_i - \bar{x})^2$
1	480	390.1	373.2	+89.9	8,082.01	106.8	11,406.24
2	625	520.0	448.6	+105.0	11,025.00	176.4	31,116.96
3	675	504.9	413.7	+170.1	28,934.01	261.3	68,277.69
4	575	590.2	470.9	-15.2	231.04	104.1	10,836.81
5	725	512.0	426.4	+213.0	45,369.00	298.6	89,161.96
					Σ=93,641.06		Σ=210,799.66

$$S^2 = (\Sigma(x_i - x)^2)/m-1$$

$$S^2 = 93,641.06/4 = 23,410.265$$

$$S = 153.004\ °F$$

$$S^2 = (210,799.66/m-1) = 52,699.915$$

$$S = 229.565$$

Using factor (% O_2 consumed x ΔLT)1/

1	480	403.7	+76.3	5,821.69
2	625	532.3	+92.7	8,593.29
3	675	569.3	+105.7	11,172.49
4	575	599.4	-24.4	595.36
5	725	525.0	+200.0	40,000.00
				Σ=66,182.83

$$S^2 = 66,182.83/4 = 16,545.7075$$

$$S = 128.630°\ F$$

1/ Factors for (% O_2 consumed x ΔLT) obtained by plotting ΔLT versus O_2 consumed, drawing line or curve through points and picking a value for O_2 consumed from curve at 25 ΔLT. This value was then multiplied by 25 ΔLT to obtain the factor which was substituted into the equation (regression) to obtain calculated TFT.

TABLE 55. - REGRESSION ANALYSIS OF 5-ML BOMB DATA OF FUEL 1-65-2
(TFT 480° F)

Y 1/ °F	X_1 O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means			
				y	x_1	x_2	x_1x_2
398	20.70	25.42	526.194	-4.93	-6.11	-8.41	-522.101
401	19.34	31.18	603.021	-1.93	-7.47	-2.65	-445.274
403	13.15	34.27	450.651	+0.07	-13.66	+0.44	-597.644
401	17.21	29.35	505.114	-1.93	-9.60	-4.48	-543.181
403	20.89	32.30	674.747	+0.07	-5.92	-1.53	-373.548
402	23.40	27.24	637.416	-0.93	-3.41	-6.59	-410.879
406	17.41	23.88	415.751	+3.07	-9.40	-9.95	-632.544
401	6.38	32.58	207.860	-1.93	-20.43	-1.25	-840.435
397	13.73	23.03	316.202	-5.93	-13.08	-10.80	-732.093
406	29.98	31.88	955.762	+3.07	+3.17	-1.95	-92.533
354	19.92	12.55	249.996	-48.93	-6.89	-21.28	-798.299
415	49.71	44.99	2236.453	+12.07	+22.90	+11.16	+1188.158
416	44.68	54.30	2426.124	+13.07	+17.87	+20.47	+1377.829
414	53.19	45.28	2408.443	+11.07	+26.38	+11.45	+1360.148
427	52.51	59.24	3110.692	+24.07	+25.70	+25.41	+2062.397
$\bar{y}$=402.93	$\bar{x}_1$=26.81	$\bar{x}_2$=33.83	$\bar{x}_1\bar{x}_2$=1048.295				

Squares:
$\Sigma(x_1)^2 = 3353.0567$
$\Sigma(x_2)^2 = 2137.9666$
$\Sigma(x_1x_2)^2 = 13,133,304.864$

Products:
$\Sigma x_1y = 1876.8703$
$\Sigma x_2y = 2273.0428$
$\Sigma(x_1x_2)y = 144,641.971$

$Y = 402.93 + \beta(X - x)$

1. $Y = 402.93 + (1876.8703/3353.0567)(X_1 - 26.81$
2. $Y = 402.93 + (144,641.971/13,133,304.864)(X_1X_2 - 1048.295)$
3. $Y = 402.93 + (2273.0428/2137.9666)(X_2 - 33.83)$

1. $Y = 387.92 + 0.55975X_1$ [O_2 consumed]
2. $Y = 391.39 + 0.01101X_1X_2$ [ΔLT x O_2 consumed]
3. $Y = 366.96 + 1.06318X_2$ [ΔLT]

TABLE 55. - REGRESSION ANALYSIS OF 5-ML BOMB DATA OF FUEL 1-65-2
(TFT 480° F)--continued

Y 1/ °F	X_1 O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means			
				y	x_1	x_2	x_1x_2
502	78.21	77.29	5890.271	7.07	+0.27	+11.00	+859.419
501	80.46	69.68	5606.453	6.07	+4.52	+3.39	+575.601
501	79.88	68.12	5441.426	6.07	+3.94	+1.83	+410.574
531	83.75	62.34	5220.975	36.07	+7.81	-3.95	+190.123
528	70.60	76.16	5376.896	33.07	-5.34	+9.87	+346.044
535	82.98	64.74	5372.125	40.07	+7.04	-1.55	+341.273
533	75.63	72.78	5504.351	38.07	-0.31	+6.49	+473.499
529	83.17	67.00	5572.390	34.07	+7.23	+0.71	+541.538
540	82.59	64.74	5346.877	45.07	+6.65	-1.55	+316.025
459	68.47	67.00	4520.490	-35.93	-7.47	+0.71	-510.362
449	63.25	66.15	4183.988	-45.93	-12.69	-0.14	-846.864
451	76.98	57.12	4397.098	-43.93	+1.04	-9.17	-633.754
438	70.21	59.10	4149.411	-56.93	-5.73	-7.19	-881.441
432	68.92	55.85	3849.182	-62.93	-7.02	-10.44	-1181.670
$\bar{y}$=494.93	$\bar{x}_1$=75.94	$\bar{x}_2$=66.29	$\bar{x}_1\bar{x}_2$=5030.852				

Squares:

$\Sigma(x_1)^2 = 571.7236$
$\Sigma(x_2)^2 = 541.5919$
$\Sigma(x_1x_2)^2 = 5,680,759.876$

Products:

$\Sigma x_1y = 2737.2269$
$\Sigma x_2y = 1882.7507$
$\Sigma(x_1x_2)y = 304,375.461$

1. $Y = 494.93 + 4.7877(X_1 - 75.94)$
2. $Y = 494.93 + 0.05358(X_1X_2 - 5030.852)$
3. $Y = 494.93 + 3.4763(X_2 - 66.29)$

1. $Y = 131.352 + 4.7877X_1$ [O_2 consumed]
2. $Y = 225.377 + 0.05358X_1X_2$ [ΔLT x O_2 consumed]
3. $Y = 264.486 + 3.4763X_2$ [ΔLT]

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X_2 = Loss in light transmittance units, values between 5 and 35 units.
3/ X_1X_2 = ΔLT x O_2 consumed, percent.

TABLE 56. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 2-65-2
(TFT 625° F)

Y[1/] °F	X_1 O_2 consumed, percent	X_2[2/] ΔLT, percent	X_1X_2[3/] factor	Deviation of means y	x_1	x_2	x_1x_2
404	61.33	8.46	518.852	+19	17.91	2.19	+191.471
400	51.03	8.03	409.771	+15	7.61	1.76	+82.390
399	56.06	6.87	385.132	+14	12.64	0.60	+57.751
400	56.98	7.29	772.649	+15	13.56	1.02	+445.268
401	53.78	7.72	415.182	+16	10.36	1.45	+87.801
396	53.32	8.25	439.890	+11	9.90	1.98	+112.509
401	59.04	7.19	424.498	+16	15.62	0.92	+97.117
401	58.81	7.08	416.375	+16	15.39	0.81	+88.994
405	59.73	7.29	435.432	+20	16.31	1.02	+108.051
307	8.20	2.28	18.696	-78	-35.22	-3.99	-308.685
346	7.17	1.65	11.831	-39	-36.25	-4.62	-315.550
372	4.71	4.76	22.420	-13	-38.71	-1.51	-304.961
373	26.64	6.20	165.168	-12	-16.78	-0.07	-162.213
372	26.84	4.03	108.165	-13	-16.58	-1.97	-219.216
396	59.22	7.55	447.111	+11	+15.80	+1.28	+119.730
390	62.09	6.10	378.749	+5	+18.67	-0.17	+51.368
382	33.20	5.89	195.548	-3	-10.22	-0.38	-131.833
$\bar{y}$=385	$\bar{x}_1$=43.42	$\bar{x}_2$= 6.27	$\bar{x}_1\bar{x}_2$=327.381				

Squares:

$\Sigma(x_1)^2 = 6986.6127$
$\Sigma(x_2)^2 = 63.102$
$\Sigma(x_1x_2)^2 = 691,024.018$

Products:

$\Sigma x_1y = 7355.67$
$\Sigma x_2y = 736.620$
$\Sigma(x_1x_2)y = 67,256.650$

$y = 385 = (7355.67/6986.6127)(X_1 - 43.42)$
$y = 385 + 11.6735(X_2 - 6.27)$
$y = 385 + 0.097328(X_1X_2 - 327.381)$

$y = 339.29 + 1.05282X_1$ [O_2 consumed]
$y = 311.81 + 11.6735X_2$ [ΔLT]
$y = 353.14 + 0.097328(X_1X_2)$ [ΔLT x O_2 consumed]

TABLE 56. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 2-65-2 (TFT 625° F)--continued

Y 1/ °F	X_1 O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means y	x_1	x_2	x_1x_2
397	70.71	7.93	560.730	-145.8	-9.68	-20.48	-1807.616
684	89.55	55.84	5000.472	+141.2	+9.16	+27.43	+2632.126
6[illegible]	91.19	42.30	3857.337	+132.2	+10.80	+13.89	+1488.991
672	90.16	36.19	3262.890	+129.2	+9.77	+7.78	+694.544
436	69.26	15.20	1052.752	-106.8	-11.13	-13.21	-1315.594
438	80.94	12.72	1029.557	-104.8	+0.55	-15.69	-1338.789
434	76.02	15.31	1163.866	-108.8	-4.37	-13.10	-1204.480
565	79.51	32.99	2623.035	+22.2	-0.88	+4.58	+254.689
565	78.28	32.68	2558.190	+22.2	-2.11	+4.27	+189.844
562	78.28	32.89	2574.629	+19.2	-2.11	+4.48	+206.283
$\bar{y}$=542.8	$\bar{x}_1$=80.39	$\bar{x}_2$=28.41	$\bar{x}_1\bar{x}_2$=2368.346				

Squares:

$\Sigma(x_1)^2 = 542.6558$
$\Sigma(x_2)^2 = 2076.8657$
$\Sigma(x_1x_2)^2 = 18,330,241.586$

Products:

$\Sigma x_1y = 5644.7288$
$\Sigma x_2y = 14,463.4400$
$\Sigma(x_1x_2)y = 1,373,313.516$

$y = 542.8 + 10.402(X_1 - 80.39)$
$y = 542.8 + 6.96407(X_2 - 28.41)$
$y = 542.8 + 0.07492(X_1X_2 - 2368.346)$

$y = -293.42 + 10.4020X_1$ [O_2 consumed]
$y = 344.95 + 6.96407X_2$ [ΔLT]
$y = 365.36 + 0.07492X_1X_2$ [ΔLT x O_2 consumed]

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X_2 = Loss in light transmittance units, values between 5 and 35 units
3/ X_1X_2 = ΔLT x O_2 consumed, percent.

TABLE 57.- REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 3-65-2
(TFT 675° F)

Y[1/] °F	X_1 O_2 consumed, percent	X_2[2/] ΔLT, percent	X_1X_2[3/] factor	Deviation of means			
				y	x_1	x_2	x_1x_2
390	60.74	9.80	595.252	+7.57	+12.69	-1.48	+3.246
404	70.60	12.55	886.030	+21.57	+22.55	+1.27	+287.532
408	63.64	14.38	915.143	+25.57	+15.59	+3.10	+316.645
399	63.83	11.90	759.577	+16.57	+15.78	+0.62	+161.079
397	60.74	11.37	690.614	+14.57	+12.69	+0.09	+92.116
417	71.37	17.25	1231.133	+34.57	+23.32	+5.97	+632.635
408	67.70	13.07	884.839	+25.57	+19.65	+1.79	+286.341
407	69.05	12.94	893.507	+24.57	+21.00	+1.66	+295.009
352	2.16	6.31	13.630	-30.43	-45.89	-4.97	-584.868
337	16.02	7.72	123.674	-45.43	-32.03	-3.56	-474.824
355	20.56	9.14	187.918	-27.43	-27.49	-2.14	-410.580
350	14.72	4.50	66.240	-32.43	-33.33	-6.78	-532.258
380	48.05	11.33	544.407	-2.43	0	+0.05	-54.091
380	47.40	12.74	603.876	-2.43	-0.65	+1.46	+5.378
396	58.44	16.47	962.507	+13.57	+10.69	+5.19	+364.009
384	65.15	13.64	888.646	+1.57	+17.10	+2.36	+290.148
380	56.06	12.10	678.326	-2.43	+8.01	+0.82	+79.828
363	24.24	9.01	218.402	-19.43	-23.81	-2.27	-380.096
366	23.16	8.88	205.661	-16.43	-24.89	-2.40	-392.837
366	37.66	8.75	329.525	-16.43	-10.39	-2.53	-268.973
392	67.75	13.13	889.558	+9.57	+19.70	+1.85	+291.060
$\bar{y}$=382.43	$\bar{x}_1$=48.05	$\bar{x}_2$=11.28	$\bar{x}_1\bar{x}_2$ =598.498				

Squares:

$\Sigma(x_1)^2 = 9839.3931$
$\Sigma(x_2)^2 = 199.377$
$\Sigma(x_1x_2)^2 = 2,487,904.449$

Products:

$\Sigma x_1y = 9319.3243$
$\Sigma x_2y = 1202.807$
$\Sigma(x_1x_2)y = 148,981.514$

$y = 382.43 + (9319.3243/9839.3931)(X_1 - 48.05)$
$y = 382.43 + 0.05988(X_1X_2 - 598.498)$
$y = 382.43 + 6.0328(X_2 - 11.28)$

$y = 336.92 + 0.94714X_1$ [O_2 consumed]
$y = 346.59 + 0.05988X_1X_2$ [ΔLT x O_2 consumed]
$y = 314.38 + 6.0328X_2$ [ΔLT]

TABLE 57. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 3-65-2 (TFT 675° F)--continued

Y 1/ °F	X_1 O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means y	x_1	x_2	x_1x_2
401	77.56	10.98	851.609	-113.87	-7.07	-17.21	-1598.044
408	78.92	12.16	959.667	-106.87	-5.71	-16.03	-1489.986
445	85.50	20.85	1782.675	-69.87	+0.87	-7.34	-666.978
448	82.03	22.65	1857.980	-66.87	-2.60	-5.54	-591.673
446	85.28	20.85	1778.088	-68.87	+0.65	-7.34	-671.565
677	88.96	57.27	5094.739	+162.13	+4.33	+29.08	+2645.086
679	87.01	51.87	4513.209	+164.13	+2.38	+23.68	+2063.556
677	95.45	52.38	4999.671	+162.13	+10.82	+24.19	+2550.018
385	81.17	15.06	1222.420	-129.87	-3.46	-13.13	-1227.233
390	75.11	10.42	782.646	-124.87	-9.52	-17.77	-1667.007
481	83.37	22.34	1862.486	-33.87	-1.26	-5.85	-587.167
513	84.16	26.38	2220.141	-1.87	-0.47	-1.81	-229.512
556	85.94	29.34	2521.480	+41.13	+1.31	+1.15	+71.827
584	86.34	33.65	2905.341	+69.13	+1.71	+5.46	+455.688
633	92.67	36.61	3392.649	+118.13	+8.04	+8.42	+942.996
$\bar{y}$=514.87	$\bar{x}_1$=84.63	$\bar{x}_2$=28.19	$\bar{x}_1\bar{x}_2$=2449.653				

Squares:

$\Sigma(x_1)^2 = 405.7064$
$\Sigma(x_2)^2 = 3310.8316$
$\Sigma(x_1x_2)^2 = 29,561,580.3045$

Products:

$\Sigma x_1y = 7134.0226$
$\Sigma x_2y = 23,129.9648$
$\Sigma(x_1x_2)y = 2,156,802.1486$

$y = 514.87 + (7134.0226/405.7064)(X_1 - 84.63)$
$y = 514.87 + 6.98614(X_2 - 28.19)$
$y = 514.87 + 0.072960(X_1X_2 - 2449.653)$

$y = -973.28 + 17.5842X_1$
$y = 317.93 + 6.98614X_2$
$y = 336.14 + 0.072960X_1X_2$

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X_2 = Loss in light transmittance units, values between 5 and 35 units.
3/ X_1X_2 = ΔLT × O_2 consumed, percent.

TABLE 58. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 4-65-2 (TFT 575° F)

Y[1/] °F	X_1 O_2 consumed, percent	X_2[2/] ΔLT, percent	X_1X_2[3/] factor	Deviation of means y	x_1	x_2	x_1x_2
354	52.89	3.1	163.959	-5.53	+1.32	-1.78	-139.154
353	51.58	3.0	154.740	-6.53	+0.01	-1.88	-148.373
374	62.63	5.8	363.254	+14.47	+11.06	+0.92	+60.141
372	61.84	5.0	309.200	+12.47	+10.27	+0.12	+6.087
375	67.63	5.8	392.254	+15.47	+16.06	+0.92	+89.141
330	24.47	2.5	61.175	-29.53	-27.10	-2.38	-241.938
328	16.32	1.2	19.584	-31.53	-35.25	-3.68	-283.529
325	15.00	0.8	12.000	-34.53	-36.57	-4.08	-291.113
339	46.58	1.5	69.870	-20.53	-4.99	-3.38	-233.243
338	45.26	2.8	126.728	-21.53	-6.31	-2.08	-176.385
344	51.58	2.8	144.424	-15.53	+0.01	-2.08	-158.689
385	68.68	9.0	618.120	+25.47	+17.11	+4.12	+315.007
381	64.47	7.4	477.078	+21.47	+12.90	+2.52	+173.965
390	70.53	9.0	634.770	+30.47	+18.96	+4.12	+331.657
405	74.04	13.5	999.540	+45.47	+22.47	+8.62	+696.427
$\bar{y}$=359.53	$\bar{x}_1$=51.57	$\bar{x}_2$=4.88	$\bar{x}_1\bar{x}_2$=303.113				

Squares:

$\Sigma(x_1)^2 = 5190.0609$
$\Sigma(x_2)^2 = 178.9440$
$\Sigma(x_1x_2)^2 = 1,111,844.2879$

Products:

$\Sigma\ x_1y = 6253.9665$
$\Sigma\ x_2y = 1201.3600$
$\Sigma(x_1x^2)y = 94,780.6535$

$y = 359.53 + (6253.9665/5190.0609)(X_1 - 51.57)$
$y = 359.53 + (1201.3600/178.9440)(X_2 - 4.88)$
$y = 359.53 + (94,780.6535/1,111,844.2879)(X_1X_2 - 303.113)$

$y = 297.39 + 1.20499X_1$
$y = 326.77 + 6.71361X_2$
$y = 333.69 + 0.08525X_1X_2$

TABLE 58. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 4-65-2 (TFT 575° F)--continued

Y 1/ °F	O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means y	x_1	x_2	x_1x_2
610	76.84	26.5	2036.260	+145.31	-4.46	+12.15	+884.006
610	76.78	26.3	2019.314	+145.31	-4.52	+11.95	+867.060
401	76.67	11.6	889.372	-63.69	-4.63	-2.75	-262.882
402	85.80	9.7	832.260	-62.69	+4.50	-4.65	-319.994
408	86.00	8.2	705.200	-56.69	+4.70	-6.15	-447.054
402	86.00	8.4	722.400	-62.69	+4.70	-5.95	-429.854
404	82.96	9.5	788.120	-60.69	+1.66	-4.85	-364.134
400	77.28	11.5	888.720	-64.69	-4.02	-2.85	-263.534
403	85.80	8.0	686.400	-61.69	+4.50	-6.35	-465.854
403	86.41	9.8	846.818	-61.69	+5.11	-4.55	-305.436
400	78.70	12.1	952.270	-64.69	-2.60	-2.25	-199.984
453	79.33	10.4	825.032	-11.69	-1.97	-3.95	-327.222
480	81.65	15.9	1298.235	+15.31	+0.35	+1.55	+145.981
516	81.65	17.3	1412.545	+51.31	+0.35	+2.95	+260.291
559	77.00	21.4	1647.800	+94.31	-4.30	+7.05	+495.546
584	81.97	23.0	1885.310	+119.31	+0.67	+8.65	+733.036
$\bar{y}$=464.69	$\bar{x}_1$=81.30	$\bar{x}_2$=14.35	$\bar{x}_1\bar{x}_2$=1452.2[illegible]				

Squares:

$\Sigma(x_1)^2 = 221.2918$
$\Sigma(x_2)^2 = 641.8000$
$\Sigma(x_1x_2)^2 = 3,620,815.9682$

Products:

$\Sigma x_1y = -2397.7776$
$\Sigma x_2y = 7905.1500$
$\Sigma(x_1x_2)y = 596,818.5495$

$y = 464.69 + (-2397.7776/221.2918)(X_1 - 81.30)$
$y = 464.69 + (7905.1500/641.8000)(X_2 - 14.35)$
$y = 464.69 = (596,818.5495/3,620,815.9682)(X_1X_2 - 1152.254)$

$y = 1345.61 - 10.83537X_1$
$y = 287.94 + 12.31715X_2$
$y = 274.77 + 0.16483X_1X_2$

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X_2 = Loss in light transmittance units, values between 5 and 35 units.
3/ X_1X_2 = ΔLT x O_2 consumed, percent.

TABLE 59. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 5-65-2
(TFT 725° F)

Y[1/] °F	X_1 O_2 consumed, percent	X_2[2/] ΔLT, percent	X_1X_2[3/] factor	Deviation of means y	x_1	x_2	x_1x_2
399	60.70	12.99	788.493	+8.59	+8.11	+3.20	+194.457
401	58.08	14.14	821.251	+10.59	+5.49	+4.35	+227.215
405	60.70	12.68	769.676	+14.59	+8.11	+2.89	+175.640
407	61.35	14.14	867.489	+16.59	+8.76	+4.35	+273.453
401	57.42	11.33	650.569	+10.59	+4.83	+1.54	+56.533
401	64.19	9.98	640.616	+10.59	+11.60	+0.19	+46.580
406	58.52	12.68	742.034	+15.59	+5.93	+2.09	+147.998
404	55.46	11.75	651.655	+13.59	+2.87	+1.96	+57.619
402	68.56	11.95	819.292	+11.59	+15.97	+2.16	+225.256
411	73.36	13.72	1006.499	+20.59	+20.77	+3.93	+412.463
353	14.74	2.80	41.272	-37.41	-37.85	-6.99	-552.764
349	10.53	2.28	24.008	-41.41	-42.06	-7.51	-570.028
353	40.35	1.76	71.016	-37.41	-12.24	-8.03	-523.020
364	16.14	4.87	78.602	-26.41	-36.45	-4.92	-515.434
362	30.35	5.07	153.875	-28.41	-22.24	-4.72	-440.161
362	27.72	4.55	126.126	-28.41	-24.87	-5.24	-467.910
388	58.77	8.90	523.053	-2.41	+6.18	-0.89	-70.983
386	61.23	7.76	475.145	-4.41	+8.64	-2.03	-118.891
379	48.42	6.52	315.698	-11.41	-4.17	-3.27	-278.338
419	75.79	15.22	1153.524	+28.59	+23.20	+5.43	+559.488
416	74.74	14.18	1059.813	+25.59	+22.15	+4.39	+465.777
421	79.82	16.15	1289.093	+30.59	+27.23	+6.36	+595.057
y=390.41	x_1=52.59	x_2= 9.79	x_1x_2=594.036				

Squares:

$\Sigma(x_1)^2 = 8,819.9334$
$\Sigma(x_2)^2 = 439.6450$
$\Sigma(x_1x_2)^2 = 3,138,629.6902$

Products:

$\Sigma x_1y = 9,293.9164$
$\Sigma x_2y = 2,180.1836$
$\Sigma(x_1x_2)y = 182,770.2451$

$y = 390.41 + (2725.6181/8,819.9334)(X_1 - 52.59)$
$y = 390.41 + 0.05823(X_1X_2 - 594.036)$
$y = 390.41 + 4.9590(X_2 - 9.79)$

$y = 335.05 + 1.05261X$ [O_2 consumed]
$y = 355.819 + 0.05823X_1X_2$ [ΔLT x O_2 consumed]
$y = 341.861 + 4.9590X_2$ [ΔLTpercent of initial]

TABLE 59. - REGRESSION ANALYSIS OF 5-ML BOMB DATA FOR FUEL 5-65-2 (TFT 725° F)--continued

Y 1/ °F	X_1 O_2 consumed, percent	X_2 2/ ΔLT, percent	X_1X_2 3/ factor	Deviation of means y	x_1	x_2	x_1x_2
449	88.60	16.77	1485.822	-85.50	+4.33	-10.93	-847.480
452	82.11	16.98	1394.228	-82.50	-2.16	-10.72	-939.074
458	81.58	22.77	1857.577	-76.50	-2.69	-4.93	-475.725
483	82.63	26.29	2172.343	-51.50	-1.64	-1.41	-160.959
497	84.74	28.78	2438.817	-37.50	+0.47	+1.08	+105.515
533	84.74	29.71	2517.625	-1.50	+0.47	+2.01	+184.323
563	86.49	30.43	2631.891	+28.50	+2.22	+2.73	+298.589
618	81.93	35.30	2892.129	+83.50	-2.34	+7.60	+558.827
623	85.44	36.02	3077.549	+88.50	+1.17	+8.32	+744.247
669	84.39	33.95	2865.041	+134.50	+0.12	+6.25	+531.739
y=534.50	x_1=84.27	x_2=27.70	x_1x_2=2333.302				

Squares:

$\Sigma(x_1)^2 = 45.5693$
$\Sigma(x_2)^2 = 439.3806$
$\Sigma(x_1x_2)^2 = 3,135,505.7547$

Products:

$\Sigma x_1y = 67.4650$
$\Sigma x_2y = 4514.5100$
$\Sigma x_1x_2y = 382,938.7950$

$y = 534.50 + (67.465/45.5693)(X_1 - 84.27)$
$y = 534.50 + 10.2747\ (X_2 - 27.70)$
$y = 534.50 + 0.12213(X_1X_2 - 2333.302)$

$y = 409.74 + 1.4805X_1$
$y = 249.89 + 10.2747X_2$
$y = 249.53 + 0.12213X_1X_2$

1/ Y = Bomb temp. after 20 min. heating, °F.
2/ X_2 = Loss in light transmittance units, values between 5 and 35 units.
3/ X_1X_2 = ΔLT x O_2 consumed, percent.

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13. ABSTRACT This investigation is concerned with the contribution of selected components and additives of high-temperature aircraft fuels to thermally induced deposits before and after 52 weeks storage at 130° F. Of particular concern is the influence of these fuel constituents on thermal stability quality of these jet fuels during storage. The study utilizes a microfuel coker test apparatus to measure the thermal stability of test fuels and blends. The contribution of selected fuel components, labeled with carbon-14, to deposit-forming mechanisms is determined by radioactive counting techniques.

Twenty-eight blends of the five test fuels with carbon-14-labeled fuel additives or components reached the final stage of storage at 130° F and received final analyses for deposit forming tendency. These additives included an amine-type antioxidant, a metal deactivator, and a corrosion inhibitor. Also included in this study group were oleic acid and 1,5-hexadiene. All three additives showed a great tendency to degrade and react during storage and thermal stress. It was found that oleic acid interacts with cadmium present in aircraft fuel systems to produce deleterious effects upon the thermal stability quality of the fuel.

Sixteen blends of the five test fuels with nonradioactive components were prepared as a part of a special study. Six of these blends contained 1 percent of selected aromatic compounds, five blends contained an anti-icing additive, and five blends contained an organic sulfur compound. Results showed changes in thermal stability quality of many of these blends containing sulfur compounds.

Four additional special studies were conducted as preliminary investigations to continued research of jet fuel stability characteristics. Both of these studies were aimed at improving or developing new and better thermal stability test procedures.

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