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KNOCK-LIMITED PERFORMANCE OF N-METHYLANILINE AND XYLIDINE BLENDS IN AN AIR-COOLED AIRCRAFT CYLINDER

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ADVANCE RESTRICTED REPORT

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SUMMARY

In order to compare the antiknock effectiveness of N-methylaniline and xylidines as fuel additives under severe engine operating conditions, 5-percent concentrations by weight were blended with an alkylate blending agent and a virgin-base gasoline. The N-methylaniline was also blonded in a 5-percent concentration with a base fuel containing 75 percent (by weight) virgin-base gasoline and 25 percent toluene. All blends contained 4 ml TEL per gallon. The knock-limited performance of each of these aromatic-amine blends was compared with the knock-limited performance of the leaded base fuels in an air-cooled aircraft-engine cylinder. As a fuel antiknock additive, N-methylaniline was equal to or better than xylidines. Neither N-methylaniline nor xylidines is of value as a fuel antiknock additive in the lean-mixture region.

INTRODUCTION

Engine tests to determine the antiknock effectiveness of selected groups of research fuels are being conducted at the NACA Cleveland laboratory. As part of this program, N-methylaniline and xylidines when blended with an alkylate blending agent and a virgin-base gasoline were tested in an air-cooled aircraft-engine cylinder to compare under severe engine operating conditions their antiknock effectiveness. The results of these tests and also tests of a blend containing N-methylaniline, virgin-base gasoline, and toluene are reported herein. All fuels tested contained tetraethyl lead.

FUELS

The two aromatic amines were blended with each of two base fuels before being tested. A fifth blend of N-methylaniline and 75 percent virgin-base gasoline and 25 percent toluene was tested. The composition of the test fuels are given in the following table:

Aromatic amine	Aromatic amine in blend (by weight) (percent)	Base fuel	Tetra-ethyl lead in blend (ml/gal)
N-Methylaniline	5	Virgin-base gasoline	4
N-Methylaniline	5	Alkylate blending agent	4
N-Methylaniline	5	75 percent virgin-base gasoline plus 25 percent toluene (by weight)	4
Xylidines	5	Virgin-base gasoline	4
Xylidines	5	Alkylate blending agent	4

APPARATUS AND PROCEDURE

Tests were conducted with a full-scale aircraft-engine cylinder mounted on a CUE crankcase. The apparatus is described in detail in reference 1. The most important alteration to the apparatus described in reference 1 is the installation of a thermocouple embedded in the cylinder head about one-sixteenth inch from the combustion-chamber wall at the exhaust end zone. An automatic potentiometer regulator was attached to this thermocouple and controlled the cooling-air flow to maintain the temperature constant at the thermocouple. This alteration was found desirable because previous tests had indicated that better reproducibility of the knock limit, particularly in the lean region, was obtained when the temperature of the cylinder wall at the point nearest the knocking zone was held constant.

The exhaust system of the test setup was also modified so that the engine could be operated with either atmospheric or reduced exhaust pressure.

The fixed engine operating conditions were:

Compression ratio 7.46
Engine speed, rpm 2000
Condition of fuel-air mixture . . . . Prevaporized
Inlet-mixture temperature, °F 240
Spark advance, both plugs, degrees B.T.C. 20, 30
Cooling-air temperature, °F . . . . 90 ±5
Oil pressure, pounds per square inch 65
Oil-in temperature, °F 185
Cylinder-head temperature at exhaust end zone, °F 350
Exhaust back pressure, inches mercury absolute . . . . . 15 ± 0.2

The exhaust pressure of 15 inches of mercury was chosen because of the existence of a critical relation between manifold and exhaust pressures and knock-limited power in the lean region where the manifold pressure is not very different from the exhaust pressure.

Complete mixture response curves were obtained for the test fuels at spark advances of 20° and 30° B.T.C.

DISCUSSION OF RESULTS

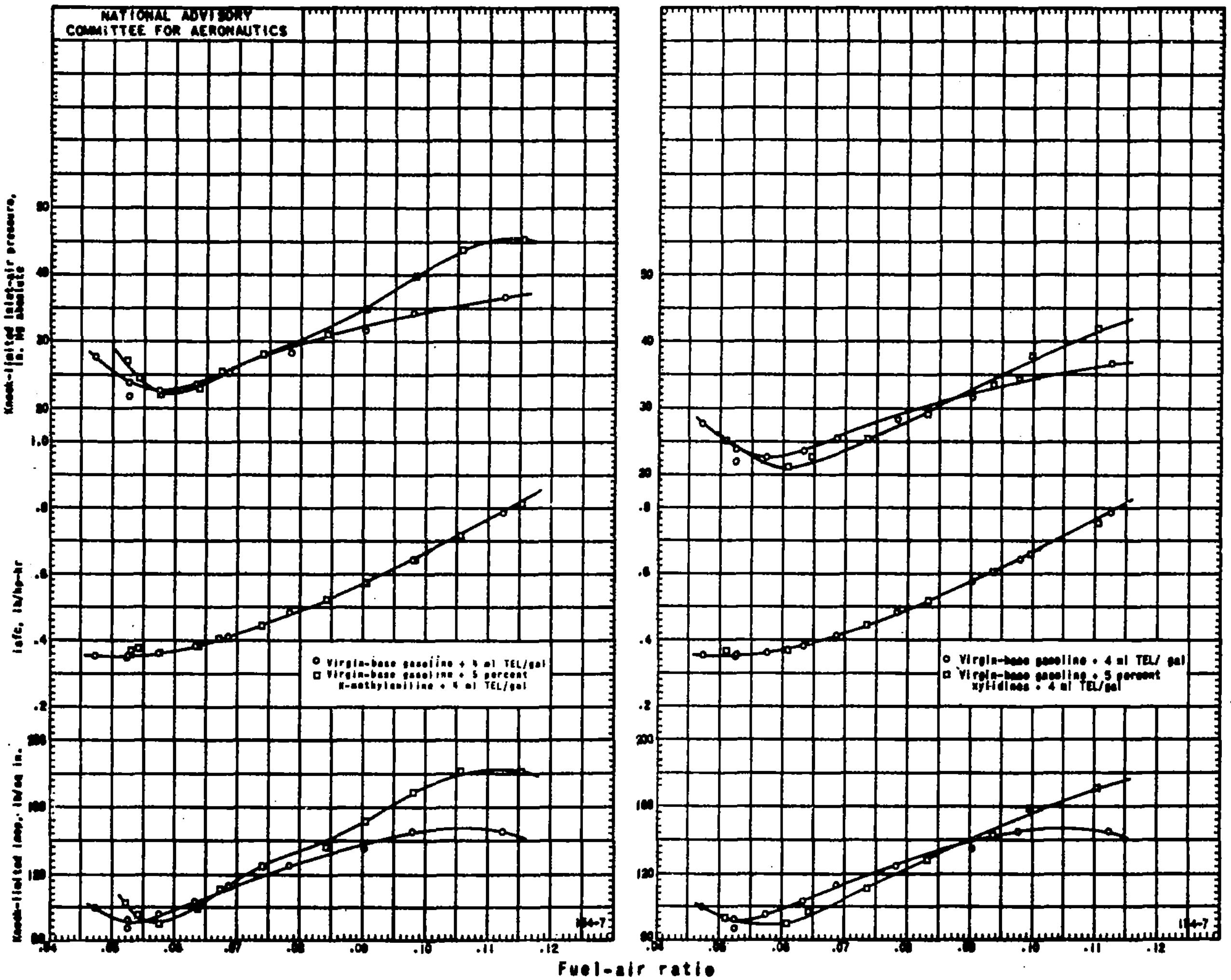
The results of the tests are presented in figures 1 to 5 and table 1. Figures 1 and 2 compare the knock-limited performance of the amine and virgin-base blends at spark advances of 20° and 30° B.T.C., respectively. These figures show that at a spark advance of 20° B.T.C., the N-methylaniline increased the knock limit of virgin-base gasoline at fuel-air ratios above 0.067 whereas the xylidines increase the performance only at fuel-air ratios above 0.09.

At the more severe condition (spark advance, 30° B.T.C.), the N-methylaniline improved the knock-limited performance of virgin-base gasoline above a fuel-air ratio of 0.095; xylidines improved the base-fuel performance above a fuel-air ratio of 0.106.

The behavior of the amine and alkylate blends (figs. 3 and 4) was similar to that of the amine and virgin-base blends differing only in the fuel-air ratios at which performance improvement began and in the magnitude of the improvement. The improvement in power caused by the addition of either amine was greater in the alkylate blends than in the virgin-base blends. In all cases examined the blend containing N-methylaniline was equal to or greater than the xylidine blend over the entire mixture range.

The gain or loss in power of the base fuel due to the addition of the amines is indicated by the data in table 1.

The addition of toluene to the virgin-base gasoline (fig. 5) had little or no effect on the improvement due to the addition of N-methylaniline. These data are included in table 1 for comparison with other tests.

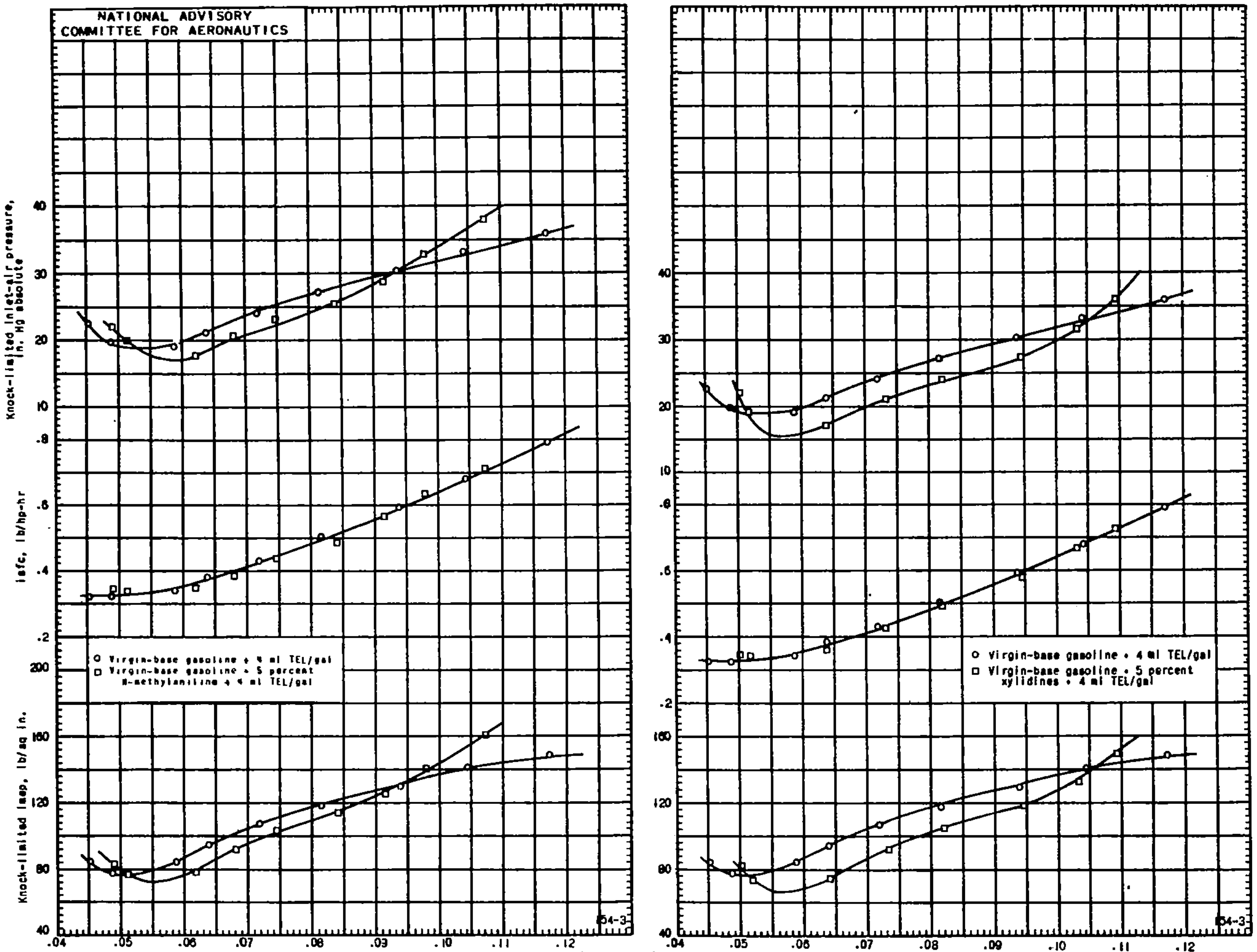


(a) Virgin-base gasoline plus 4 ml TEL per gallon and virgin-base gasoline plus 5 percent N-methylaniline plus 4 ml TEL per gallon.

(b) Virgin-base gasoline plus 4 ml TEL per gallon and virgin-base gasoline plus 5 percent xylidines plus 4 ml TEL per gallon.

Figure 1. - Knock-limited performance of virgin-base fuel blends at spark advance of 20° B.T.C. obtained on full-scale aircraft-engine cylinder. Compression ratio, 7.46; engine speed, 2000 rpm; inlet-mixture temperature, 240° F; cylinder-head temperature at exhaust end zone, 350° F.

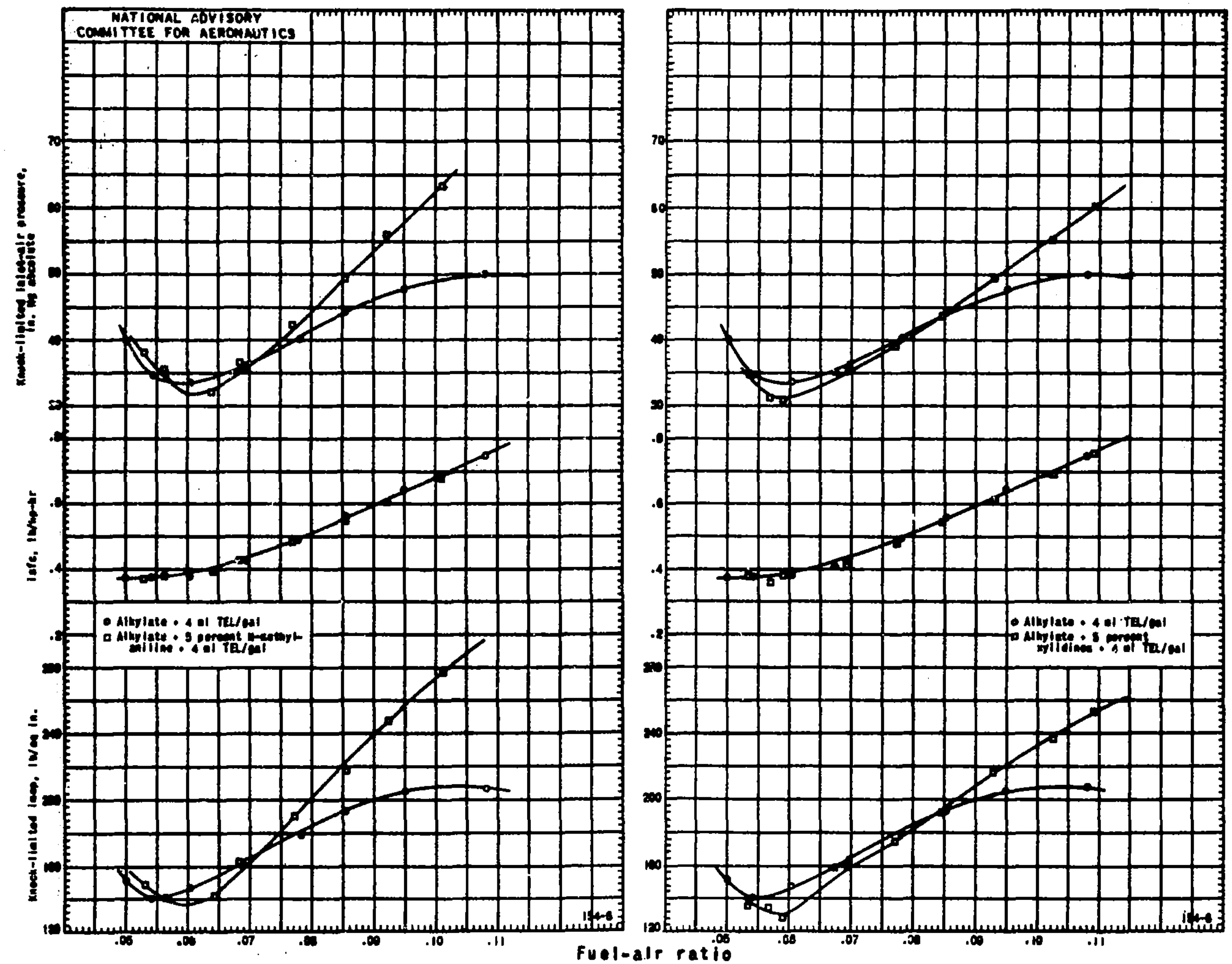
Fig. 1



(a) Virgin-base gasoline plus 4 ml TEL per gallon and virgin-base gasoline plus 5 percent N-methylaniline plus 4 ml TEL per gallon.

(b) Virgin-base gasoline plus 4 ml TEL per gallon and virgin-base gasoline plus 5 percent xylidines plus 4 ml TEL per gallon.

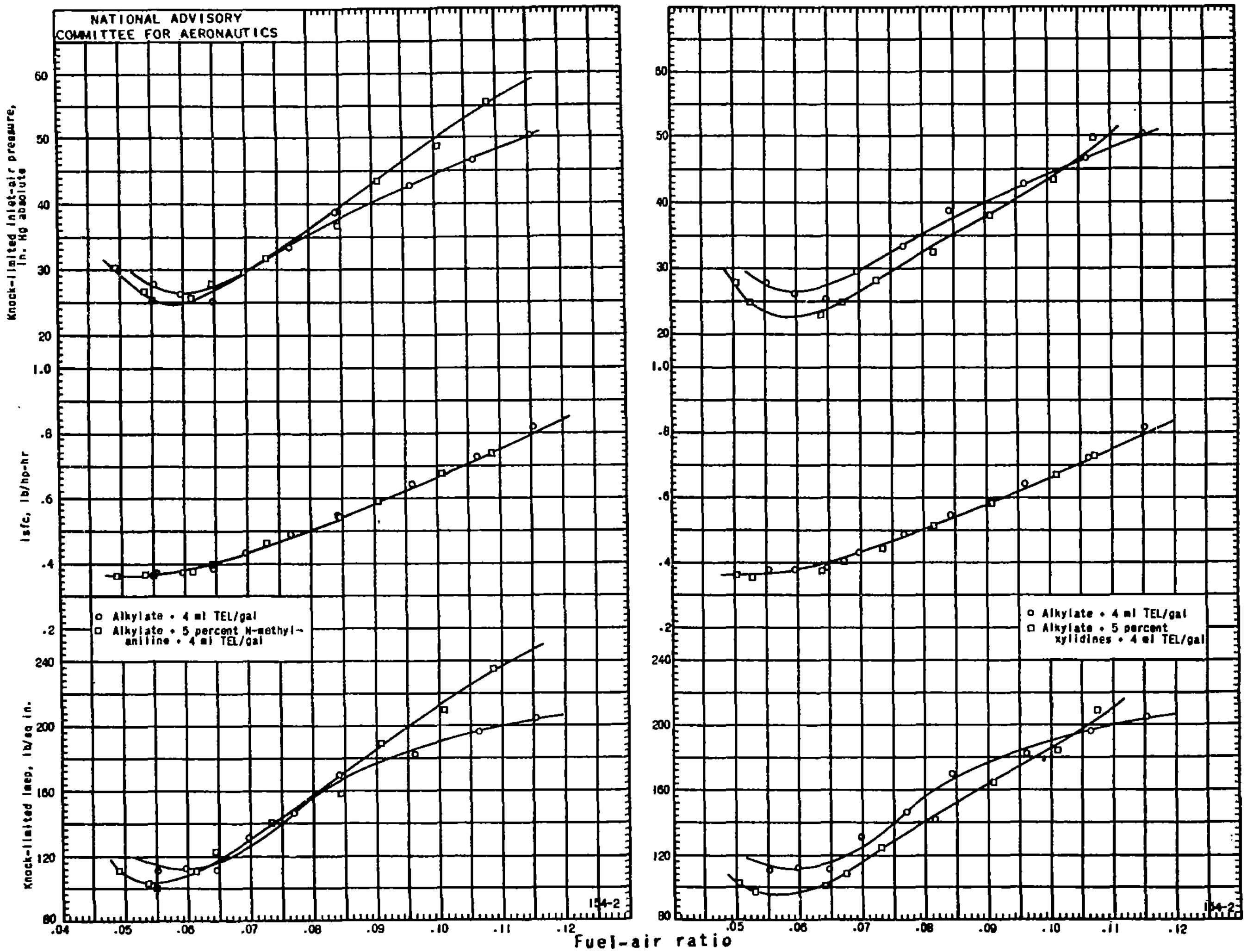
Figure 2. - Knock-limited performance of virgin-base fuel blends at spark advance of 30° B.T.C. obtained on full-scale aircraft-engine cylinder. Compression ratio, 7.46; engine speed, 2000 rpm; inlet-mixture temperature, 240° F; cylinder-head temperature at exhaust end zone, 350° F.



(a) Alkylate plus 4 ml TEL per gallon and alkylate plus 5 percent N-methylaniline plus 4 ml TEL per gallon.

(b) Alkylate plus 4 ml TEL per gallon and alkylate plus 5 percent xylidines plus 4 ml TEL per gallon.

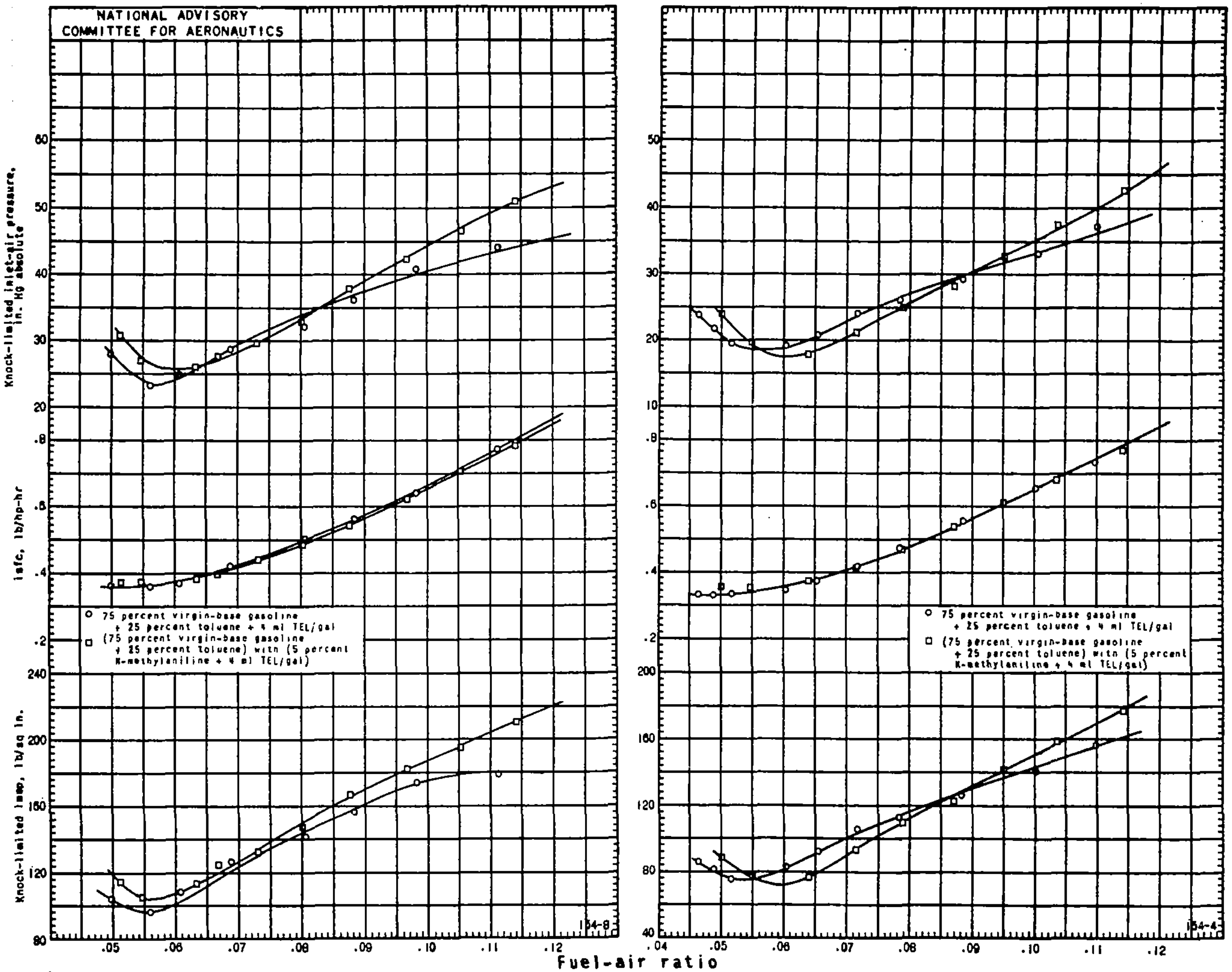
Figure 3. - Knock-limited performance of alkylate fuel blends at spark advance of 20° B.T.C. obtained on full-scale aircraft-engine cylinder. Compression ratio, 7.46; engine speed, 2000 rpm; inlet-mixture temperature, 240° F, cylinder-head temperature at exhaust end zone, 350° F.



(a) Alkylate plus 4 ml TEL per gallon and alkylate plus 5 percent N-methylaniline plus 4 ml TEL per gallon.

(b) Alkylate plus 4 ml TEL per gallon and alkylate plus 5 percent xylidines plus 4 ml TEL per gallon.

Figure 4. - Knock-limited performance of alkylate fuel blends at spark advance of 30° B.T.C. obtained on full-scale aircraft-engine cylinder. Compression ratio, 7.46; engine speed, 2000 rpm; inlet-mixture temperature, 240° F; cylinder-head temperature at exhaust end zone, 350° F.



(a) Spark advance, 20° B.T.C. (b) Spark advance, 30° B.T.C.

Figure 5. - Knock-limited performance of blends of virgin-base gasoline plus toluene and virgin-base gasoline plus toluene plus 5 percent N-methylaniline obtained from full-scale aircraft-engine cylinder. Both fuels contain 4 ml TEL per gallon. Compression ratio, 7.46; engine speed, 2000 rpm; inlet-mixture temperature, 240° F; cylinder-head temperature at exhaust end zone, 350° F.

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ABSTRACT

To compare antiknock effectiveness of N-methylaniline and xylidines as fuel additions under severe engine operating conditions, 5% concentrations were blended with an alkylate blending agent and a virgin-base gasoline. N-methylanline was also blended in 5% concentration with a base fuel containing 75% virgin-base gasoline and 25% toluene. All blends contained 4 ml TEL per gallon. Knock tests on air-cooled aircraft engine cylinder showed, that as a fuel antiknock additive, N-methylaniline was equal to or better than xylidines. Neither is of value in the lean-mixture region.

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