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OPPORTUNITIES FOR GASOLINE OCTANE INCREASE BY USE OF IRON CONTAINING OCTANE BOOSTER

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Abstract

An investigation refer to the opportunity to increase octane number of gasoline samples having research octane number (RON) in the range of 78.6 -95.9 by use of ferrocene containing octane booster has been carried out at the LNB Research Laboratory. It has been established that treatment of the investigated gasoline samples with octane booster results to octane number increase according to research method by 0.7 up to 1.9 points and as per motor method by 0.4 up to 0.9 points at 1000 ppm booster consumption. It has been ascertained that the booster effectiveness depends on the upgraded gasoline total content of naphthenes and olefins. As higher this content is so the octane booster effect is more effective. The carried out study shows that the maximum RON increase at ferrocene containing octane booster use may be up to 5.7 points and the minimum one is 2.1 points. Maximum MON increase may be 2.7 points and the minimum one is 1.2 points.

Key words*:* Gasoline octane; octane booster; ferrocene.

1. Introduction

The present-day gasoline is produced by blending of components from different petroleum refining processes like light straight run naphtha isomerization, fluid catalytic cracking (FCC), catalytic reforming, alkylation and others. The automobile park renovation is accompanied with increase search for premium gasoline (research octane number of 95) and decrease demand of regular gasoline (research octane number of 92). That is why refiners are faced with challenge to search ways to increase the octane number of the gasoline produced by them. Notwithstanding of the reached developments of catalytic reforming and catalytic cracking processes providing opportunities for producing gasoline components with octane number of 100 and 94 respectively [1] without use of high octane additives such as MTBE (RON =118, MON = 101), ETBE (RON=118, MON = 102), TAME (RON=109, MON=99) and ethanol (RON=130, MON=96) commodity gasoline with octane number over 95 production is still very difficult task. By the reason of proved unhealthy effect all lead containing octane boosters have been eliminated from present –day gasoline formulas. Instead of them octane boosters on the base of manganese and iron occur. The investigations have revealed that person exposure on manganese impact may result to irreversible nervous system injury [2]. It is not proved that iron containing boosters have the same harmful effect on person health and environment as those containing lead and manganese. That is why investigations of the ferrocene containing booster influence on octane number of gasoline with octane number in the range 78.6 and 95.9 have been carried out at LNB Research laboratory. The aim of the present work is to discuss the results obtained.

2. Experimental

Three basic gasoline types are used in this study: commodity regular gasoline A-92, gasoline produced by blending of all gasoline components produced at LNB refinery (RON=95.9) and straight run light low octane naphtha (fraction IBP – 100°C). Two gasoline types with research octane number 78.6 and 92.2 have been prepared by blending IBP-100 °C fraction with regular gasoline A-92 and this with octane number 95.9 respectively. Physical-chemical properties of these gasoline types are presented in Table 1. Industrial ferrocene containing booster of quantity up to 3000 ppm has been added to gasoline types shown in Table 1 (with exception to IBP-100 °C fraction). Higher quantities have not been studied due to the information submitted by the booster manufacturer indicating that over this doze it is possible some problems to arise in present engines operation. The booster below this doze has no effect on petrol engine operation.

Table I Physical-chemical properties of the studied gasoline types

Physical-chemical properties	Gasoline A-92	Gasoline mixture (RON=95.9)	IBP-100°C fraction	Blend 79% gasoline mixture (RON=95.9) /21% IBP-100°C fraction	Blend 70%A-92/ 30% IBP-100°C fraction
Density, d_4^{20}	0.7553	0.7559	0.6733	0.7439	0.7384
Distillation, ASTM D-86					
IBP, °C	35	35	37	35	35
5 %	46	44	49	40	44
10 %	53	52	49	47	50
30 %	76	77	58	72	70
50 %	99	103	65	94	90
70 %	129	125	71	122	114
90 %	182	187	81	170	159
95 %	210	216	91	196	183
PONA analysis, wt.%					
Paraffins	38.8	44.0	71.9	48.7	50.1
Olefins	19.0	16.0	0.2	13.3	12.6
Naphthenes	7.4	6.4	25.8	12.9	10.3
Aromatics	34.8	33.6	2.1	25.0	27.0
Group hydrocarbon composition (ASTM D-1319 – FIA method), % v/v					
Saturates	46.2	50.4		61.7	60.4
Olefins	19.0	16.0		13.0	12.6
Aromatics	34.8	33.6		25.0	27.0
Octane number					
RON	92.5	95.9	63.2	92.0	78.6
MON	82.4	84.9	60.6	82.6	73.6

3. Results and discussions

The Table 1 data shows that IBP-100 °C fraction addition to A-92 gasoline and to this with RON = 95.9 influences in different ways the obtained blend octane number. In the first case the IBP-100 °C fraction calculated octane number, assuming that octane number is linear combination of the volume percentage and individual components octane number, run up to 46.9 while in the second case it runs up to 77.3. This proves prior founded out relationships at blending of gasoline types that octane number of given blend from several components depends on these components hydrocarbon composition [3]. By this manner we obtain four gasoline types with different hydrocarbon composition and octane number varying in the range 78.6-95.9. The relationships of octane number (RON and MON) versus octane booster concentration are shown on Figures 1-4. It is obvious from this data that booster effectiveness is higher regarding to RON. The slope of RON change depending on booster concentration at four investigated gasoline types varies between 0.0007 and 0.0019 while slope of MON change varies between 0.0004 and 0.0009. Hence, the booster predominantly increases RON rather than MON of the upgraded gasoline types. These data shows also that slope of octane number change is different for the various gasoline types. Figure 5 data shows that exists relationship between gasoline basic MON and MON change slope depending on the booster concentration (R^2=0.758) while it is obvious from Figure 6 data that booster effectiveness is not affected by the basic gasoline initial RON (R^2=0.2041). As we attempt to find out correlation among any of gasoline parameters and the ferrocene containing octane booster impact we have established that the booster effectiveness is function of the total olefins and naphthenes content in the upgraded gasoline (Figures 7 and 8). As higher is the total content of olefins and naphthenes in upgraded gasoline so ferrocene containing octane booster is more effective.

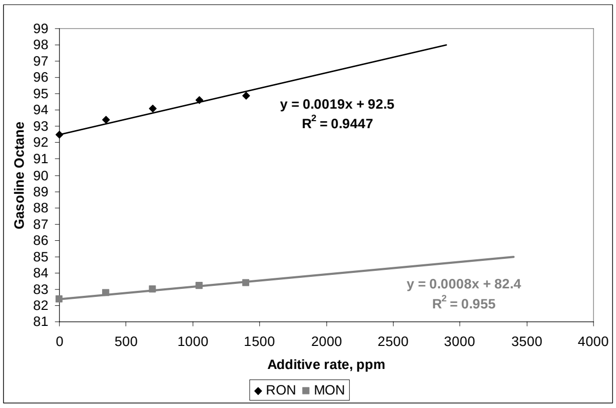

Figure 1 Dependence of octane number (RON, MON) on octane booster additive rate added to A-92 gasoline

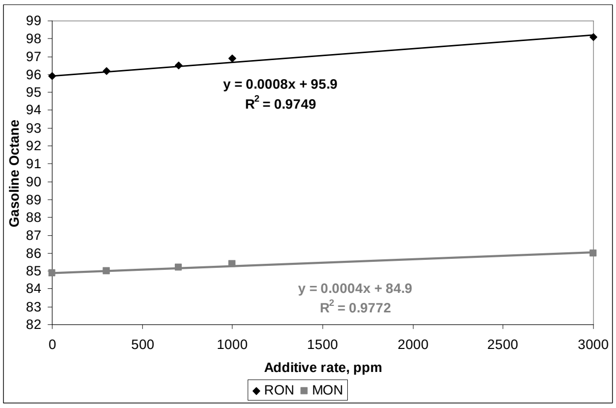

Figure 2 Dependence of octane number (RON, MON) on octane booster additive rate added to gasoline with RON =95.9

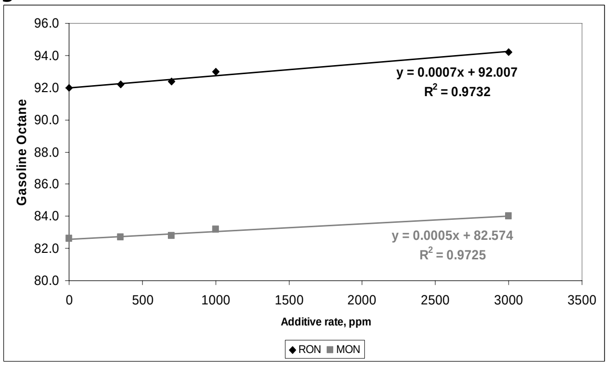

Figure 3 Dependence of octane number (RON, MON) on octane booster additive rate added to gasoline blend RON =95.9 79 % / 21 % IBP- 100 ^{o}C fraction

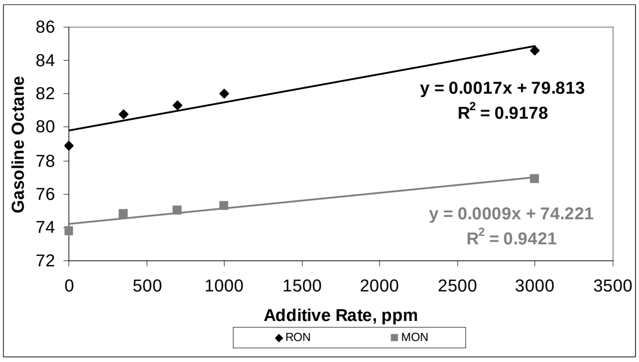

Figure 4 Dependence of octane number (RON, MON) on octane booster additive rate added gasoline blend A-92 gasoline 70 %/30 % IBP-100^{o}C fraction.

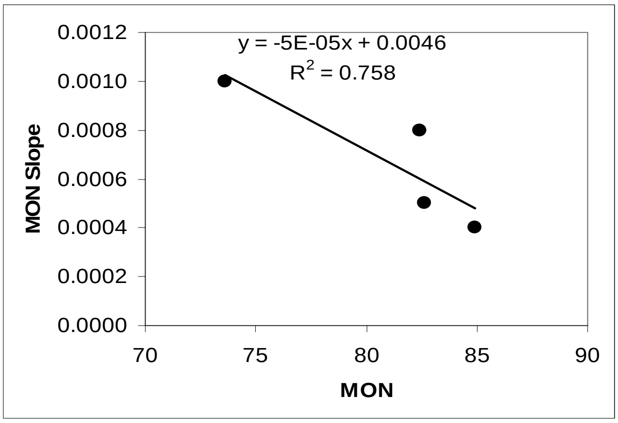

Figure 5 Dependence of the MON slope change on initial MON of the upgraded gasoline

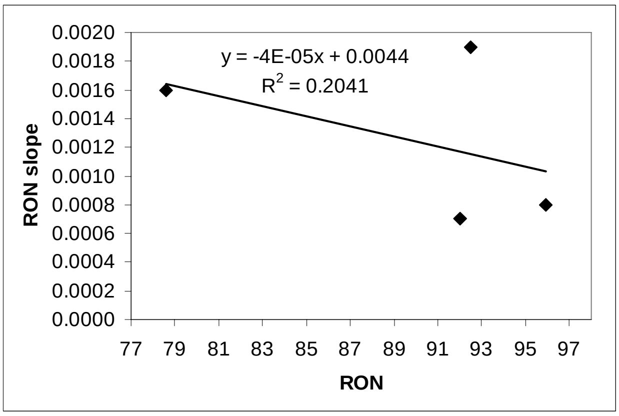

Figure 6 Dependence of the RON slope change on initial RON of the upgraded gasoline

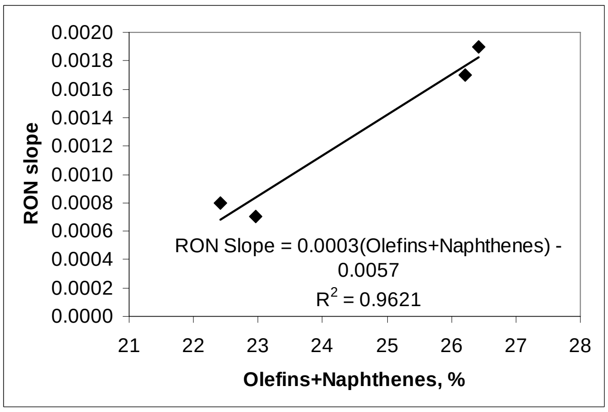

Figure 7 Dependence of the RON slope change on the upgraded gasoline total content of naphthenes and olefins

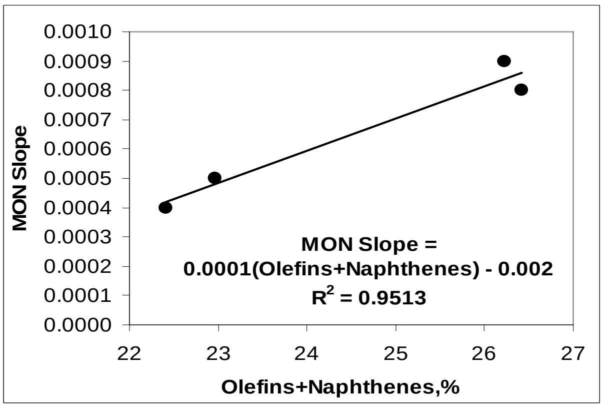

Figure 8 Dependence of the MON slope change on the upgraded gasoline total content of naphthenes and olefins

4. Conclusions

It has been ascertained that addition of ferrocene containing octane booster to gasoline types with research octane number in the range of 78.6 – 95.9 results to research octane number increase by 0.7 up to 1.9 points and of motor octane number by 0.4 up to 0.9 points at 1000 ppm booster consumption. The booster effectiveness depends on the total naphthenes and olefins content in the upgraded gasoline. As higher is this content so ferrocene containing octane booster is more effective. On the base of carried investigation it may be concluded that the maximum RON increase at ferrocene containing octane booster use may be up to 5.7 points and the minimum one is 2.1 points. The maximum MON increase may be 2.7 points and the minimum one is 1.2 points.

Reference

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