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IHD Gasoline Quality and Yield

By: Dr. Donath, Ludwigshafen,
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Summary:

From two reports of the 5.March and 25.July 1941, the quality and yield for the feed material used in January in the Ludwigshafen IHD plant, Stall 801, which had an aniline point of about 43.5 and an octane number of 61.5, can now be ascertained.

The quality is given by an overload curve, which at L (lambda) = 1.1, is from 0.2 to 0.4 atm. above CV_2b. It agrees well with the actual overload curves, which, at L = 1.1, are about 0 to 1 atm. above CV_2b RLM (Reichs Aviation Ministry). By comparison, a Rumanian gasoline, from crude oil C, for instance, with an aniline point of 48.4 and an octane number of 59, produced a IHD gasoline in the 50 kw. converter, which is at least 2 atm. above CV_2b RLM. (Report #191791 of 25.August 1941).

Values from 75.4 to 77.2% can be calculated for the yield, which are somewhat higher than the yield of 73% obtained in January. An improvement in the yield of Stall 801 may, therefore, be expected in the course of operations.

Data on quality and yield of IHD gasoline from Rumanian gasoline are contained in the report "Aviation Gasolines and High Test Fuels from Rumanian Oil" (Do. 5.5.41 #182941) and "Production of High Test Fuels by the IHD Process" (Do. 25.7.41 #190341).

#2. Quality

The feed material for Stall 801 in January, according to Dr. Hirschberger, consisted of:

I.	(28.5%) 20-25% heavy gasoline (ostmale)	O.N. 64
II.	40% heavy gasoline somewhat better than C, (semi-paraffinic)	O.N. 60
III.	(31.5%) 35-40% light gasoline D, (paraffinic)	O.N. 62
	Mean octane number	61.5

The analytical data of the heavy gasoline mixture used as feed, according to Dr. Süssenguth, are:

Spec. Gravity	0.780
Aniline Point I/II	43.5/60
Initial Boil	100°C
- 120°	30%
- 150°	80%
End Point	165°C
Aromatics	19%
Naphthenes	27%
Paraffins	53.5%
Olefins	0.5%

If we figure that 15%, based on the total feed, of light constituents were separated from the light D-quality gasoline, we find that of the total DHD-gasoline 21.5% originate from I (cetenic), 37.5% from II (somewhat better than C) and 41% from III (D), while the corresponding values for the residual gasoline are 16% from I, 27% from II and 57% from III.

A calculation of the residual gasoline octane number of the DHD gasoline, from the illustration on page 2 of the report of 25.7.41, is possible in two ways, shown in detail in Appendix 1. The first is based on taking the residual gasoline octane numbers of the three raw materials given in that illustration and multiplying them by the constituent of the residual gasoline of the three kinds of gasoline. The second, probably more accurate way, is based on the conversion of the octane number of the feed material to 16% aromatics + olefins and about 50% - 100°C. The first method gives us a DHD residual gasoline octane number of 64.9 or 65.7; the first figure based on the composition of the residual gasoline, the second on the total DHD-gasoline. The second method will give us a DHD residual gasoline octane number of 65.8. The two methods of calculation agree with each other quite well. CV_2b, by comparison, has a residual gasoline octane number of 64.

The magnitude of the variation in again expressed in atm. P_{Mo} at the minimum of the overload curve in the following. The difference between the residual gasoline octane numbers 64 and 76, compare report of 25.7.41, illustration page 2, corresponding to CV_2b and DHD from bit. coal, corresponds to a difference of about 2.7 atm. P_{Mo} of the overload curve @ L = 1.1. A change of one unit in the octane number, therefor, corresponds to $\frac{2.7}{76-64} = 0.225$ atm. P_{Mo} @ L = 1.1. The following values are then derived for the above residual gasoline octane numbers:

Resid. Gasol. O.N.	Difference between CV_2b resid. gasoline	Atm. P_{Mo} above CV_2b @ L = 1.1
64.9	0.9	0.2
65.7	1.7	0.4
65.8	1.8	0.4

According to the above mentioned reports, then, an overload curve may be expected, which @ L = 1.1, is from 0.2 to 0.4 atm. higher than CV_2b. The overload curves actually obtained are from 0 to 1 atm. higher than CV_2b RIM. The agreement, therefore, is very close.

#2. Yield

The yield can also be calculated in two ways. From page 1 of the report of 3.3.41 may be seen that the DHD gasoline yield of Rumanian distillate gasoline from octanic crude oil is 78%, 75% of oil C and 73% of oil D. With the composition of the feed material given above, considering the unequal distribution of the light gasoline, a mean yield of 75.4% DHD-gasoline with 50%/wt. aromatics is calculated; compare Appendix 2.

The second method is based on using illustration 2, preceding page 3 of the report of 25.7.41, which shows a relation between the aniline point of the heavy gasoline processed, based on about 10% aromatics, and the DHD-gasoline yield. The aniline point of the heavy gasoline is 43.5 @ 10% aromatics. Such a gasoline behaves like a gasoline with an aniline point of 46° and 10% aromatics. The illustration mentioned will give a DHD-gasoline yield of 77.2% for this aniline point.

In January a gasoline yield of 75 %/wt. was obtained in Stall 801. This figure is still too low, compared to [illegible] calculated from the material used up to now. It is to be expected that the yield of Stall 801 will be further improved after full operation of the distillation and stabilisation in Oppau.

Appendix 1

Calculating the Residual Gasoline Octane Number

1). The residual gasoline octane number of DHD-gasoline from paraffinic gasoline is 62.5, from semi-paraffinic it is 64.6 and from octanic 73.8; compare illustration preceding page 2 of report of 25.7.41.

From the constituents in the residual gasoline or, in parenthesis, in the DHD-gasoline (see report) we get:

62.5 x 0.57 (0.41)	=	35.7 (25.6)
64.6 x 0.27 (0.375)	=	17.4 (24.2)
73.8 x 0.16 (0.215)	=	11.8 (15.9)
O.N. of DHD residual gasoline	=	64.9 (65.7)

2). By removing about 9% aromatics, octane number 99, and adding 20 parts of constituents - 100°C, the gasoline is brought to roughly 30% aromatics and 50% - 100°C.

	Fraction		O.N. x constituent
	Constituent	O. N.	100
Feed Material	100	61.5	61.5
Aromatics	-9	99	-8.1
Light Gasol. - 100°C	+20	74	+14.8
Gasol. 50% - 100°C, End Point 150°C 10% Aromatics	111	61.4	68.2

The octane number 61.4 corresponds to a residual gasoline octane number of the IHD-gasoline of 65.8, according to report of 25.7.41, figure 1.

Appendix 2

The feed material consists of 22.5% octanic heavy gasoline, 40% heavy gasoline C and 37.5% light gasoline D, see preceding section on quality. Since only the last material contains light constituents, about 15 parts, an injection material of the following composition goes into the stall:

22.5 parts octanic heavy gasoline	=	26.5%
40 " heavy gasoline C	=	47.0%
22.5 " heavy gasoline D	=	26.5%
85.0 parts	=	100%

From these figures the following yield is derived:

26.5 x 0.78	=	20.7%
47 x 0.75	=	35.3%
26.5 x 0.73	=	19.4%
IHD-gasoline yield	=	75.4%

If we use the composition of the feed mixture directly, without considering that only D-gasoline with light constituents is available, we get a yield of 74.9%.

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