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Discussion of Knock Limit Curves According
to the Injection Process with Divided Injection
By Fromherz & Müffling, Ludwigshafen, 7 April 1941
(From Dr. Pier's Files, marked "Geheim")
(See also T-377 & T-378)

## 1. Introduction.

According to report #1604, dated 2 April 1944, from the DVL
(Deutsche Versuchsanstalt für Luftfahrt), an appreciable improvement in
the knock behavior of fuels, particularly in the excess air range ($\lambda > 1$),
can be obtained by the injection process developed there, in which only a
small portion of the fuel is injected during the suction stroke, while the
main portion is injected during the compression stroke and/or after
ignition has started. The attached curves (missing, but see T-378), Pme
dependent upon $\lambda$, are flatter than for the present process. Particularly
noticeable is a rise in the Pme at its minimum, compared to the former
curves. A similar change in the overload curves has already been
described some time ago, i.e. in comparing the overload curves with a
variable and a constant ignition period, report #180631, 23 January 1941.
At that time the attendant phenomena were explained, and it was shown how
raising the minimum in the lean range can be obtained only at the expense
of a lower efficiency and correspondingly greater fuel consumption.

## 2. Divided Injection.

It is now very probable that conditions for the above described
operating method with divided injection are very similar. As shown in the
curves sent us by DVL the load pressures, together with the mean effective
pressure Pme, rise above former values in the lean range. Since with
constant $\lambda$ (air/fuel ratio) the quantity of fuel consumed is dependent
upon the quantity of air, increasing the load pressure naturally also means
an increase in the quantity of fuel consumed. The curves presented by
DVL point out that the increase in the Pme and consequent increased power
of the motor is obtained by a corresponding increase in fuel consumption,
but that no increase in the efficiency of the fuel used is obtained in any
way.

Should this assumption be correct, the point of intersection of
the Pme curves of the normal and the new injection method must be at about
the same $\lambda$ as the point of intersection of the corresponding load pressure
curves, i.e. equal power corresponds to equal load pressure and, therefore,
equal fuel consumption. As may be seen from an examination of the DVL
curves, this is exactly so for 130° C and 160° C charged air temperature;
at 120° C the points of intersection in $\lambda$ deviate slightly from each other,
but still agree with each other within the limits of errors for the determination of $\lambda$.

**3. Essential Data for Final Evaluation of the Process.**

The DVL curves discussed in the foregoing chapter point out that in the new process the efficiency of the fuel used is about equal to that of the standard process, but that greater power (Leistung) without knocking can be obtained with it with lean mixtures, with correspondingly increased fuel consumption, which is possible only with much richer mixtures in the standard process.

These curves give no indication of greater efficiency of the new process. Greater efficiency would be shown only if it were possible in the new process to obtain greater power than at present or to obtain the present $p_{me}$ values with lower load pressure (Ladedruck), and consequent lower fuel consumption, by increasing the compression ratio with constant $\lambda$ and load pressure.

Corresponding experimental data are urgently needed for final evaluation and further recommendation of the process for practical application.

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