response occurs, and provides reassurance that these findings do not arise from nonspecific sources such as movement, direction of gaze, and so forth. Similar reassurance is derived from the fact that 39 of the 56 cells examined showed no significant differences either early or late in the post-stimulus response. Perhaps the most convincing support for the statement that these findings are not attributable to nonspecific causes comes from the fact that 15 of the 16 plastic cells showed no significant differences during the early segment of the post-stimulus histogram. The latency span of the early segment of the histogram corresponds to the sensory-specific or exogenous portion of the evoked response, and should reflect changes in the afferent input that might derive from changes in the direction of gaze or level of arousal. All 16 plastic cells showed changes in the long-latency segment of the histogram that corresponds to the latency region of the endogenous components described in the introduction to this report.

The body of data presented in this report indicates that two classifications of cells exist in the thalamus and cortex. We have called "stable" those cells whose average firing patterns are determined by the parameters of the physical stimulus, and "plastic" those cells whose response patterns vary, in their late components, depending upon the meaning attributed to the afferent input. Our findings suggest that the endogenous processes observed in the brain are related to the activity of a subset of cells, which we term plastic cells. The fact that both stable and plastic cells exist within a given recording site indicates that the set of stable cells may fulfill the role of providing a stable, afferent input, while the set of plastic cells, through differential late responses, may mediate operations on the afferent input that are correlated to the cognitive process of the animal. Establishing whether stable and plastic cells represent different types of neurons would seem to merit high priority.

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18 November 1975

Hydrogen Produced from Decomposition of Methanol During Engine Compression?

Reed and Lerner discussed methanol as a fuel for internal combustion engines (*1*). They reported improved acceleration, lower levels of CO in the exhaust, better fuel economy (miles per gallon), and improved octane rating for a fuel consisting of 5 to 15 percent (by volume) methanol in gasoline. Further, Reed and Lerner proposed a mechanism "to account for the disproportionate effects of methanol on the octane value and other properties of gasoline." Additional information on the performance attributes of methanol-gasoline blends has recently been presented (*2*).

According to the Reed and Lerner hypothesis, methanol can decompose into CO and H_2 during the compression stroke of an internal combustion engine. Since this decomposition is endothermic, heat would be absorbed, the cylinder charge cooled, and premature combustion reactions quenched. They further relate that "the CO and H_2 formed on dissociation increase the flame velocity of the charge, giving more complete and efficient combustion."

To support their methanol decomposition mechanism Reed and Lerner calculate from data in Kirk and Othmer [reference 7 in (*1*)] that "at 10 atmospheres methanol is 18, 85, and 99.7 percent dissociated at 100°, 200°, and 300°C, respectively," However, these results are misleading because (i) they apply to equilibrium conditions only and (ii) they apply to the CH_3OH, CO, H_3 system and not to a system that includes air. No reason was given to indicate that decomposition is fast enough for high CO and H_2 levels to be established during the compression stroke of an operating engine. Furthermore, if it is assumed that the reaction rate is relatively fast, Reed and Lerner did not explain what effect carbureted air may have on any CO or H_2 generated in the combustion chamber prior to ignition.

To explore the validity of Reed and Lerner's mechanism, we investigated methanol decomposition experimentally by measuring the amount of CO and H_2 in the unburned charge of a single-cylinder engine operated at equivalence ratios (ϕ) equal to 0.82 (lean) and 1.2 (rich). Pure methanol was tested rather than a gasoline-methanol blend since the Reed and Lerner proposal does not depend on the presence of gasoline, and we expected the use of pure methanol to increase decomposition product levels.

A poppet valve (*3*) was used to extract gas samples from the combustion chamber prior to flame arrival at the sampling

Table 1. Combustion chamber CO and H_2 concentrations.

Fuel	ϕ	H_2 (% by volume) Observed	H_2 (% by volume) Corrected	CO (% by volume) Observed	CO (% by volume) Corrected
		Following compression, prior to ignition			
Methanol	0.82	0.4	−0.1	0.0	0.0
Indolene	0.82	0.4	0.0	0.0	0.0
Methanol	1.2	0.6	0.0	0.4	0.0
Indolene	1.2	0.5	−0.1	0.5	0.1
		In unburned charge, near end of combustion			
Methanol	0.82	0.4	0.2	0.2	0.1
Indolene	0.82	0.0	−0.1	0.1	0.1

point. The following analytical instruments were used: nondispersive infrared detectors for CO and CO_2, a thermal conductivity bridge for H_2, a polarographic analyzer for O_2, a flame ionization detector for gaseous hydrocarbons, and a chemiluminescence analyzer for oxides of nitrogen (NO_x). The observed concentrations of both CO and H_2 in the cylinder samples were adjusted for contributions from the residual gases (*4*). Residual gas was determined by comparing the CO_2 concentration in the compressed charge with that in the exhaust gas. The observed H_2 concentrations were also corrected for response of the thermal conductivity bridge to exhaust species other than H_2.

Sampling of the unburned cylinder charge was carried out at two points in the engine cycle—near the end of compression and near the end of combustion. The results obtained with methanol were compared to those obtained with more conventional hydrocarbon fuels (Indolene and isooctane).

A standard Waukesha split-head CFR (*5*) single-cylinder engine was used for obtaining samples of the combustion chamber gases near the end of the compression stroke. The engine was operated at 1200 rev/min, a compression ratio of 8, and constant airflow. The sampling valve was installed in the knock pickup hole and timed to open at 30 crank angle degrees before top center (BTC) and close about 10 degrees later. This permitted sampling the combustion chamber gases at the minimum spark advance for best torque (MBT) ignition time for both methanol and Indolene. Both H_2 and CO from methanol decomposition must be present if the mechanism is correct. The actual ignition timing was set at 0 to 5 degrees BTC to eliminate the possibility of early combustion gases entering the sampling valve.

The results, in Table 1, indicate that CO and H_2 were essentially absent from the combustion chamber at 20 to 30 degrees BTC after compression of either methanol-air or Indolene-air mixtures in an operating engine. The small negative H_2 concentrations result from the corrections to the raw data. The estimated uncertainty in the results is ±0.5 and ±0.3 percent by volume for the H_2 and CO values, respectively.

After making these measurements we tested our sampling and analysis system to be sure CO and H_2 were not lost prior to analysis. To do this, we operated the engine at $\phi = 0.82$ with a fuel mixture consisting of 35 percent CO and 65 percent H_2. The engine operation and gas sampling conditions were the same as for the methanol tests. The concentrations of CO and H_2 sampled from the combustion chamber (prior to ignition) were in agreement with those predicted from the fuel composition and the metered air and fuel flow. Hence, it appears that CO and H_2 concentrations in the combustion chamber may be determined with reasonable accuracy with the sampling technique.

Although the above results showed essentially no H_2 or CO after compression prior to ignition, we hypothesized that methanol might still decompose ahead of the flame at the higher temperatures occurring later in the combustion event. Consequently we sampled the unburned charge ahead of the flame as close as possible to the end of combustion. For this purpose we used a modified split-head CFR engine with a compression ratio of 6.8. The engine was operated at the same conditions as before, except for spark timing which was set at MBT. This engine was equipped with a rectangular combustion chamber with the spark plug at one end and the sampling valve at the other end in the end-gas region. Flame arrival at the sampling valve was detected by an ion gap mounted in the valve housing. With the valve lift and ion gap signals displayed on a dual-channel oscilloscope, the sampling valve was timed to close at 10 degrees after top center (ATC) just before flame arrival at 15 degrees ATC.

The tests were performed with both methanol and isooctane at the lean equivalence ratio ($\phi = 0.82$) tested previously. End-gas samples were obtained and analyzed. The results (Table 1) indicate that the adjusted H_2 concentration was slightly higher for methanol than for isooctane but the concentrations of both H_2 and CO were less than the estimated uncertainty of the measurements for either fuel.

In summary, the unburned combustion chamber gases in an operating engine were sampled near the end of either compression or combustion and analyzed. No significant levels of CO or H_2 were observed for either methanol or more conventional hydrocarbon fuels. Apparently, the decomposition hypothesis of Reed and Lerner does not explain the octane and other performance characteristics of methanol.

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9 July 1975

Hilden and Stebar have presented what seems to be a sufficient test of our dissociation hypothesis and shown that the antiknock behavior of methanol cannot be attributed to dissociation during compression or before the flame front.

Octane is one of the most important indices of gasoline quality, and in the last few years we have paid a heavy price in vehicle performance and efficiency for removing the tetraethyl lead for environmental reasons. It is not clear that the substitution of benzene and toluene is environmentally safe either. We hope that Hilden and Stebar will continue to look for the cause of octane enhancement by methanol.

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27 February 1976