

## DISCUSSION

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*J. J. Mikita*<sup>1</sup> (*written discussion*)—When I received the first announcement for this Workshop some weeks ago, I was pleased to see that a paper was to be presented by Faust and Sterba. I thought we now would learn something about the new Universal Oil Products (UOP) catalytic reactor which has received so much attention by the press in recent months. Accordingly, I sought an opportunity to discuss the paper, thinking that perhaps I might in doing this make some slight contribution to this Workshop.

However, when I received a copy of the paper, I learned to my chagrin that it contained nothing new with the exception of a little bit of data on polynuclear aromatics. In fact, recent press reports contain more information on UOP's new catalytic reactor than does this present paper.

Since the authors are predicting with very little uncertainty that catalytic-exhaust converters will be used universally by 1980, and they ask that it be especially noted that they are speaking of catalytic control of nitrogen oxides as well as hydrocarbons and carbon monoxide; and since the catalytic converter data reported in the current paper has to do with noble metal catalysts which, I understand, perhaps incorrectly, is not being considered for commercial across-the-board use on automobiles, I think it is not unreasonable to ask the authors for some backup data for their prediction. So I would appreciate it if the authors would address themselves to the following questions.

1. When the new UOP catalytic exhaust reactor is properly installed on a car, what are the results obtained on the official cold start Federal Test Cycle in terms of grams per mile of hydrocarbons, carbon monoxide, and nitrogen oxides?

2. If cars with this device have been run on the road, how did the official cold start Federal Test results fare as mileage was accumulated? And how were the vehicles operated? Are there any data to show how well the device controls emissions under motorist-type driving conditions?

3. What results have been obtained on the cold start true mass emission procedure?

4. How quickly does the converter warm-up in the cold start Federal Test Procedure?

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5. Would the authors please describe their catalytic system in terms of the number of reactors required, and what auxiliary controls and engine adjustments are required? Where on the vehicle is the converter or are the converters installed?

6. Would they please elaborate on the statement, "Vehicles equipped with catalytic converters will perform better than automobiles do today or will in the next few years, although close control of air-fuel ratio will be required? Would they particularly address themselves to the question of how close the air-fuel ratio must be maintained?

Some discussion of information bearing on these questions, as previously indicated, would be in order, so that the audience might be able to make some independent assessment of the predictions being made by the authors.

And one final thing: the data presented on polynuclear aromatics show that PNA in the exhaust does not increase as the aromatic content of the fuel is increased from 31 to 45 percent. This is contrary to a published report by Begeman, and contrary to results obtained in our laboratory. Accordingly, I would like to ask on what kind of engine were these results obtained, how was the engine operated, and how were the exhaust gas samples obtained?

As everybody is well aware, the authors' paper discusses a subject of paramount importance to the petroleum and automotive industries and to the motoring public. For this reason, in a meeting of this type, it is only fair to ask for backup data when important conclusions are drawn or important prognostications are made.

*R. K. Stone*<sup>2</sup> (*written discussion*)—You have just heard a paper discussing a subject which has long been a major issue in vehicle exhaust emission control circles. This is, of course, the role of catalytic devices in achieving low emission goals and, more particularly, the future of lead in gasoline. The matter of lead usage in future gasolines is undoubtedly the most serious issue yet faced by the petroleum industry in the interests of smog abatement.

I have sat through more than 60 h of testimony on the subject of lead in gasoline as related to air pollution during the past six months. Most of this testimony has been presented at legislative hearings in California; but there also have been lengthy hearings in several other states, such as Hawaii, New York, and Pennsylvania, as well as at the federal level. In light of the apparent complexity of the subject, the paper just presented therefore has been most refreshing to me. In just a few paragraphs, Mr. Faust has presented his entire case for the inevitability of catalytic exhaust devices and the need for unleaded gasolines.

More seriously, I believe that proponents of the inevitability of catalytic exhaust controls, particularly those with such strong convictions as Uni-

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versal Oil Products (UOP), owe the technical community an indepth technical treatise with extensive test data to support their beliefs. The cloak of secrecy must be removed from the catalytic exhaust control device by companies such as UOP to permit independent assessment of their potential when placed in direct competition with alternate types of control systems. Proponents of noncatalytic systems performing quite satisfactorily on present leaded gasolines have published a great deal of technical information on their devices over the past several years. Prototype models of their devices have been made available for private evaluation by both industry and Government. This type of evaluation is needed most urgently for catalytic devices.

Referring more specifically to the contents of Mr. Faust's paper, I would like to update one piece of historical information he presented. It is mentioned that a bill to limit almost immediately the use of lead in gasoline marketed in California and to ultimately phase it out entirely by 1 Jan. 1974, was introduced in the California State Legislature on 6 Jan. 1970. It may be of interest to know that this particular bill recently has been rather drastically amended in a number of very significant ways. In general, these amendments were for the purpose of recognizing the continuing need for older cars to be supplied with high-octane gasoline for many more years to come, and that such a gasoline could not be provided at reasonable cost if use of lead were not permitted. It is too early to say what the ultimate fate of the California lead bill will be. However, it is most unlikely that it will even faintly resemble that which was described in the Faust paper.

I would like to close my remarks by asking two questions of the author. First, could he give us something more concrete about the state of development of catalytic exhaust devices. For example, are there now in progress, or in the planning stages, any large-scale field test programs on commercial prototypes of UOP catalytic systems by Government agencies such as NAPCA or the California Air Resources Board?

Secondly, does research by UOP on catalytic devices suggest the possibility that they might be adapted to used car retrofit at reasonable cost? If so, what would be the effectiveness of such a retrofit device for each of the major exhaust pollutants; and would such retrofit devices require unleaded gasoline?

*W. J. Faust and M. J. Sterba (authors' closure)*—The subject of this symposium was "The Effect of Automotive Emission Requirements on Gasoline Characteristics." We addressed ourselves to this subject rather than to a detailed, in-depth, technical treatise on the performance of UOP's catalytic exhaust-gas converter. Based on our own work with catalytic converters and cooperative work with domestic and foreign automobile builders, it is our belief that catalytic converters will be used extensively to enable the automobile builders to meet the increasingly stringent emission standards at the lowest cost in money and performance.

Such converters will require the use of lead-free gasoline. The production of lead-free gasoline will result in changes in gasoline characteristics as outlined in the text.

Extensive test data and the answers to some of the discussers' specific questions are contained in Ref 1. Several makes and types of catalytic converters are being tested by the automobile builders. The kind of catalyst used, the number of reactors required, the converter location, the engine adjustments, and the carburetion range required will be determined by each manufacturer for the level of conversion required for his vehicles. These manufacturers are making their own independent assessment of the catalytic converter's "potential when placed in direct competition with alternate types of control systems." It is not the authors' prerogative to disclose the test results of others, nor is there any obligation for the automobile manufacturers to publish their results at this time. Their only obligation is to build vehicles that meet the emission standards. We think that the overwhelming majority of these vehicles will be equipped with catalytic converters.

To answer Mr. Stone's specific questions:

1. Fleet tests of UOP converters are being implemented with the City of New York and with the Chicago Police Department. These converters cannot be considered commercial prototypes because the vehicle manufacturer is not involved.
2. Used-car retrofit, indeed, is suggested. Lead-free fuel would be required.