SUMMARY

By Dan P. Barnard[1]

The technical objectives of this symposium are: (1) to identify those product quality areas in which development is active, (2) to indicate requirements for improved (or new) referee and developmental procedures, (3) to point out wherein product specifications may be affected, and (4) to serve as a forum.

Nine papers were presented. One of these discussed needs from the car manufacturer's point of view, while the other eight can be considered as responses by those engaged in various aspects of fuel development. Although the papers were independently prepared, the symposium can be appraised in terms of "need and response."

Since all nine papers discussed both referee and developmental problems, the author of this summary feels that it is necessary to state, as terms of reference, his understanding of the terms: "specification," "referee test," and "developmental test."

Specification.—A statement of a minimum level in some quality feature (or of some dimension) below which the product is unacceptable. User's specifications normally do not place upper limits on quality features nor do they assign increased value to quality above the called-for minimum.

Referee Test.—A highly standardized procedure employed to define or measure an individual property or dimension. It is usually a conventionalized device which by itself does not necessarily determine final suitability for a particular use. (*Example.*—A micrometer may measure the diameter of a shaft with great precision, but it will not evaluate hardness, strength, corrosion resistance, or other factors which may be all-important to the final application.)

Developmental Test.—A scheme (frequently functional) evolved to reflect some important characteristic of product behavior. It must be readily reproducible and—if it is to be really useful as an aid to product development—it must be orders of magnitude cheaper and faster than the "service test." Sometimes the duties of the "developmental test" can be performed by interpretation of values from standardized "referee tests." All tests or evaluations to be reliable guides for product development must reflect the service needs deemed most important at the time. Since competition involves continuous improvement, such guiding procedures must promptly reflect changing needs or opportunities to enhance business.

Problem Areas

The car manufacturer's point of view, as expressed by Risk and Cleveland (**1**)[2] is that the fuel properties most in need of attention are: (1) volatility, (2) combustion, including knock resistance, and (3) dirt, including stability.

The papers from the fuel development side responded as follows:

Volatility:

The present standardized test methods are considered adequate by Legatski and Bridgeman (**2**). Dempster (**3**) implicitly agrees while pointing out some of the problems of evaluating additives as

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[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

carburetor icing-preventives. Even the questions raised by Risk and Cleveland (1) indicate that a number of methods of estimating volatility behavior are available and that decisions rather than new methods are in order. Very briefly, it appears that no great changes in volatility characteristics are imminent—either in effect on specifications or in the field of standardized tests.

Combustion:

A clean separation between knock and the other manifestations of abnormal combustion is difficult—if not impossible. In the field of knock resistance, or "octane number," differentiation must be made between referee (or control) test methods and evaluations for product and process improvement. The consensus appears to be that referee tests for octane number determination can stand simplification, improved reproducibility, and better terminology—especially at levels above 100 octane number. As to "abnormal combustion other than knock," the manifestations are so varied, definitions so uncertain, that test standardization seems impractical at this time. It follows that inclusion in specifications would be correspondingly difficult.

Dirt:

Adventitious dirt cannot be wholly controlled at the point of manufacture. To be effective, samples would have to be taken at point of use. If the need should become sufficiently acute—and if procedures for managing sampling and testing can be worked out—the test method problem and inclusion in specifications would appear technically straightforward. Chemical stability is the opposite sort of problem. Here it seems that the existing tests are quite useful and that changes or improvements would require much justification. This quality feature is being subjected to wide and intense developmental effort, however, and as real progress is made it will be appropriately reflected in specification changes.

The effects of the above general opinions on the questions of referee and development testing are discussed in the following sections.

REFEREE METHODS

Burk (4), summarizing the programs of Research Division I on Combustion Characteristics of ASTM Committee D-2 on Petroleum Products and Lubricants, says, "The objective agreed upon . . . is as follows:

"By January 1, 1964, devise single cylinder engine test method (or methods) which will measure the antiknock characteristics of current and future motor gasolines and components, and will:

"1. Provide improved reproducibility over that obtained with the present Motor method and over that obtained with the Research method at high octane levels. This reproducibility should be equal to or better than that obtained with the present Research method (D 908 – 59) in its most precise range.

"2. Reduce by one-half the variability between actual road performance values and those predicted by the present laboratory engine test methods alone.

"3. Provide economy and simplicity of equipment and procedure consistent with the requirements of routine commercial laboratories.

"NOTE.—A basic assumption associated with this objective is that ratings of fuels by the new methods will not necessarily result in the same octane numbers as those determined by the present methods."

Burk stresses the need for improved precision in referee knock test procedures. Little emphasis was placed on the need for new or improved procedures for knock ratings above 100 octane number, although Wagner and Getz (5) stressed the need for a more significant test and for a continuous scale to extend beyond 100 octane number. Gibson and Wilson (6) as well as discussors from the floor fell that hysterical action to improve significance could not be strongly supported at this time.

As to the practicability of establishing standardized tests for abnormal combustion (other than knock), the conclusion of Pastell and Hyatt (7) adequately summarizes the present comments:

"In summary, it is the authors' opinion that there is not now a sufficiently clear understanding of the fundamentals of the deposit ignition problem nor are there sufficiently valid test techniques known to warrant attempts at devising standardized tests for evaluating the deposit ignition properties of gasolines at this time. Attempts to do so might inhibit rather than further development of solutions to the problem."

This conclusion was supported by discussion.

RESEARCH AND DEVELOPMENTAL TESTS

Great interest is currently shown in methods for evaluating knock ratings and for appraising other abnormal combustion phenomena. With respect to the former, the expression "significance" of knock tests recurs time and again.

Burk states that Research Division I has the objective to "reduce by one-half the variability between actual road performance values and those predicted by the present laboratory engine test methods alone." (This item in Burk's outline of objectives does not conform to the definition of a referee or standardized test appearing earlier in this summary. Rather it belongs—at this time—in the developmental test category.) He also outlines the proposed road test procedures and other tests needed to support the accompanying method developmental work. Risk and Cleveland (1) emphasize the significance of knocking behavior at part throttle. Gibson and Wilson (6) delineate the several CFR programs aimed at obtaining service evaluations of fuels and equipment knocking characteristics and tying them into single-cylinder laboratory engine determinations. They further stress the need for information adequate to the proper interpretation of standardized laboratory methods. As mentioned earlier, Wagner and Getz (5) stress this need and add the requirement for a scale including the range above 100 octane number. The foregoing observations are also emphasized by Pastell and Hyatt (7).

In the area of other abnormal combustion phenomena, Risk and Cleveland stress ability of the fuel to resist hot-spot and deposit ignition and recommend developing standards of measurement for combustion noise due to abnormal or surface ignition. Faust (8) also pleads for work in this field and Dempster (3) points out that the development of additives to control these various erratic combustion phenomena poses peculiar problems of evaluation. Again Pastell and Hyatt review the test method needs and possible implications of developments in this area.

The importance of engine cleanliness was heavily stressed by Risk and Cleveland. They emphasized the undesirability of any foreign substance, chemical or physical, which interferes with satisfactory operation of the engine. Included are sludge, varnish, combustion chamber, valve, and spark plug deposits, and adventitious dirt particles. Sludge and varnish are mainly phenomena of fuel (and lubricant) composition; combustion chamber deposits are principally associated with the use of antiknock compounds; and adventitious dirt (frequently iron oxide) is probably dependent on handling of the fuel between refinery and user. Risk and Cleveland urge the development of standards of measurement for dirt of all varieties and of sensitivities of engines to dirt, and of new or revised test techniques for measurement and evaluation of combustion chamber deposits, carburetor and intake system deposits, and particle plugging of filters and small passages.

Bender (9) reviewed the storage stability programs of the Office of the Chief of Ordnance and Bureau of Mines at Stanford Research Inst. He pointed out that because of the chemical complexities of the problem a combination of analytical and semi-functional tests may prove to be the most practical way of defining the storage stability of gasolines.

Dempster (3) stressed the part played by additives in controlling the various types of deposits and pointed out the need for more adequate development and control test procedures. He supported the present programs aimed at establishing broadly acceptable test procedures. Care in choosing objectives was emphasized most ably by Rendel (10).

The papers from the fuel development side did not deal with the problem of dirt contamination. This problem is necessarily so closely tied to the circumstances of transportation and handling that the manufacturer can do very little. Since any effective testing would need to be done at the point of use, it seems impractical to attempt to test—or specify—against suspended dirt at the point of fuel manufacture.

GIST OF THE SYMPOSIUM PAPERS

In brief, the papers presented the following views:

Fuel volatility developments which might require new test procedures do not appear likely, nor do imminent specification changes.

Knock test methods could stand increased precision, decreased complexity and, perhaps, a continuous scale to include the range above 100 octane number.

Developmental test procedures are needed for almost every phase of fuel quality improvement—particularly in the area of knock rating interpretation and abnormal combustion other than conventional knock. Such methods must be flexible and must respond to immediate and foreseen requirements.

Fuel stability test procedures as presently used need more positive data on interpretation. In time they may require revision as additives and other developments in manufacturing ensue.

Adventitious fuel contamination may require a specific test. (This, however, would necessarily be applied at the point of use.)

As to the possible effects of fuel development on specifications: Changes in volatility specifications do not seem imminent. Refinements of knock testing procedures may require a new system of "numbers" as the logical result of new calibrations. Specification of abnormal combustion properties (other than knock) seems a long way off, indeed. Changes in standardized stability specifications and provisions against chance dirt do not appear probable in the near future.

LIST OF PAPERS

(Page numbers are to location in this publication.)

(1) T. H. Risk and A. E. Cleveland, "Present and Future Requirements of Motor Gasoline to Meet Needs for Satisfactory Engine Performance," see p. 88.

(2) T. W. Legatski and O. C. Bridgeman, "Significance in Evaluation of Motor Fuel Volatility," see p. 74.
(3) John M. Dempster, "The Role of Motor Gasoline Additives," see p. 43.
(4) F. C. Burk, "Motor Gasoline Octane Test Method Developments," see p. 37.
(5) J. E. Getz and T. O. Wagner, "Relation Between Laboratory Knock Ratings and Customer Satisfaction on the Road," see p. 3.
(6) H. J. Gibson and H. I. Wilson, "Coordinated Research Council Work on Antiknock," see p. 22.
(7) D. L. Pastell and K. Hyatt, "Other Abnormal Combustion Phenomena—Are Gasoline Specifications Necessary?" see p. 12.
(8) W. J. Faust, "Effect of Composition on Future Motor Gasoline Specifications, or Vice Versa," see p. 70.
(9) R. O. Bender, "Gasoline Stability: Possible Effects of Current Research on Future Methods and Specifications," see p. 61.
(10) T. B. Rendel, discussion of J. M. Dempster, "The Role of Motor Gasoline Additives," see p. 57.