Discussion

D. L. Katz. The authors are commended for their efforts to improve the accuracy and facility for determining the compressibility of natural gases. The following comments or questions are raised on the subject of the paper:

1. Many engineering problems in the natural-gas industry require compressibility data at conditions beyond the scope of this paper. Methods often employed involve the computation of reduced temperature and pressure from composition followed by finding the compressibility factor from a chart or table. Have the authors compared their compressibility-factor data with the charts in common use in the industry? Assuming that the authors' results are an improvement on earlier methods, have they considered presenting a compressibility-factor chart using charts and tables in common use in the industry? Assuming that the authors' results are an improvement on earlier methods, have they considered presenting a compressibility-factor chart using reduced temperature and reduced pressure, which could be used for gases having compositions outside the limits of their equations?

2. In metering gases, there are three factors which are functions of temperature, pressure, and gas gravity. It was suggested some 15 years ago that these be combined into a single factor as follows:

$$F_{pr} = \left( \frac{520}{\text{GTZ}} \right)^{1/2}$$

It was shown that the variation in $F_{pr}$ with pressure and temperature would be no more severe than for $F_{pr}$ and that the combination would omit two steps in meter calculations. Did the authors consider this combination of variables? Do they see any reason why it would not be possible to correlate $F_{pr}$ with pressure, temperature, gas gravity, and composition?

3. The last comment is a remark to the profession and gas industry and not to the authors alone. For those who have worked at pressures of 6000 psi or above, the use of the prefix “super” on the “compressibility factors” has been questionable. Presumably, the prefix is intended to denote that the gas is more compressible than an ideal gas. At higher pressures, common in natural gas reservoirs, natural gas is less compressible than an ideal gas. For those using the prefix super, it would be necessary to change the name to “subcompressibility” factors when the gas became less compressible. For this reason, elimination of the prefix super is urged, for the term compressibility factor is adequate to cover conditions at which a gas is both more compressible and less compressible.

H. B. McNichols. The authors have presented a very interesting approach to a subject which has great importance to the natural-gas industry. It should be pointed out that during the infancy of the gas industry, delivery pressures were of the magnitude of 200 or 300 psi and the commodity itself was rather inexpensive. However, today the field price of natural gas has tripled and the metering pressures are around 1000 psi. The supercompressibility of natural gas was considered a straight-line function with its slope varying with temperature and specific gravity. Operating supercompressibility factors were developed to cover a pressure range up to 500 psi. As flowing pressures began to increase, the tables were extended to 1000 psi only by changing the intercept constant of the straight-line equation.

E. E. Stovall. The authors are to be complimented on their fine presentation. A method for more accurately predicting supercompressibility factors throughout the normal operating range of conditions in the natural-gas industry has been needed. The method described in the paper has proved to be the answer to that need and has been widely accepted by the gas-industry engineers. Actual tests in operating practices have proved the accuracy of the method.

Authors' Closure

The authors appreciate the comments by Dr. Katz. A formal and detailed comparison of the results of this method with other methods has never been completed. The authors should complete the comparison. A study to extend the range of applicability of the present data is now in progress. It is expected that a compressibility chart will be developed which could be used for gases having compositions outside the limits of the present working method.

Relative to the use of a combined correction factor for temperature, gravity, and compressibility, the authors have given much thought to this possibility and feel that there is no significant advantage to the combined arrangement. The combination would have a basic disadvantage in that the flexibility of use would be reduced. It would be necessary to evaluate $F_{pr}$ only as a function of the specific gravity. The present method which separates the factors allows the use of any method in defining $F_{pr}$, e.g., a fractional analysis, or gravity and heating value, etc. The authors agree in principle with Dr. Katz's remarks on naming of the deviation factors. However, these names have come to have certain specific meanings and it is doubtful if change would be of any benefit to natural gas industry.

The authors are grateful to Mr. McNichols and Mr. Stovall for their comments.

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