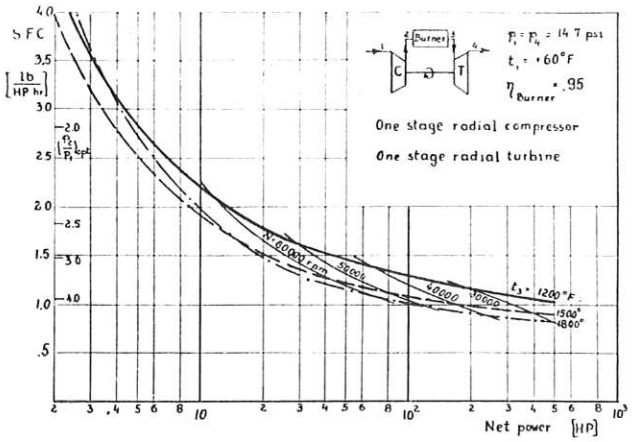

FIG. 54 MINIMUM SPECIFIC FUEL CONSUMPTION OF SMALL POWER PLANTS AS FUNCTION OF NET POWER

power. It is interesting to note that for extremely small net power the application of especially high gas temperatures increases the fuel consumption.

It may be mentioned that the investigations also revealed that lower fuel consumptions (up to 15 per cent) than indicated in Fig. 54 can be obtained when two turbines are used (one turbine driving the compressor and a power turbine), because thus the speeds of compressor and turbine are closer to the optimum speed of each unit. With this arrangement the speed of the unit must be increased (up to 40 per cent).

ACKNOWLEDGMENTS

The author expresses his gratitude to Prof. F. L. Schwartz, University of Michigan, for his interest and support in submitting this paper. Special acknowledgment is due to Dr. F. J Neugebauer, General Electric Company, and Dr. M. Schilhansl, Brown University, for valuable advice in discussing the essential phases of this paper.

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Discussion

W. T. VON DER NUELL.[18] The author has presented a chart demonstrating his opinion with regard to the influence of the Reynolds number on the efficiency of turbomachines. An increase of 10 points in efficiency is co-ordinated with an increase in Reynolds number from approximately 3×10^5 to 2×10^6.

This subject can safely be called a controversial one. And cases are known where, in spite of rather accurate testing both with variation in size of the machines tested and in flowing substances, only minor if any Reynolds-number influence could be detected, although also, surface roughness conditions were observed as closely as engineering (as contrasted with the physicist's work) would permit.

It would be quite interesting to hear whether those who know are in agreement with the author or care to present their experience.

AUTHOR'S CLOSURE

The influence of the Reynolds number on the efficiency of turbomachines has been studied in several places and has also been treated in the literature.[19] As an example, a pertinent

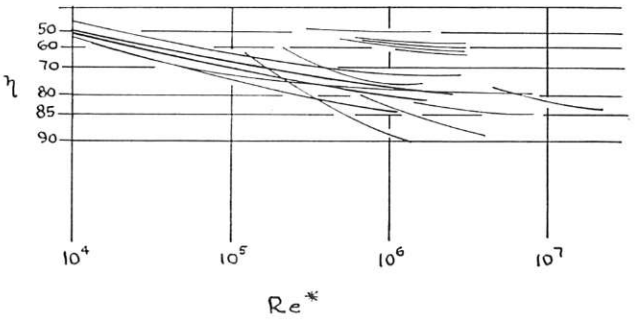

FIG. 55

diagram[20] presenting test results regarding the influence of the Reynolds number on the efficiencies of turbomachines is shown in Fig. 55 which shows the same tendency and in very many cases the same absolute values as shown in Figs. 51 and 52. This seems to prove that the concepts used in the precalculations give sufficient consideration to the main influences, usually experienced in turbomachines. One aspect, however, which cannot yet be covered adequately is the influence of the degree of turbulence on the characteristics of turbomachines.

The influence of the degree of turbulence was first encountered as measurements on the same airfoil gave different results

[18] AiResearch Manufacturing Company, a Division of the Garrett Corporation, Los Angeles, Calif.

[19] "The Influence of Reynolds Number on the Performance of Turbomachinery," by Hunt Davis, Harry Kottas, and A. M. G. Moody, Trans. ASME, vol. 73, 1951, pp. 499–509.

[20] Diagram of Fig. 55 taken from footnote 19.

when tested in wind tunnels of different sizes and design. This difference is explained by the fact that the degree of turbulence of the wind tunnel flow varies with design and tunnel size. By determining a turbulence factor[21] (defined as the ratio of the critical Reynolds number of a sphere in a nonturbulent air stream to the critical Reynolds number in the tunnel), the different results can be correlated. This turbulence factor and its characteristics has been investigated in wind-tunnels and it seems to be standard practice for wind-tunnel tests to refer the test results to a specified standard turbulence.

In the field of turbomachines, the degree of turbulence very probably has some influence also and occasionally may compensate the influence of the Reynolds number However, the knowledge of the turbulence factor in turbomachines does not seem to have progressed far enough to establish definite relationships for its influence in radial turbomachines.

In view of these considerations, it seems justified to assume that the precalculated values are fairly correct, as long as they are referred to the same degree of turbulence (for example, to the turbulence of the free atmosphere). If, therefore, cases are known where only a minor, if any, Reynolds number influence could be detected, it would be quite interesting to know the details of machines size and test setup in those cases, in order to learn more about the turbulence factor in radial turbomachines.

[21] "Turbulence Factors of N.A.C.A. Wind Tunnels as Determined by Sphere Tests," by Robert C. Platt, NACA Report No. 558.