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TO ERNST SCHMIDT ON HIS 70TH BIRTHDAY

THIS special volume is dedicated to a scientist who started his work in the pioneer days of heat transfer research and who not only essentially influenced the early formulations of this science, but who also contributed continuously to its development to the present time.

Ernst Heinrich Schmidt was born on 11 February, 1892 in the village of Vögelsen near Lüneburg in the northwestern part of Germany, an area inhabited by the Westphalian branch of the German people known for their strong sense of independence. E. Schmidt started his college years in 1909 at the Institute of Technology, Dresden, and continued at the Institute of Technology, Munich. During the First World War, which interrupted his studies, he served as a lieutenant in the Signal Corps of the German Army. After the end of hostilities, he continued his studies in Electrical Engineering and received his diploma in 1919. In 1918 he became assistant in the Institute for Applied Physics of the University, Munich, a position which he held from 1918 to 1922, during which time he received his doctor's degree for a thesis on vibrations in machine foundations. During the years 1922 to 1925, he was chief of a research institute for heat economy at Munich financed by industry. This activity instigated him to invent among others his heat flux meter, an instrument which is widely used for the measurement of heat losses in industrial devices. During this period E. Schmidt also obtained his habilitation at the Institute of Technology in Munich with a thesis on thermal radiation of solid materials.

In 1925 he was called to the Institute of Technology at Danzig to become Professor and Director of the Engine Laboratory as successor to Rudolf Plank who had moved to Karlsruhe. He started his activity with a lecture on the performance of finned surfaces, published in the *Journal of the German Engineering Society* (*VDI*), and today still considered as one of the basic contributions to this subject. The time from 1925 to 1937, in which he worked not only himself on many research projects but also guided a considerable number of students in their thesis work, belongs to the most fruitful periods in his life. The Engine Laboratory soon achieved international recognition through his studies.

In 1936, the Institute of Technology at Dresden offered him a Professorship in succession to the famous thermodynamicist Richard Mollier; however, the Head of the National Socialist Party of Saxony did not approve, and he moved in 1937 to Braunschweig, joining a newly founded Aeronautical Research Establishment (LFA) to head one of its institutes, with the task of organizing and developing basic research in aircraft propulsion. E. Schmidt gathered around him a group of outstanding scientists, many of whom were his previous students, and soon had a research effort under way which encompassed all fields of propulsion. He himself obviously felt that an understanding of combustion processes was the weak link in the development of aircraft engines and therefore devoted much of his own time to a study of combustion. A device to which he gave his special attention was the gas turbine capable of operation at high gas temperatures.

At the end of the Second World War, the Aeronautical Research Establishment was occupied at first by American troops and afterwards by the British. E. Schmidt received an offer to continue his research in the United States. He went instead, not completely on a voluntary basis, to England where he worked for a short period. Returning to Braunschweig, he took up a position as Professor of Thermodynamics at the Institute of Technology. The following years were the years of reconstruction in Germany and E. Schmidt succeeded in establishing a new well-designed and equipped laboratory. Just when it was finished, he was offered a Professorship at the Institute of Technology in Munich as successor to Wilhelm Nusselt. He accepted and occupied the Chair for Thermodynamics and the attached Institute until his retirement in 1960. The fact that he became

Professor Emeritus in this year, however, meant for him characteristically only that the release from his representational and administrative duties should give him again more time for his scientific activity which he now pursues with the same vigor as ever before.

The scientific areas to which E. Schmidt contributed are so numerous that only the most significant ones can be discussed. Following up his investigation of radiative properties published in his habilitation thesis, he measured with instruments of his own design hemispherical and directional emissivities for a number of solid surfaces and liquids of engineering importance as well as the emissivities of water vapor up to 1000°C. As a true engineer, he always found novel applications for the knowledge gained through his research. Thus he obtained a patent for the use of aluminium foil for thermal insulation. Such an insulation equals in its heat conduction properties the best known insulating materials and surpasses them by its small heat capacity. Today, after expiration of the patent, it is in practically general use and found in each household.

A field in which our present-day knowledge is largely based on E. Schmidt's work is heat transfer by natural convection. After some early publications on home heating equipment, he published his classical paper on natural convection at a vertical plate. His measurements of the local heat flux. of the velocity and temperature field, done partially with newly invented instruments, gave a complete experimental description of this heat transfer process and enabled E. Pohlhausen to solve the relevant boundary layer equations. Schmidt also introduced a new schlieren method to the study of this field and demonstrated how quantitative information on heat transfer and boundary layer thickness can be obtained from such photographs. More recently his interest turned to a study of the strong natural convection currents which arise in a fluid close to its critical state. Based on the knowledge gained in this way, he proposed a new cooling method for the rotor blades of gas turbines. A number of experimental turbines with this cooling method were built during the last war and an industrial turbine of this type has now successfully completed its trial runs in an industrial plant in Germany. In recognition of his contributions to this field, he was, at the suggestion of Ludwig Prandtl, invited to present a summarizing paper on heat transfer at the Fourth International Congress for Applied Mechanics at Cambridge and again at one of the annual lectures held in commemoration of Ludwig Prandtl. An analytical study published in 1929 demonstrated the similarities between heat and mass transfer and pointed out the possibility to utilize information on heat transfer for the calculation of mass transfer processes. This paper, published simultaneously with and independently of a paper on the same subject by W. Nusselt, created the basis for our treatment of mass transfer processes. He also recognized the possibility of dropwise condensation and measured the large heat transfer coefficients connected with it. A series of publications were devoted to the study of natural circulation in steam boilers.

His excellent experimental skill and inventiveness is demonstrated by precision measurements of various thermodynamic properties which he or his students performed. These measurements include the heat conductivity of water, carbon dioxide, and other fluids, the viscosity of water vapor, and the state properties of CO_2 near and at its critical condition. For his measurements, he designed new instruments which enabled him to exceed considerably the accuracy of reported data.

During the period at Braunschweig, he paid special attention to combustion problems, guiding his co-workers in various research projects in this area. Publications on knocking and on early reactions in combustion engines, on photographic studies revealing the details of combustion processes in tubes are the outcome of this activity. This work is also reflected in the part "The Foundations of Chemical Thermodynamics" which he added in 1950 to his book on Engineering Thermodynamics. The book itself, first published in 1936, has found such a widespread recognition that it is today in its 8th edition. It has been translated into a number of foreign languages and is the standard textbook at the German Institutes of Technology. He also prepared treatises on various aspects of thermodynamics and heat transfer for the engineering handbook *Hütte*, for the classic collection of physical properties generally known under the abbreviated name *Landolt–Börnstein* in its new edition which was published after the last war, and in the *VDI Heat Transfer Atlas*. He also

took care of the recent editions of the VDI steam tables. Through a long number of years he served the scientific community as editor of the magazine *Forschung auf dem Gebiete des Ingenieurwesens*, which was founded by Max Jakob, and as chairman of the VDI Committee for Thermodynamic Research.

In recognition of his scientific contributions, E. Schmidt received, among others, the Leibnitz prize, the Grashof gold medal, and the Cross of Merit of the government of the German Federal Republic. He was awarded honorary doctorates by the Institute of Technology at Aachen and by the University of Glasgow, Scotland. He was a member of the pre-war German Academy for Aeronautical Research and is still a member of the Bavarian Academy of Sciences. The recognition, however, which is probably most valuable to him is the fact that a large number of his former students and co-workers who have learned from his extraordinary experimental and analytical skill continue his work in responsible positions all over the Western World, and that all join on his birthday in wishing him many more active and happy years.

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