Introduction

ASTM Committee C16 on Thermal Insulations will be celebrating its golden anniversary in 1988. During the early days of its establishment over forty years ago the membership realized the significance and importance of the need to develop a reliable test method to measure the thermal performance of the materials and systems for which they were responsible. Much attention was paid to this subject, and, as a result of their early efforts, ASTM C 177 describing and utilizing the guarded hot plate method was published in 1945. This quickly became recognized and accepted as the fundamental absolute technique for measuring the thermal conductivity of thermal insulations and materials of low thermal conductivity. Many countries subsequently produced similar types of test method documents based on the technique.

During the following two decades there were significant developments of newer types of thermal insulations including fibrous glass and cellular plastics. In addition, new applications and uses of thermal insulation combined with increased use, particularly in buildings, produced a significant growth in the volume of insulation being manufactured and used. There was corresponding increase in the need for the measurements of properties of these materials and especially the thermal performance.

It became obvious however, that there was now a requirement for a method of measurement of thermal conductivity which was both more rapid and less complex than that utilizing the guarded hot plate, particularly for use during the manufacturing process. During this era several organizations had started working with a heat flux transducer calibrated within a hot and cold plate system with a reference material of known thermal properties. Their experience resulted first in a tentative test method in 1962 and ultimately in 1964 with ASTM C 518 the Heat Flow Meter Method. This again became accepted worldwide as the prime secondary method for measuring thermal conductivity of thermal insulations.

The first documents were, in general, directed towards evaluation of such materials at or near room temperature. Their contents were based totally on the expertise and experience of those few careful and dedicated experimental workers who had the foresight to become members of the T-6 Subcommittee of C16. This was the forerunner of the present C16.30 Subcommittee on Thermal Measurements, the body which organized the present meeting. However, as time progressed, the requirements for measurements at both elevated and cryogenic temperatures became more necessary. Thus, in 1963 the first major revision of C 177 was undertaken to reflect this need with a further

more detailed revision taking place in 1971. In 1970, the C 518 method was also revised to reflect the additional knowledge gained in using the technique since it was first adopted. As a result of these revisions it was believed then that both methods reflected the state of the art and provided the means to obtain reliable results on the materials for which they were suitable.

However, as we are all aware, the world energy crisis of the early seventies provided a significant stimulus to the concept of energy conservations both for building and industrial applications. As a result, more insulation was prescribed, thicknesses of use increased, many more people became involved in measurement both in the laboratory and production areas, more and larger equipment, including commercial models, were being developed and used, and regulatory bodies became involved to mandate and regulate performance requirements. Each of these factors imposed new burdens on the measurement community.

It quickly became apparent that heat transmission characteristics particularly radiation and to a lesser extent convection imposed a need for more stringent test criteria. Heat transfer phenomena were complex through a media where solid conduction was not the prime mode of heat transmission. The old simple definition of thermal insulation having a thermal conductivity was abandoned in favor of the more correct individually measured thermal resistance or thermal conductance concept. In 1976, both C 177 and C 518 documents were revised radically in their philosophy to reflect the true requirements of the thermal insulation community.

During the seventies, the C16.30 Thermal Measurements Subcommittee took the world lead in this area by organizing three symposia. These were directed towards general and specific understanding of heat transmission phenomena in insulations and their measurement. Position Papers were developed by the Subcommittee to address the specific areas of measurement philosophy and the need for reference materials and transfer standards for ensuring good measurements. International participation was sought and encouraged. This stimulated significant cooperative efforts between North America and European workers, and overseas membership of the subcommittee grew. Members of the Subcommittee actively participated in the formation in 1976 of the ISO TC163 Committee on Thermal Insulations and in its subsequent work, particularly on the Subcommittee SCI Test Method Group. As a result of these cooperative efforts truly satisfactory comprehensive guarded hot plate and heat flow meter test method documents have been developed and are in the promulgation stage.

During the past decade or so there has been considerable additional worldwide efforts expended in the area of measurement of thermal performance of insulations by these two recognized methods. Efforts have been directed toward better analysis of the methods in order to devise improved means of attainment of one-dimensional heat flow or to obtain more precise corrections. In addition, great improvements have been made in apparatus design

and operation while newer concepts have been also developed. There was a need to bring these experiences together especially as C16.30 in the process of undertaking further revisions of the documents to reflect the newer information.

The Symposium was organized, therefore, to provide a forum for an exchange of these ideas and experiences by the group of international workers and to document the current state of the art specifically involved with these two methods. The ultimate goal being to enable better measurements to be made on all types of insulations at all temperatures and conditions with comparable reliability whoever is involved and whichever of these two techniques are utilized.

The international group of papers covers a wide variety of subjects from basic analyses, apparatus design and development, and instrumentation details to applications and use. These papers should provide the required stimulus to achieve the desired goal.

The Chairmen wish to thank all of the authors, session chairmen, and many reviewers for their efforts in making the Symposium a success. Due to illness our good friend and colleague Dr. Karl Heinz Bode was unable to present his paper but with the approval of Pergammon Press we have included an important contribution of his which is directly relevant to this subject. Finally, we wish to thank The National Research Council of Canada for its financial support and particularly Ben Stafford of the Division of Building Research for his stalwart local organizational efforts.

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