



PROCEEDINGS OF THE

THIRD
INTERNATIONAL
HEAT TRANSFER
CONFERENCE

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PAPERS 1-40

VOLUME I

THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE



*Professor James W. Westwater
Chairman, Third International Heat
Transfer Conference and Joint Com-
mittee of North American Particip-
ating Societies.*

The Third International Heat Transfer Conference follows in the path of the First, held in London in 1951, and the Second, held in Boulder, Colorado in 1961 with a continuation in London in 1962. Like the earlier ones, the goal of this conference is to provide a forum for experts from all over the world to meet, present papers, and discuss the science and engineering of heat transfer.

A specific host society guarantees financial responsibility for each conference; the Institution of Mechanical Engineers (London) for 1951, the American Society of Mechanical Engineers for 1961, and the American Institute of Chemical Engineers in 1966. These three societies and the Institution of Chemical Engineers (London) have worked together as a unit to sponsor the conferences. This is a remarkable demonstration of informal, international cooperation.

In addition to the four sponsoring societies, a number of other engineering and scientific societies cooperate. These societies generate papers, publicize the conference and furnish members for the important planning committees. The societies for the Third International Heat Transfer Conference are identified in this volume, and the names of the many persons who donated generously of their time are listed with gratitude.

A trend toward broader participation by additional societies and additional nations is apparent. A modified and more formal arrangement between nations may occur by the time of the next International Heat Transfer Conference. Intensive efforts aimed at that result are now under way.



*Professor Sir Owen A. Saunders
Chairman, British and European
Organizing Committee, Third Inter-
national Heat Transfer Conference.*

The first Conference held in London in 1951 was very successful in bringing together many workers in heat transfer on both sides of the Atlantic and in publishing many papers in the relatively new and advancing field of heat transfer. Between 1951 and 1961, when the second Conference was held in Boulder, the number of publications in the subject continued to increase and the 1961 Conference was again very well supported and included many papers on specialist topics. It is clear that there is now a real need for Conferences at shorter intervals than ten years if we are to keep pace with the developments in the subject and its many important applications. It is to be hoped that in future the basis of these conferences will be broadened internationally so as to bring together work from countries in all parts of the world.



*Professor Alan S. Foust, Program
Chairman, Third International Heat
Transfer Conference*

The challenge of assembling a program to report the progress of heat transfer studies and to present an optimum balance for the varied interests of the group is a truly difficult, if not impossible, task.

Something over 400 papers were offered in abstract form to the two committees—the British and European Committee and the Joint Committee of North American Participating Societies. These range from highly abstract theory and philosophy to completely straightforward measurement of results or performance. Some bear only vague relations to the kind of heat transfer designs expected of most of us; some foreshadow the kind of designs we may be doing in the future. Some represent improvements in established practices, and some so little improvement that inclusion did not appear justified. Some of the more erudite efforts appeared to hold interest for only a small fraction of the attendees. The 177 papers selected cover essentially every facet of heat transfer.

We offer thanks to the authors for providing the research and engineering effort which makes this program possible. We also express genuine appreciation to unsuccessful prospective authors whose papers fell by the wayside in the intense competition for places on the program. We give genuine appreciation and thanks to those unsung heroes who handled and provided the reviewing.

With such excellent cooperation from all, it has been a very satisfying task—except that I had to say to too many authors: "Sorry."

J. R. Blizzard, A.I.Ch.E., Cochairman, Local Arrangements Committees, Third International Heat Transfer Conference.



J. R. Gedney, ASME, Cochairman, Local Arrangements Committees, Third International Heat Transfer Conference.

The Local Arrangements Committees welcome you to Chicago—the Mid-west's bustling city on the shore of Lake Michigan. Chicago is famed for many things—Michigan Avenue's "Magnificent Mile"; the Stockyards; Grant Park with its summer concerts under the stars; the Field Museum; Shedd Aquarium; the Museum of Science and Industry; the Loop, containing many outstanding buildings of "Chicago School" architecture; the Mid-west Board of Trade; Marina City; cool, refreshing parks and beaches; Lake Shore Drive; and State Street with its fine shops.

It is fitting, we believe, that Chicago, a city that can be characterized as ever changing, ever improving is the host for this international gathering in Heat Transfer Technology, which is also dynamic in its make-up. We hope that you will be able to enjoy some of the attractions while in Chicago. We, of the Local Arrangements Committees, are here to be of assistance to you in any way we can.