Preface

Ideals are simple and able to be easily understood, but never exist in reality.

In this book a theory based on the second law of thermodynamics and its applications are described. In thermodynamics there is a concept of an ideal gas which satisfies a mathematical formula $PV = RT$. This formula can approximately be applied to the real gas, so far as the gas has not an especially high pressure and low temperature. In connection with the second law of thermodynamics there is also a concept of reversible and irreversible processes. The reversible process is a phenomenon proceeding at an infinitely low velocity, while the irreversible process is that proceeding with a finite velocity. Such a process with an infinitely slow velocity can really never take place, and all processes observed are always irreversible, therefore, the reversible process is an ideal process, while the irreversible process is a real process.

According to the first law of thermodynamics the energy increase $\mathrm{d}U$ of the thermodynamic system is a sum of the heat $\mathrm{d}Q$ added to the system and work $\mathrm{d}W$ done in the system. Practically, however, the mathematical formula of the law is often expressed by the equation , or some similar equations derived from this formula, is applied to many phenomena. Such formulae are, however, theoretically only applicable to phenomena proceeding at an infinitely low velocity, that is, reversible processes or ideal processes. The question arrives whether or not such mathematical formulae which are only applicable to ideal processes can also approximately to real processes.

Since Jost wrote the book on combustion "Explosions-und Verbrennungsvorgänge in Gasen," a lot of book on ignition, combustion, flames, and detonation waves have been published. In these books, the mathematical formulae which are applicable only to ideal processes are applied to all phenomena of ignition, combustion, and explosion, assuming that the mathematical formulae introduced for the reversible processes can approximately be applied to the irreversible phenomena, too.

Nevertheless there are still many phenomena, for example, fluctuating phenomena in ignition and detonation waves, or anomalous high temperature of

free electrons and ions in the flame and behind detonation waves which cannot be explained by the theories introduced and applied in those books.

In an irreversible process at least once for a short time a nonequilibrium and heterogeneous state appears which causes some stochastic phenomena. In this book the author tries to explain that the reversible and irreversible processes are quite different from one another and that the mathematical formulae which are applicable to the reversible process cannot be applied to the irreversible process, not even approximately, in so far the process has a large entropy increase, i.e., a large irreversibility, and further tries to explain many phenomena in the combustion science applying the characteristics of the irreversible phenomena, since ignition, combustion, explosion, detonation, and other phenomena in the combustion are distinctly irreversible processes accompanied by a large entropy increase. By observing the phenomena in combustion as irreversible, we find quite a different world from that described according to classical concepts and theories.

In this book the theory and its applications are explained mainly according to the experimental results obtained by the author and his coworkers, because there are very little experiments carried out under the concept of an irreversible process. Therefore, only a few references are made of books on combustion science, since these books, using the classical concept, are written in a philosophy which is quite different from that used in this book.

The dimensions of the experimental apparatus illustrated in this book are shown as exactly as possible, because the irreversible phenomena proceed accompanied by some stochastic phenomena and the probabilities also depend on the quantity of materials used in the phenomena.

The theory is very simple and can easily be applied to the practical calculation and industrial purposes. The author is, however, only afraid, if he had preached Buddha, or carried owls to Athens.

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