

Preface

Before starting your journey reading this monograph, I want to explain three concepts from etymology perspective (using only etymology dictionary at <http://etymonline.com/>).

The first concept is “inflamm,” from which flammability is derived. It first appeared in the mid-fourteenth century, “make (someone) ardent; set (the spirit, etc.) on fire” with a passion or religious virtue, a figurative sense, from Old French enflamer, from Latin inflammare “to set on fire, kindle,” figuratively “to rouse, excite,” from in- “in” + flammare “to flame,” from flamma “a flame.” Literal sense of “to cause to burn” first recorded in English in the late fourteenth century. Meaning “to heat, make hot, cause inflammation” is from the 1520s. In order to get a flame, you need fuel/air combination, which is difficult to characterize, since air itself is a mixture of oxygen/nitrogen. The tertiary nature of the mixture makes a universal consistent flammability theory difficult to establish.

The second concept to appear is “explode,” “to reject with scorn,” from Latin explodere “drive out or off by clapping, hiss off, hoot off,” originally theatrical, “to drive an actor off the stage by making noise,” hence “drive out, reject, destroy the repute of” (a sense surviving in an exploded theory), from ex- “out” (see ex-) + plaudere “to clap the hands, applaud,” which is of uncertain origin. Athenian audiences were highly demonstrative: clapping and shouting approval, stamping, hissing, and hooting for disapproval. The Romans seem to have done likewise. So the act of “explode” has nothing to do with a fuel, simply related to the capability of air to support noise (acoustic wave) or flame (combustion wave). In this monograph, the latter is used for combustion safety, not explosion safety.

Finally, “Ignite” appeared in the 1660s, from Latin ignitus, past participle of ignire “set on fire,” from ignis “fire.” Igneous is derived from Latin igneus “of fire, fiery,” from ignis “fire,” or Sanskrit agnih “fire, sacrificial fire.” So the latest word has a much remote origin. Perhaps, it is the extreme weather in the 1660s that made the fire initiation process difficult, so an ancient word was revived to describe the difficulties in setting a fire. However, there is no air involved in the ignition process, assuming air is always sufficient.

Based on the original meanings, the explosibility of air and the ignitability of fuel are redefined to describe the flammability of fuel/air mixture. Similar concepts have already been utilized in industry. The explosibility of air is called “In-Service Oxygen Concentration (ISOC),” while the ignitability of fuel is called “Out-of-Service Fuel Concentration (OSFC).” By isolating the concepts of ignitability and explosibility from the concept of flammability, and correlating them with the simple oxygen calorimetry, a new flammability theory is born. It shows mass transfer is more important than heat transfer, though radiative loss is only important in determining the flammability. In order to understand critical behaviors for gases and vapors, we need to understand first principles in heat and mass transfer. This is the starting point of this monograph. Hope you can have a comfortable journey with these concepts.

In addition, I would like to take this opportunity to thank Prof. Steven Spivak for accepting me into the ENFP program at the University of Maryland to study fire. Without his interests in my career goal, it would have been difficult for me to pursue fire studies 16 years ago. My second thanksgiving should be to Prof. Jose Torero, whose teaching on advanced fire suppression technologies in the spring of 2001 lent me the foundation to build this flammability theory. I am also indebted to Prof. Arnaud Trouvé, from whose numerical training I developed an interest in theoretical development. I would also like to thank my colleagues, Drs. Michael Larrañaga and Qingsheng Wang, whose kind help supported my teaching work at OSU. Special thanks should be extended to my former students, Caleb Scheve, Nash McMurtrey, and Kevin Stamper for supporting my writing. They are the targeted audience of this monograph and were willing to help me to get this project through. I am proud of them.

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