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**On the Transition from Smoldering to Flaming** B. MATKOWSKY, A. ALDUSHIN, A. BAYLISS, Northwestern University — Though there have been numerous experimental studies of the transition from smoldering to flaming, it has been virtually untouched theoretically. We focus on determining the mechanism and conditions that trigger the transition. We consider a forward smolder wave in a porous sample, driven by a forced flow of gas containing oxidizer. The kinetics includes the fuel oxidation, pyrolysis, and char oxidation reactions. There have been various speculations about the trigger mechanism, including the gaseous reactions, destruction of the porous matrix, the char oxidation reaction, and others. However, no mechanism has as yet been theoretically demonstrated to be capable of acting as the trigger. We show that, due to its small reaction rate, the char oxidation reaction hardly affects the characteristics of the smolder wave as it propagates. However, under appropriate conditions, it can act as the trigger for the transition due to its ability to self-accelerate. Thus, we provide a theoretical underpinning for char oxidation as the trigger mechanism. We introduce the concept of, and determine, a quantity that we term the flaming distance $L_F$, the distance that the smolder wave travels before the char oxidation reaction spontaneously self-accelerates, resulting in a temperature eruption in the smolder front, to a level high enough to ignite the gaseous flaming reactions. Smolder waves propagating in samples of length $L$ do (do not) exhibit a transition to flaming if $L > L_F (L < L_F)$.

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