

# ZFK-FKPP Transition Boundary to Describe Critical Instability Parameter of 1D Detonation Wave

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## Abstract

“Instability parameter,  $\chi$ ” [1] is an established criterion for classifying the cellular regularities of gaseous detonations. It is known that  $\chi = 1.5$  is a widely applicable threshold, but its physical interpretation is still unknown. As the  $\chi$  is the ratio of the induction length to the reaction length, we assume  $\chi$  is associated with Zel’dovich number. Furthermore, the critical instability parameter is assumed to have a relation to the transition boundary between the Zel’dovich-Frank-Kamenetskii (ZFK, representing high-Zel’dovich number) to the Fisher-Kolmogorov-Petrovsky-Piskunov (FKPP, representing low-Zel’dovich number). A linear eigenvalue analysis revealed that this transition in the type of reaction front occurs when the normalized temperature  $\theta = (T - T_{\min}) / (T_{\max} - T_{\min})$  at the maximum reaction rate,  $\theta_c$ , is below  $\theta_c \leq 2/3$ . To validate the present criterion, fourteen experimental results [2,3] that report regularities of the cell structure, were analyzed based on the present theory,  $\theta_c$ , and the instability parameter,  $\chi$  [1]. The  $\theta_c$  and  $\chi$  were estimated from the ZND structure using SDToolbox [4] with the Konnov model [5]. The mixtures with the irregular cell structures exhibited  $\theta_c \leq 2/3$  and  $\chi > 1.5$  respectively. Therefore, our theoretical consideration provided the physical interpretation of the instability parameter.

## References

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