

The method of self-similar solution for energy gain scaling in ICF targets

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Achieving to high energy gain is the most important purpose in inertial fusion. For this, many different solutions of hydrodynamic equations for considering the physical concepts of this phenomenon are presented. Here, we use self-similar solution of hydrodynamical equations for obtaining associated mass and energy relations. Also, we calculate the fuel energy gain and limiting fuel gain curves for ignition configuration of DT sphere at optimistic condition without imposing any constraint. So, we obtain the scaling relations $G_f^* \propto E_{ig}^{0.32}$ and $E_{ig} \propto \alpha^3 U_{im}^{-10}$. Then, we went closer to the real problem by imposing the condition of spark formation and ignition for a tamped DT sphere and obtained the proper spark parameter values in H_s - T_s ($\rho_s R_s$ -Temperature) plane that the spark parameters in this region satisfy both conditions of formation and ignition. It results in $G_f^* \propto E_{ig}^{0.40}$ and a relax behavior of ignition scaling and $E_{ig} \propto \alpha^3 U_{im}^{-7}$. We also showed that when we consider the pusher/fuel mass ratio in our calculations, we do not allowed to change this ratio arbitrary since it directly affects on admissible region of spark parameter in H_s - T_s plane and for its high ratio we see no ignition. Since in a real problem in inertial fusion we should take into account the additional constraints due to drive asymmetry and hydrodynamical instability, they cause to change our original results of energy gain curves and their corresponding limiting gain curves slope. By applying these conditions, we demonstrated a more realistic picture which in it, we found the same scaling of ignition condition for thin shell targets, but in contrast, in thick shell targets we do not obtain a generalized scaling law and it consequently depends on primary design of target.