Target survival during injection in an inertial fusion energy power plant

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Abstract. In Inertial Fusion Energy (IFE) power plant designs, the fuel is a spherical layer of frozen DT contained in a target that is injected at high velocity into the reactor chamber. Driver beams of laser or heavy-ions converging at the center of the chamber (CC) compress and heat the target to fusion conditions. To obtain the maximum energy yield from the fusion reaction, the frozen DT layer must be at about 18.5 K and the target must maintain a high degree of spherical symmetry and surface smoothness when it reaches the CC. During its transit in the chamber the cryogenic target is heated by radiation from the hot chamber wall. In certain reactor designs the target is also heated by convection as it passes through the rarefied fill-gas used to control chamber wall damage by x-rays and debris from the target explosion. This article addresses the temperature limits at the target surface beyond which target uniformity may be damaged. Detailed results of parametric radiative and convective heating calculations are presented for direct-drive targets during injection into a dry-wall reactor chamber. The baseline approach to target survival utilizes highly reflective targets along with a substantially lower chamber wall temperature and fill-gas pressure than previously assumed. Recently developed high-Z material coatings with high heat reflectivity are discussed and characterized. The article also presents alternate target protection methods that could be developed if targets with inherent survival features cannot be obtained within a reasonable time span.