This work focuses on the numerical dissipation features of high-order flux reconstruction (FR) method combined with different numerical fluxes in turbulence flows. The famous Roe and AUSM+ numerical fluxes together with their corresponding low-dissipation enhanced versions (LMRoe, SLAU2) and higher resolution variants (HR-LMRoe, HR-SLAU2) are incorporated into FR framework, and the dissipation interplay of these combinations is investigated in implicit large eddy simulation. The numerical dissipation stemming from these convective numerical fluxes is quantified by simulating the inviscid Gresho vortex, the transitional Taylor–Green vortex and the homogenous decaying isotropic turbulence. The results suggest that low-dissipation enhanced versions are preferential both in high-order and low-order cases to their original forms, while the use of HR-SLAU2 has marginal improvements and the HR-LMRoe leads to degenerated solution with high-order. In high-order the effects of numerical fluxes are reduced, and their viscosity may not be dissipative enough to provide physically consistent turbulence when under-resolved.