The idea of spatial filtering is central in approximate deconvolution large-eddy simulation (AD-LES) of turbulent flows. The need for low-pass filters naturally arises in the approximate deconvolution approach which is based solely on mathematical approximations by employing repeated filtering operators. Two families of low-pass spatial filters are studied in this paper: the Butterworth filters and the Padé filters. With a selection of various filtering parameters, variants of the AD-LES are systematically applied to the decaying Burgers turbulence problem, which is a standard prototype for more complex turbulent flows. Comparing with the direct numerical simulations, it is shown that all forms of the AD-LES approaches predict significantly better results than the under-resolved simulations at the same grid resolution. However, the results highly depend on the selection of the filtering procedure and the filter design. It is concluded that a complete attenuation for the smallest scales is crucial to prevent energy accumulation at the grid cut-off.