Continuous biodiesel production from a waste pig-roasting lard, methanol and KOH was carried out in a reciprocating plate reactor (RPR) using a factorial design containing three process factors, namely methanol/lard molar ratio, catalyst loading, and normalized height of the reactor. The main goals were to optimize the influential process factors with respect to biodiesel purity using the response surface methodology and to model the kinetics of the transesterification reaction in order to describe the change of triacylglycerols (TAG) and fatty acid methyl esters (FAME) concentrations along the RPR height. The first-order rate law was proved for both the reaction and the mass transfer. The model of the changing reaction mechanism and mass transfer of TAG was also applicable. Both kinetic models agreed with the experimental concentrations of TAG and FAME determined along the RPR height.