We present a numerical model that can simulate a magnetocaloric sample on the grain size level, including magnetostatics, heat transfer, local hysteresis and spatial variation of stoichiometry expressed as a variation in Curie temperature. Grain structure of a sample is realised as a number of regions each having a uniform and defined through a Voronoi-map. We show that demagnetising effects, caused by a finite sample size, and spatial variation in can account for the previously experimentally observed ‘virgin’ effects in the adiabatic temperature change and isothermal entropy change, respectively and first order reversal effect as a function of temperature. We conclude that even a very little variation in local stoichiometry of less than a percent, corresponding to a standard deviation in of for has a significant impact on the overall properties and history dependence of a sample.