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The effect of porosity and pore size on a single particle under varying non-isothermal conditions

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Many emerging technologies, among them biomass gasification, oxyfuel combustion and calcium looping, require extensive computational modelling. For high-fidelity simulations, it is critical to model the interaction between the gas and solid phase accurately. However, current modelling approaches neglect the effects of porosity and pore size distribution, which are important for the thermochemical conversion. This study aims to study their effects on the drag coefficient and Nusselt number of a single particle under non-isothermal conditions in low Reynolds number flows. The study was conducted by comparing a non-porous and a porous particle under varying Reynolds- and Biot numbers. In order to achieve this, two-dimensional PR-DNS (particle-resolved direct numerical simulations) for both inside and outside the particle were implemented in OpenFOAM. A low Reynolds number compressible solver was used, and the energy and momentum equations were modified to model the particle. The result of this study gives an insight into when porosity and pore size will cause the drag coefficient and Nusselt number to differ from a non-porous particle. Based on these results, it is expected that a new correlation can be derived to allow the effect of pore structures to be modelled.