Motivation for the present work arose from the need to model the processes inside a wood gasifier. The process of conversion of \( CO_2 \) to CO occurs through the reaction of \( CO_2 \) with porous hot char. The conditions prevalent inside the reactor involve varying fractions of \( CO_2 \) and \( H_2O \) at mole fractions typically to of 18-20 % for both. The rest of it will be the inert, \( N_2 \). In order to provide fundamental data for modeling the process in the reactor, it is necessary to determine \( C-CO_2 \) conversion rate in an environment where diffusion and reaction are present.

This provides the natural choice of wood char spheres as test objects for the thermochemical conversion studies - geometrically simple and elegant and also amenable for theoretical and computational treatments which are far more straightforward. The size of the sphere was also chosen so as to simulate the conditions inside the reactor so that both diffusion and chemical kinetics can be taken into account.

The sections to follow summarise the contributions of this work.
Experimental study

The experiments conducted in the present work have been useful in understanding diameter and flow effects and, to examine the results of Standish and Tanjung. Several important observations relating to the size changes during the char conversion process have been made. The present experimental results agree well with as those of Standish and Tanjung. The SEM photographs and the surface area measurements have provided support for using a simplified model.

Mathematical modeling

The modeling of porous char gasification, taking into account both diffusion and reaction processes, has resulted in establishing the kinetic parameters for CO$_2$ gasification. Several of the present experimental results, as well those of Standish and Tanjung, have been predicted with good agreement. The model has been used to establish the diameter dependence of conversion time - the time of conversion as a function of diameter has been shown to be, $t_c/p = 0.3d_{1.03}^3$. Except for the flow effects which are only qualitatively explained, most of the other phenomena relating to gasification of char with CO$_2$ have been addressed.

Scope for further studies

In order to establish the reduction reactions in the gasification process, the other reactants which need to be addressed are oxygen and steam. These reactions need to be considered with the same rigor as has been done in the case of CO$_2$ reaction. Providing completeness to the present work calls for correlations for heat transfer at low Re and Gr under opposing conditions of free and forced convections.