THERMOCHEMISTRY OF COAL OXIDATION

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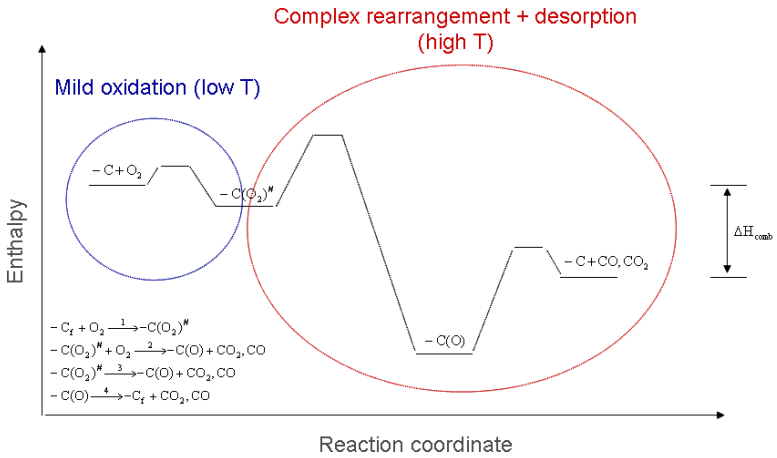
Coals have a pronounced tendency to chemisorb oxygen at moderate temperatures and desorb surface oxides as combustion products (CO, CO2) once the oxidized fuel is heated up under inert conditions. Based on this feature, a novel process of combustion of carbons has been recently proposed and patented by C.N.R. with the name of CarboLoop [1].
An experimental procedure was also set up in the labs of IRC-CNR to assess the thermochemistry of mild oxidation and of desorption of surface oxides on coal The procedure, based on complementary thermoanalytical techniques (TG, DSC, TPD), was applied to a South African bituminous coal [1] with the remarkable finding that oxygen chemisorption was moderately exothermic while desorption of surface oxides during TPD appeared to be strongly exothermic.
The present work reports results of more recent experiments carried out on a suite of coals of different rank and confirm the intriguing result of an exothermal behaviour during surface oxide desorption, at odds with the common perception that abstraction of CO and CO2 from oxidized carbon is inherently endothermic [2-3].
This finding can be explained on the basis of a mechanism that assumes that oxygen is first uptaken in a metastable form at moderate temperature, possibly according to a non-dissociative chemisorption step. Metastable surface oxides may be stabilized at higher temperatures into more energetically favourable carbon-oxygen complexes and this exothermic process might overcome the endothermic behaviour associated with desorption of stable surface oxides into CO and CO2.



1. Salatino P., Senneca O., Plant and process for the looping combustion of solid carbon containing fuels, International patent application number: PCT/EP2009/061636- WO 2010/026259 A2
2. Senneca O., Salatino P., Proc. Combust. Inst. 34 (2) (2013) 2787-2793

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