Project proposal summary

Conventional CO_2 capture processes have large costs and energy penalties associated with gas separation. Chemical-Looping Combustion (CLC), a new combustion principle avoids this difficulty by inherent CO_2 capture, using metal oxides for oxygen transfer from air to fuel. The process has been demonstrated in small scale with gaseous fuels as well as with solid fuels. However, with solid fuels it would be very difficult to reach high fuel conversion, with the oxygen-carrier materials used so far. But a new type of combined oxides based on manganese has the ability not only to react with combustible gases, but also to release gaseous oxygen, which would fundamentally change the concept.

The programme proposes a detailed study of such combined manganese oxides, in combination with studies of fluidized bed reactor design, actual operation in pilot plants and modelling to provide a basis for commercialization and scale up of this new principle of combustion.

The programme would provide i) new oxygen-carrier materials with unique properties that would make this low-cost/high-efficiency option of CO_2 capture possible, ii) cold-flow model investigation of suitable reactor system configurations and components, iii) a demonstration of this new combustion technology at the pilot plant level, iv) a model of the system allowing for scale-up, comprising a full understanding of the process, including kinetics, equilibria, hydrodynamics of fluidized reactors, mass and heat balances.

The significance and basis for this programme is the discovery of a number of oxygen-releasing combined manganese oxides, that appear to have properties that can make a CLC with solid fuels a very attractive and simple process for CO_2 capture with low costs and high efficiency. The purpose of the programme is to perform a comprehensive study of these materials, to demonstrate that they work in a real system, to achieve a full understanding of how they work in interaction with solid fuels in fluidized beds and to show how this process would work in the full scale.

The programme would lead all the way from a few laboratory investigations already available, clearly indicating that such oxygen carriers are possible to use for the process, to small pilot-scale demonstration and extensive understanding of the technology. The programme would also provide the scientific basis and proof of concept necessary for the further up-scaling and commercialization of the technology.

A low cost option for CO_2 capture in combustion of solid fuels can be expected to give a very significant contribution to climate mitigation as it would be applicable to 25% of the CO_2 emissions (coal fired power plants), and in the future provide a means of removing CO_2 from the atmosphere at low cost (by burning biofuel and capture CO_2). A low-cost high-efficiency technology for CO_2 capture from coal, could very significantly facilitate climate negotiations and international agreements