1st Post Combustion Capture Conference

Future-Proofing Coal Plants with Post-Combustion Capture against Technology Developments

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1. Introduction

The IEA Technology Roadmap for CCS forecasts that a significant number of CCS to power generation projects by 2020 will be required worldwide to meet CO_2 emission reduction under its BLUE Map scenario and stabilise atmospheric CO2 emissions around 450ppm CO2eq [1]. This represents a very challenging build rate for a technology that has yet to be been proven at large scale in power generation. Whilst CCS is demonstrated globally first-movers into capture technologies will face a period with fast learning curves. Technology and cost uncertainty is a topic of particular concern for power generation assets usually paid back over extensive periods of time. This has generally been detrimental to the initial implementation of CCS in competitive electricity markets.

Amine capture systems proposed for post-combustion capture have historically been developed in the oil and gas industry. These units are financed and operated under a different business model to that expected for typical fossil fuel power generation with CCS. Higher levels of CO_2 removal are favoured to meet pipeline and natural gas sales specifications over low thermal energy consumption, and the CO2 is subsequently vented. The emphasis in power generation is somewhat different. Low electricity consumption instead is a key factor to guarantee the lowest cost of electricity generation, but also needs to be traded off against ancillary power consumption for capture and compression to the delivery pressure for CO_2 transport. Flue gas scrubbing systems using aqueous solvents in power plant applications can, thus, be expected to improve significantly as the first tranche of projects on pulverized coal plants are implemented.

The first generation of CCS plants is thus at risk of rapidly becoming technology obsolete. The cost to society of these first-of-a-kind projects may be mitigated by considering a spectrum of design and investment decisions to facilitate upgrading these plants when better capture technology becomes available, and maintain competitive costs of electricity generation. Ideally, CCS plants would therefore be capable of operation with a broad range of solvent

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properties. This work specifically focuses on pulverised coal plants fitted with post-combustion CO2 capture from the outset and on plants built as capture-ready for that technology.

2. Scope of work

First, we examine the motivations for changing the solvent of an existing post-combustion capture unit. A methodology to compare new potential solvents against a benchmark CCS plant with current state-of-the-art solvents is then presented. Any attempt at predicting technology development pathways in detail is bound to be unsuccessful due to the inherent unpredictability of progress in academic and industrially applied research. We instead adopt a strategy based on a sensitivity analysis on the electricity output penalty of capture of key design parameters of conventional solvent systems. Solvent properties - such as enthalpy of reaction, temperature of regeneration, degradation rates, etc – and their interaction with process parameters are evaluated using an integrated flowsheet developed in gPROMs of the steam cycle/ the capture unit and the compression system. This guarantees that each solvent is assessed on a rigorous basis with efficient thermodynamic integration with both the power plant and the compression unit. Potential improvement of hardware equipment, e.g. such as column packings, are also discussed and critical pieces of equipment for future-proof solvent upgradability are identified. Design strategies are proposed to accommodate the implementation of new solvents.

This work will then investigate the economic value of upgrading the solvent of a pulverised coal plant under future carbon price scenarios, and then assess potential strategies to inform investment by exercising the option to change the solvent.

Finally, 2050 greenhouse gas atmospheric concentration targets may require close to zero (and possibly negative) emission levels in power generation to compensate for other sectors of the economies where cuts are more difficult to achieve [2]. Although CCS plants will often have been built to achieve a 90% reduction in emission levels initially, it is important that the capture system is not locked into fixed capture levels. In fact, very high levels of CO_2 removal can be feasibly attained in the future when the regulatory and economic drivers are in place.

The potential to implement second and third generation technologies of capture on the first generation of CCS plants will be discussed based on the findings of the economic analysis.

3. References

[1] International Energy Agency, Energy Technology Perspective 2010, OECD/IEA, 2010

[2] Committee on Climate Change, Building a low-carbon economy - the UK's contribution to tackling climate change, 2008, The Stationery Office, London, UK