Environmental Regulation of Carbon Capture

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Environmental Regulation of Net Zero Technologies

- Technology include CCuS, BECCS & DACCS, blue & green H2 and H2 combustion
- Carbon capture = pre & post, oxyfuel, Allam cycle & others
- Industries include power, refineries, EfW, cement, I&S etc.
- Clusters – CO2 & H2 pipe lines
- Storage – H2 on shore. But not CO2 off shore
- Most are new or emerging so no established BAT / standards

Environmental Regulation of Carbon Capture (link)

- Planning Permission – some times national infrastructure
- Environmental Permit (EPR in England & Wales)
- COMAH (major accidents) HSE & environmental regulators
- CO2 Emissions Trading (UKETS)

- EPR Permits addresses:
  - Emissions to air, land & water
  - Energy efficiency and resource efficiency i.e. abstraction of cooling water
  - Protects human health and Habitats

What is a BAT guidance?

- Where no BRef – the regulator sets permit conditions following 14.6 of the IED in discussion with operators
- BAT Guide assists applicants & regulators in the permit process
- Guides summarise the evidence available following Annex III
- In consultation with industry & agreed by UK regulators
- Identify key environmental issues to address & best practice
- Not a regulatory requirement
- Permit conditions will protect the environment i.e. via environmental quality standards (Art.18)

BAT Guide for PCC – 2 documents

- BAT Review for New-Build & Retrofit Post-Combustion Carbon Dioxide Capture Using Amine-Based Technologies for Power and CHP Plants Fueled by Gas and Biomass as an Emerging Technology under the IED for the UK – UKCCSRC website.

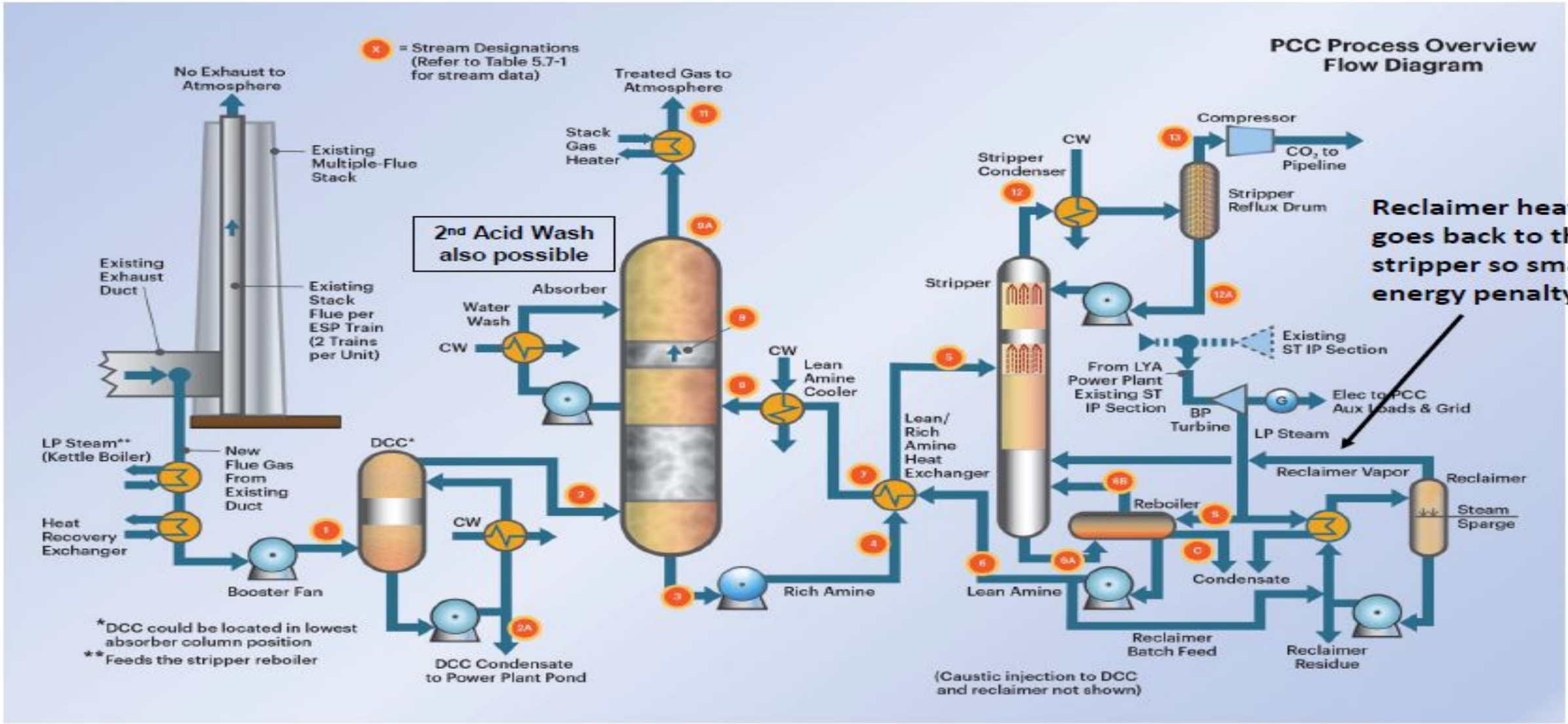
- BAT Guide summary – published on gov.uk

BAT Guide for PCC – planned amendments

- **Autumn 2022**
- Include PCC for Energy from Waste (UKCCSRC review)
- Planned venting of CO2 & bypassing CC unit
- Start review of evidence for PCC on refineries – Autumn 2022
- **2023**
- Review evidence for ‘other combustion’ e.g. medium & engines
- Review evidence for amine capture on Cement processes

- Also due to issue separate guides for Blue (Sept 2023) and Green H2

Post Combustion Capture using amine solvent - process flow



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CC Pilot plant, SSE, Ferrybridge

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CCU plant, Winnington Sodium Carbonate Manufacturing Site

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BAT guidance for PCC

- Design for > 95% CO2 capture
- CO2 quality – fit for purpose i.e. NG specification
- Design for flexible operation – support renewable generation
- Pilot the capture solvent on the flue gas
- Emissions to air, land & water
- Air - degradation products from capture solvents – e.g. nitrosamine EAL = 0.2 ng/m3 + model to demonstrate no harm
- Energy Efficiency very important – maximise heat integration
- Cooling – follow existing sector guidance
- Monitoring – process & stack

PCC capture system emissions to atmosphere – main area of interest for environmental impact

A. Determine the possibilities for environmental impacts from emissions by solvent selection

Solvent selection locks in the potential for different types of emissions and the impacts of those emissions due to the toxicity of the substances, also potential rates of formation and removal of unwanted substances:

a) Potential for absorber stack emissions and environmental impacts

- Direct emissions of solvent components
- Formation of additional substances in the PCC system and emissions of those substances
- Formation of further additional substances in the atmosphere from emissions from the PCC system

b) Potential for solvent reclaiming

- Primary: can unwanted components realistically be removed from the solvent inventory during operation to avoid impurity accumulation and the formation of degradation products?
- Secondary: can a high fraction of good solvent be recovered during reclaiming?
- Reclaiming rate can be adjusted to compensate for rates of formation/accumulation

B. Reduce degradation and impurity addition rates and accelerate degradation production and other impurity removal rates (all additions must be balanced by removals)

Flue gas cleaning can reduce the following, but hard to get to zero

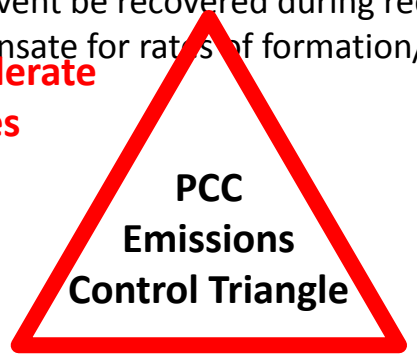
- SOx – affects solvent consumption but limited effect on emissions
- NOx – impact on emissions varies with solvent
- Aerosols – may not be present, but serious if they are
- Materials that accumulate as impurities in the solvent (metals, chlorine, fly ash etc)

Absorber operation

- Peak temperatures in the stripping process
- Minimising the effect of oxygen (reduced residence times - direct O_2 removal not demonstrated at scale)

Remove unwanted impurities

- Must have solvent reclaiming technique available that removes all impurities to avoid accumulation
- Other partial removal techniques may be helpful if they reduce the need for reclaiming by targeting critical components



C. Trap potential emissions at the absorber exit

Absorber exit measures

- Water wash – effective against amines but not NH_3
- Acid wash – effective against NH_3 and amine vapour loss, less so for mist
- Droplet removal – required after washes
- Elevated lean solvent & wash temperatures to avoid mist – only of benefit if aerosols in the flue gas, otherwise disbenefits
- **Further measures possible, at a cost**

D. Dilute and disperse emissions

Flue gas heating to aid plume dispersion

What is next for regulating carbon capture?

- Improved modelling of atmospheric chemistry of Amines
- Certified monitoring methods
- Develop more EALs for amine solvents & degradation products (link)
- BAT for Clusters e.g. multiple sources of amines & heat integration
- Disclosure of amine emissions to air
- CO2 capture & utilisation as an activity in EPR
- CO2 as a COMAH substance
- Other priorities?