Wastewater treatment for amine-based CO_2 capture – Concept development based on tests with real wastewater

Josef Beckmann, Gabriele Böhm, Peter Moser, Georg Wiechers, Reiner Brambach and Tobias Blach

In line with the ambitious European and international climate targets, the German Climate Protection Act stipulates that in Germany climate neutrality must be achieved by 2045. Without the cross-sector use of CO_2 capture from exhaust gases and geological storage, as well as the utilisation of the captured CO_2, it will be almost impossible to achieve the climate protection targets in Germany, Europe and worldwide. Biogenic CO_2, which is removed from the atmosphere by plants and separated from the exhaust gas during the thermal utilisation of biomass, is of great importance for achieving so-called negative emissions. RWE is examining the feasibility of amine-solvent-based capture plants for its plants in Germany, the Netherlands and the United Kingdom that combust biomass or biogenic residues and waste materials. Licensors and manufacturer of capture technology generally consider the treatment of wastewater from capture plants to be the responsibility of the plant operator. RWE and EnviroChemie have jointly investigated wastewater treatment using real samples from RWE's capture pilot plant at Niederaussem. Based on continuous membrane reactor tests, aerobic and anoxic biobatch tests, and tests of nitrification inhibition, oxidation with ozone and UV/H_2O_2, adsorption with activated carbon, and evaporation, concepts for wastewater treatment were developed and evaluated to reduce TOC, COD, sulphates and nitrogen content in the wastewater to the target values.

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1 Introduction

The Working Group III contribution to the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC) concluded that, regardless of the mitigation scenario to limit global warming to 1.5 °C or below 2 °C by 2100, the need for extensive use of both CDR (Carbon Dioxide Removal) and CCS (Carbon Capture and Storage) remains [1]. CDR is necessary to achieve net zero CO_2 emissions by compensating residual “hard-to-abate” and “unavoidable” emissions. CDR is dominated by bioenergy with CCS (BECCS), with relatively few scenarios using direct air capture with carbon storage (DACCS) and even less with technologies like enhanced rock weathering. Biomass-based energy use for BECCS in 2050 was estimated at 61 EJ per year in scenarios limiting warming to 1.5 °C with no or limited overshoot and excluding traditional energy which results in a need of 5.3 Gt captured CO_2 per year.

RWE operates several plants in Germany, the Netherlands and the United Kingdom for thermal utilisation of biomass or biogenic residues and waste materials. Two mono-sewage- sludge combustion plants are under construction in Hürth-Knapsack [2] which are interesting candidates for capturing biogenic CO_2 in Germany, just as the Waste-to-Energy plant in Essen Karnap. In the United Kingdom RWE's Markinch Combined-Heat-

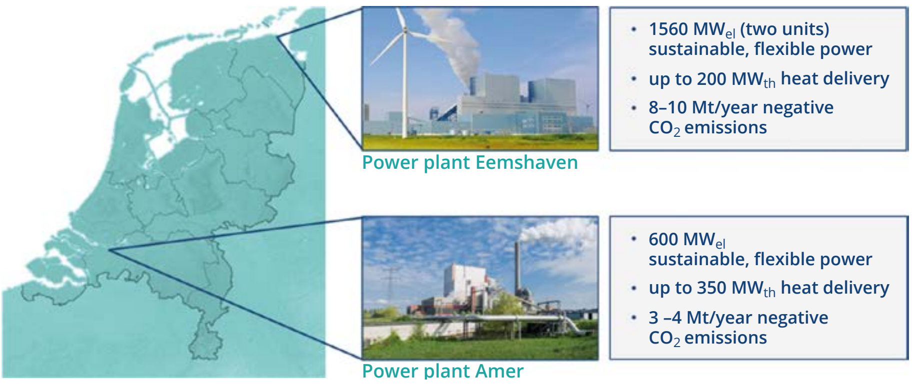

Fig. 1. Biomass-fired power plants with Carbon Capture, Usage and Storage (BECCUS) can deliver large amounts of negative emissions and at the same time reliable and controllable renewable power and heat. RWE's largest BECCUS projects are developed in the Netherlands at the power plant sites Amer and Eemshaven, with the potential of up to 14 Mt per year negative CO_2 emissions.

and-Power (CHP) biomass plant, which is located in Scotland, is the largest recovered wood CHP plant. In January 2025 the former hard-coal-fired Amer power plant in the Netherlands has finalised its transformation to 100 % biomass-fired, and the same process is ongoing for the power plant at Eemshaven. At present, 15 % of the energy is provided at Eemshaven by biomass combustion. RWE's ambition is to convert also Eemshaven into a biomass power plant, if it is economically feasible and the right permits are in place. Depending on the future full-load hours per year up to 14 Mt negative CO_2 emissions could be delivered annually together from both plants, see Figure 1. This would give the BECCUS projects in Amer and Eemshaven the potential to reduce the Netherlands' annual CO_2 emissions by 7–9 %, making a significant contribution to the country's climate goals.

While it is necessary at European level and in the individual states to establish appropriate regulatory and economic boundary conditions for BECCS, RWE is assessing the feasibility of commercial projects. Following a holistic approach, not only prominent key performance indicators, like the specific energy demand of the capture processes, solvent losses and CO_2 purity for transport, usage and storage, are considered as important for the feasibility, but also the balance of plant and especially site-specific environmental aspects, like emission limits. Explicitly the preparation of a reliable and robust wastewater treatment concept is important. While the optimisation of amine-based capture technology over the past two decades has focused in particular on further reducing the specific energy requirement for CO_2 capture and minimising solvent consumption and emissions via the depleted flue gas, little research has been conducted regarding the treatment of wastewater and waste streams generated by the plants. Licensors for the separation process and plant manufacturers generally consider this issue to be the responsibility of the plant operator. The type of wastewater produced and how it has to be treated depends on the individual amine solvent, its degradation behaviour, and the volatility of the amines and degradation products, as well as the technology used for emission reduction and cleaning of the solvent (reclaiming). Laboratory studies on wastewater treatment generally focused on specific compounds, non-representative concentrations of contaminants in the tested samples and artificial samples that are not fully representative because of a lack of access to real wastewater from a capture plant. An overview can be found in [3].

Objective of a joint study of RWE and EnviroChemie was to close this knowledge gap and to develop a generally applicable concept for wastewater treatment. The investigation program assumed here a "worst-case scenario", including three drains from the acid wash, the reclaiming system and the CO_2 compression. The wastewater treatment concept should be capable to reduce the high concentrations of chemical oxygen demand (COD, up to 85,900 mg/ℓ) and total nitrogen (TN, up to 17,200 mg/ℓ) to the lower emission limit values of the "Best available techniques reference document" (BREF) – COD <30 mg/ℓ, TN <5 mg/ℓ and sulphates <1,300 mg/ℓ. The wastewater samples, which are contaminated with organic compounds were mixed from different real drains of the capture pilot plant at Niederaussem in a way that mimicked the most unfavourable configuration of a capture process of a CCS plant.

2 Sources of wastewater and CO_2 capture process

The different sources and the amounts of wastewater in an amine-based CO_2 capture plant depend on the specific technology of the supplier. Typically, the first wastewater along the process path occurs in the Direct Contact Cooler (DCC) upstream the capture plant. Here, the flue gas is cooled down to approx. 40 °C by direct contact with a recirculating cooled water flow. To remove residual traces of SO_2, that would otherwise block the amine in the capture plant, the pH value of the scrubbing liquid is kept at 7 by addition of NaOH solution. Since the flue gas enters the DCC water saturated (e.g. because of the pre-treatment in a wet desulphurisation scrubber) condensate is formed which is often quite clean and not contaminated with organic compounds. With relatively low effort this condensate can be cleaned and used as freshwater in the power plant. Therefore, this type of wastewater was not mixed with the more challenging drains of the capture plant for the investigations in this study, see Figure 2.

The first drain that is contaminated with organic compounds results from the cleaning of the CO_2 depleted flue gas downstream the first water wash section at the head of the CO_2 absorber. In the first water wash emissions coming from the absorber are reduced by cooling of the flue gas with water which contains dissolved contaminants. This water wash is drained into the absorber and the amines which have been scrubbed out are not lost but end again in the solvent loop. However, depending on the volatility and the degradation properties of the amines and degradation products in the solvent a single water wash is not sufficient, in case no other emission mitigation technologies are implemented upstream the water wash, like the Dry bed (OASE aerozone™) which hinders compounds in the gaseous phase to enter the water wash [4]. Therefore, often a second emission mitigation section follows downstream the first water wash: a second water wash or an acid wash. In principle the second water wash works like the first water wash, but in contrast to that, a portion of the inventory is drained as a sink for the accumulating contaminants. To improve the emission mitigation performance especially with regard to the volatile amine degradation product ammonia, the pH value of the scrubbing fluid can be reduced by controlled addition of sulfuric acid. In this acid wash the pH value typically is between 4–6. Depending on the technology supplier, different configurations of cooling of the two-stage flue gas post-treatment and addition of water to keep the water balance in the process are applied. For this study samples from capture plant operation with an acid wash and with and without Dry bed have been used.

To mimic the most unfavourable configuration for wastewater treatment in this study

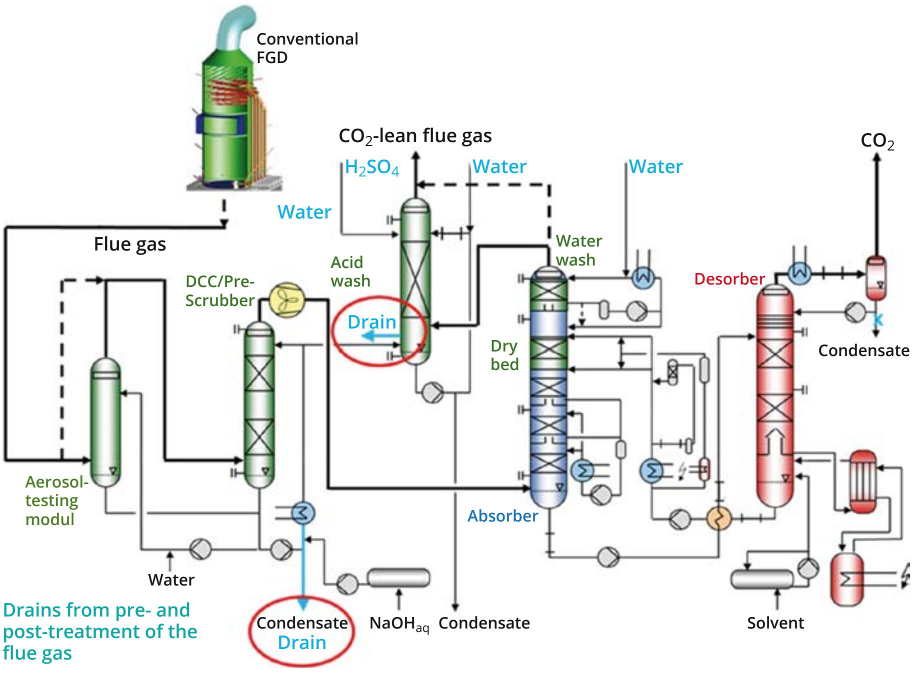

Fig. 2. Sources of wastewater in amine-based post combustion capture from the flue gas pre- and post-treatment are the Direct Contact Cooler (DCC)/Pre-scrubber and the acid wash according to the process scheme of the carbon capture pilot plant at Niederaussem.

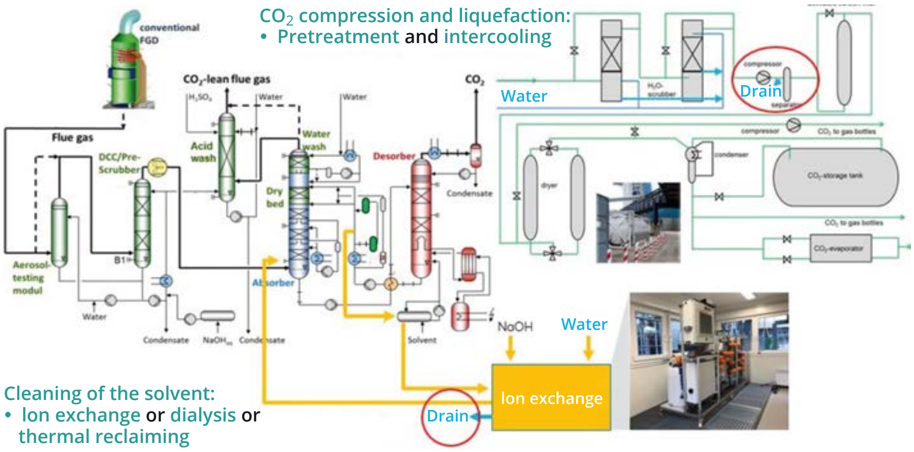

Fig. 3. Sources of wastewater in amine-based post combustion capture from CO_2 compression/liquefaction and solvent cleaning. At the carbon capture pilot plant at Niederaussem longtime tests of ion exchange with anionic and cationic ion exchange resins have been carried out.

two other possible drains have been added to the drain of the acid wash which not necessarily occur as a drain of a capture plant. While some technology providers might use the drain from intercooling in the compression step for pipeline transport or liquefaction of the captured CO_2 to close the water balance of the capture process other suppliers want to avoid this because of a potential transfer of contaminants from the compressor into the solvent loop that might cause operational issues, like foaming (see Figure 3). The condensate that is formed during the intercooling contains traces of amines and volatile degradation products. The other possible source of wastewater which is contaminated with organic compounds is the cleaning system for the solvent that removes contaminants and degradation products from the solvent to retain the capture performance of the plant and to avoid operational issues, like corrosion, precipitation, or foaming. Typical technologies are ion exchange, dialysis and thermal reclaiming. Inorganic trace compounds from the flue gas which are not completely removed by the DCC can be scrubbed out in the CO_2 capture solvent, like residual SO_2, HCl and NO_2. Most important degradation products in the solvent are residues of organic acids which are products of oxidation reactions, like formate, acetate, glycolate, oxalate and propionate which form the so called “heat stable salts”. Also, metal ions are dissolved in the solvent which arise from corrosion processes or fly ash particles in the flue gas. Ionic species can be removed by ion exchange from the solvent, but the regeneration of the resins produces significant amounts of wastewater. The dialysis technologies might be less effective in solvent cleaning, but it can be assumed that they generate less wastewater. Thermal reclaiming is a distillation process that appears wastewater-free at first glance. After batchwise addition of an alkaline agent, as NaOH or KOH, to the aged solvent, it is heated-up to temperatures >140 °C to distil off the free amines and to retain a sludge consisting of highly concentrated degradation products and inorganic salts which is transferred to an appropriate combustion plant for chemical waste. However, it should not be overlooked that the high thermal stress is accelerating degradation and that the produced volatile degradation products will most likely end up in the drain of the emission mitigation system. Nevertheless, it can be expected that the amount of wastewater is the smallest when applying thermal reclaiming.

For a large capture plant like Eemshaven the amount of wastewater with organic compounds could be in the most challenging process configuration around 40 m³/h while up to 320 m³/h of quite clean condensate are produced at the DCC.

For the joint investigation of the options for wastewater treatment RWE and EnviroChemie used real samples from the capture pilot plant at Niederaussem. The post-combustion capture pilot plant at Niederaussem has been operated for more than 120,000 hours 24/7 since the commissioning in 2009 as the first capture pilot plant at a coal-fired power plant in Germany. The plant treats 1,550 kg/h of flue gas of the lignite-fired 1,000 MW unit Niederaussem K to capture 7.2 t CO_2/d at a capture rate of 90 %. The flue gas content of CO_2 is ca. 15 vol.-% and of O_2 5 vol.-%. As capture solvent currently CESAR1 is used, an aqueous solution of 26.7 wt.-% AMP (2-Amino-2-methyl-1-propanol) and 12.9 wt.-% PZ (piperazine) which was developed 15 years ago in the CESAR EU project. This solvent clearly outperforms the old benchmark amine monoethanolamine (MEA) regarding energetic performance, degradation stability, and corrosivity. CESAR1 has a significantly lower specific energy demand for the regeneration of the solvent than aqueous 30 wt.-% monoethanolamine (CESAR1: 3.0 GJ/t CO_2, MEA: 3.5 GJ/t CO_2). In the pilot plant, an electric steam generator is used for solvent regeneration, which takes place at temperatures between 120 and 130 °C (for this study 120 °C), see Figure 2 and 3. CESAR1 is also more stable against oxidative degradation than MEA, lowering the solvent losses due to emissions and ageing. While for CESAR1 specific solvent consumptions around 0.45 kg/t CO_2 have been determined, for MEA losses up to >3 kg/t CO_2 have been described. RWE has tested CESAR1 for more than 55,000 operating hours at Niederaussem, with three times exchange of the solvent inventory (operating periods from April 2019 to February 2023 (34,080 h), April 2023 to January 2024 (15,672 h), and since February 2025). Comprehensive tests on emission mitigation technologies, degradation behaviour and solvent management have been carried out [5]. Since the capture pilot plant at Niederaussem is not permanently equipped with a reclaiming system to remove degradation products and other contaminants from the solvent, the concentration of the accumulated compounds can reach relatively high values >5 wt.-%. On dry basis the captured CO_2 coming from the desorber already has a purity of >99.8 % with the most important contaminants N_2 and O_2. The compressed and liquified CO_2, has food-grade quality and needs no further purification (>99.98 % (v/v) dry, sum of O_2/Ar content: <0.016 % (v/v), SO_2 <1 ppmv and NH3 <2.5 ppmv).

For the investigation of the performance of the different wastewater treatment technologies and the development of a concept for large-scale plants RWE operated the capture pilot plant with a CO_2 capture rate of 95 % with and without the Dry bed configuration and a pH value of 4.5 of the inventory in the acid wash. Each testing period had a duration of ca. two weeks before sampling, to guarantee stable concentration levels at steady state. The drain of the acid wash was collected in cannisters and IBC containers. According to the expected drains in a large-scale plant with ion exchange or thermal reclaiming and drain of the condensate from the intercooling in the CO_2 compression, representative amounts of wastewater from the pilot plant have been added to the drain from the acid wash before the transport of the samples to EnviroChemie.

3 Analytical methods and tests on wastewater treatment

The characterization of the wastewater samples from the capture pilot plant showed that the concentrations of the most relevant discharge parameters ranged for COD from 11–85 g/ℓ, for TN from 3–15 g/ℓ, for ammonium from 2–7 g/ℓ, and for sulphate from 10–43 g/ℓ.

Basis for the development of concepts for the wastewater treatment of a capture plant have been tests of various pre-treatment steps for removing the major organic and ammonium loads by oxidative and biological processes or evaporation, batch and con-

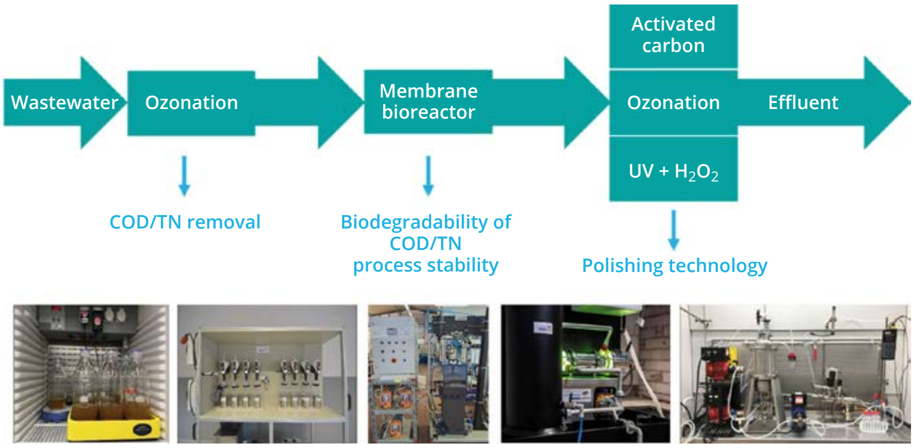

Fig. 4. Performance study of several treatment steps for COD (Chemical Oxygen Demand) and TN (Total Nitrogen) removal from wastewaters of amine-based post combustion capture plants including CO_2 compression/liquefaction and the assessment of their full-scale applicability. The study comprised batch tests and continuous test with real samples from the pilot plant at Niederaussem (photos at the bottom from left: apparatus for analysis of denitrification, batch test for aerobic COD removal, continuous aerobic test in a membrane reactor, apparatus for oxidation with H_2O_2, ozone test setup.

tinuous tests regarding biodegradability, and COD and TN removal and post-treatment with polishing technologies (see Figure 4). In the biological processes, nitrogen removal takes place via the steps of nitrification and denitrification. Therefore, the inhibition on nitrifying microorganisms was tested as well.

The effect of different ozone dosing rates to the wastewater was investigated in a batch process. While decolouring of the samples could be achieved, the COD was only partially removed, and the removal efficiency of organic nitrogen was low. Just some of the organic nitrogen was mineralized and converted into ammonia and nitrate. All in all, the ozone tests indicated, that ozonating the wastewaters is limited in mineralization of COD and removal of organic nitrogen and therefore not sufficient as a single treatment step.

For the assessment of the aerobic biodegradability in batch tests, wastewater samples were inoculated with activated sludge from a municipal wastewater treatment plant and the maximum aerobic COD removal was determined in an overhead mixer in accordance with (DIN EN ISO 9888 / OECD 302B). The analyses showed that significant concentrations of organic nitrogen were left in the samples, after the treatment. However, tests using an inoculum from later tests showed that biodegradation was much faster than in the first set of batch tests and that some adaptation of the microorganisms to the specific wastewater contaminants occurred. Unfortunately, it was observed that nitrification was inhibited. While these tests mainly focused on the maximum degradability, long-term effects on microorganisms and the performance in terms of COD degradation could not be stated. Therefore, additional tests were conducted on nitrification inhibition in accordance with DIN EN ISO 9509 and especially continuous tests using activated sludge in the Membrane Bioreactor which allows to separate the biomass from the treated wastewater by a membrane. Result of these tests was that sole biological treatment was ineffective because of inhibition of nitrification and an insufficient reduction of the COD. Therefore, batch tests on evaporation as first treatment step were performed. After evaporation, the distillate had no visible colour and significantly reduced concentrations of COD and ammonia have been determined. Although most of the pollutants remained in the residue, the distillate needed further treatment to remove COD and nitrogen sufficiently. For this, biological degradability of the remaining contaminants in the distillate and the effect of ozonation, activated carbon and reverse osmosis were tested. Pre-treating the distillate with ozone showed no positive effect on biodegradation. In raw distillate, activated carbon could lower the COD concentration to some degree. However, as the loading rates are not particularly high, the use of activated carbon must be carefully considered. The treatment of the distillate with reverse osmosis showed that the organic fraction of contaminants could be separated quite well. In the test ammonium was not separated with the same efficiency, but this small ion could be cut-off using a permeate-staged reverse osmosis. Alternatively, another type of membrane could improve the separation performance. Concerning COD and organic nitrogen, the discharge limits could be met by applying a combination of evaporation and multiple stage reverse osmosis.

4 Wastewater treatment concept

The results from the comprehensive tests of the broad range of different wastewater treatment technologies allow to derive a concept to achieve drain limits even when the three drains (from acid wash, a reclaiming system and the CO_2 compression) of the capture process must be treated, which represents a worst-case scenario. The proposed concept comprises the three stages Evaporation – Ammonia Stripping - Reverse Osmosis (see Figure 5). Depending on the degradation behaviour of the amine an optional Activated Carbon Treatment stage might be integrated before the reverse osmosis.

Since biological treatment was not promising as first treatment step, the proposed concept starts with evaporation. The volume of wastewater for disposal is reduced to 10 to 15 % of the initial amount. To remove the remaining ammonium from the distillate, which comprises 85 to 90 % of the total treated wastewater stream, a stripper unit follows as second treatment stage. Because of the insufficient performance regarding COD removal or a supporting effect for the biodegradability, ozonation was not included in the concept. Stripping ammonia reduces the need of a multi-stage reverse osmosis and reduces the amount of concentrate that needs to be disposed. The reverse osmosis shows sufficient COD removal but could face a higher membrane fouling rate due to the COD in the distillate. Therefore, an optional activated carbon treatment (third process stage) could remove the COD, leading to less fouling on the reverse osmosis membrane, which is the fourth and final, treatment stage. The concentrate of the reverse osmosis system might be recycled back to the evaporator to reduce the amount of residue.

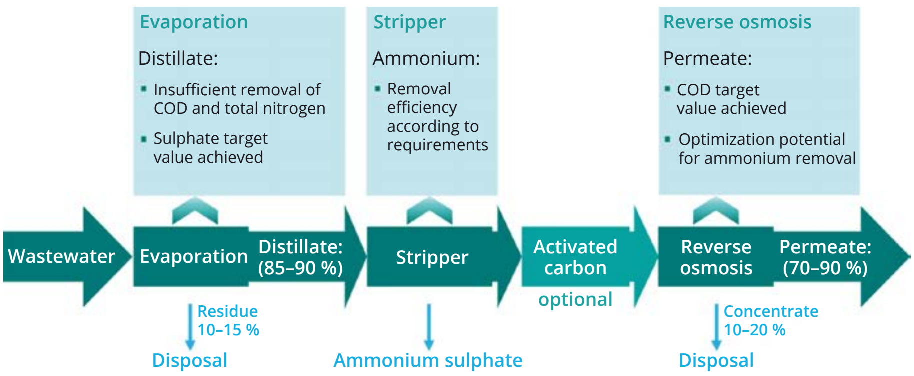

Fig. 5. Proposed wastewater treatment concept for amine-based capture processes to achieve the drain limits, comprising the stages evaporation, ammonia stripping, and reverse osmosis. The optional use of activated carbon depends on the comparative assessment of the cost of more frequent replacement of membranes of the reverse osmosis system with the cost of activated carbon.

However, this optimisation step requires further validation tests in pilot-scale. It is essential to carefully evaluate the balance between membrane lifespan, considering fouling and replacement costs, and the expenses associated with activated carbon consumption, in order to determine whether implementing activated carbon treatment is justified. To assess the full-scale feasibility of the concept for a specific amine solvent, pilot-scale tests are essential. Only pilot studies can provide detailed information about consumables, effluent quality and residue streams.

5 Conclusions

The concept for wastewater treatment for an amine-based carbon capture plant crucially depends on the solvent properties, like amine degradation stability, volatility, and biodegradability, and the specific process configuration regarding emission mitigation, solvent cleaning, and drain management from the compression/liquefaction unit. The performance of several wastewater treatment technologies has been tested with samples from RWE's capture pilot plant at Niederaussem using the solvent CESAR1. A concept has been developed that can even treat the worst-case scenario of wastewater. This includes all three wastewater streams from the carbon capture plant: those from the acid wash, the reclaiming system, and the CO_2 compression. Although this concept facilitates environmentally responsible operation of capture plants, which are essential for meeting climate protection objectives, further opportunities for optimisation remain. Depending on the solvent properties and the capture process the presented concepts might be simplified. The results show that suppliers of carbon capture processes should significantly intensify their efforts to develop more efficient microorganisms and improved biodegradation pathways for their proprietary solvents. The use of concentrated wastewater containing amines and ammonium as a source of NOx reducing species for DeNOx systems instead of injecting extra ammonia or urea depending on the emission mitigation process of the biomass-/waste-fired plant or even the return of these wastewaters to the combustion chamber could significantly reduce the cross-media effects. This should be part of further investigations.

6 Literature

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Kurzfassung

Abwasserbehandlung für CO_2-Aminwäschen – Konzeptentwicklung auf Basis von Tests mit realem Abwasser

Das deutsche Klimaschutzgesetz legt entsprechend der ambitionierteren europäischen und internationalen Klimaziele für Deutschland fest, dass bis 2045 die Klimaneutralität zu erreichen ist. Ohne den sektorenübergreifenden Einsatz der CO_2-Abscheidung aus Abgasen und der geologischen Speicherung sowie der Nutzung des abgetrennten CO_2 werden die Klimaschutzziele in Deutschland, Europa und weltweit kaum erreicht werden können. Hierbei hat biogenes CO_2, das durch Pflanzen aus der Atmosphäre entfernt wurde und nach der thermischen Verwertung der Biomasse aus dem Abgas abgetrennt wird, eine große Bedeutung für die Erzielung sogenannter negativer Emissionen. RWE prüft für seine Standorte in Deutschland, den Niederlanden und Großbritannien mit thermischer Verwertung von Biomasse bzw. biogener Rest- und Abfallstoffe die Machbarkeit von CO_2-Aminwäschenanlagen. Lizenzgeber und Anlagenbauer der Abtrenntechnik sehen die Abwasserbehandlung in der Regel als Aufgabe des Anlagenbetreibers an. RWE und EnviroChemie haben zusammen Untersuchungen zur Abwasseraufbereitung mit realen Proben aus der CO_2-Aminwäsche-Pilotanlage von RWE in Niederaußem durchgeführt. Auf Basis kontinuierlicher Membranreaktorversuche, aerober und anoxischer Biobatch-Tests, Nitrifikationshemmtests, Oxidationsversuchen mit Ozon und UV/H_2O_2, Adsorptionstests mit Aktivkohle sowie Verdampferversuchen wurden Konzepte zur Abwasserbehandlung entwickelt und bewertet, mit denen TOC, CSB, Sulfat- und Stickstoffgehalte im Abwasser auf die Zielwerte gesenkt werden können.

vgbe-Konferenz

KELI 2026 – Konferenz Elektro-, Leit- und Informationstechnik in der Energieversorgung

19. bis 21. Mai 2026 in Mannheim mit Fachausstellung

Alle 2 Jahre richtet der vgbe energy e.V. eine Fachkonferenz mit Ausstellung zur Elektro-, Leit- und Informationstechnik aus. Diese richtet sich an Betreiber, Planer, Dienstleister und Lieferanten aller Arten von Erzeugungsanlagen. Hierzu zählen neben konventionellen, H_2-, Batterie- und Wasserkraftanlagen auch regenerative, dezentrale und industrielle Erzeugungsanlagen. Die Transformation und nachhaltige Nutzung von Standorten, die zuvor für die konventionelle Energieproduktion genutzt wurden, rückt hierbei zunehmend in den Fokus.

Aktuelle Themen werden präsentiert und können mit international tätigen Experten von Betreibern, Planern, Herstellern, Dienstleistern, Versicherern, Behörden und Universitäten diskutiert werden. Begleitet werden die Vorträge durch eine Ausstellung der Hersteller und Dienstleister.

Die KELI 2026 wird ebenso eine Plattform sein, um die durch die aktuelle Energiepolitik ausgelösten technischen Herausforderungen zu diskutieren. Schwerpunkte bilden dabei:

- Die Auswirkungen des sich verändernden Energiesystems auf die Erzeugungsanlagen (Netzanschlussfragen, CCS/BECCUS,H_2-Erzeugung und (Batterie-)Speicherlösungen, Systemstabilität, Einsatzregimes, Marktmodelle).
- Neue Herausforderungen und Chancen durch Digitalisierung, KI in Industrie- und Energieanlagen, Industrie 4.0, unternehmensübergreifende Cloud-Lösungen, OT-Sicherheit KRITIS.

Die KELI 2026 steht daher unter dem Motto:

„Elektro-, Leit- und Informationstechnik für nachhaltige Energieversorgung“

Unser Fokus liegt auf folgenden Themengebieten:

- Flexibler Betrieb der Erzeugungs- und Speicheranlagen
- Technische Entwicklungen und Projekte in der Elektro-, Leit- und Informationstechnik
- Instandhaltung, Monitoring, Sicherheit, Prüfungen und Lebensdauerkonzepte
- Informationssicherheit (OT-Sicherheit KRITIS), Cybersicherheit
- KI-Anwendungen, ChatGPT, Cloud-Lösungen, usw.
- Netzanschluss und Erbringung von Systemdienstleistungen

Um den Ingenieurnachwuchs der Branche zu fördern, werden Studierende bei Anreise und Unterkunft unterstützt.

Wir – die Geschäftsstelle und der Programmausschuss – freuen uns, bei der KELI alte Bekannte und neue Gesichter zu begrüßen.

Essen, im Februar 2026

TAGUNGSPROGRAMM

(Änderungen vorbehalten) Konferenzsprache: Deutsch

DIENSTAG, 19. MAI 2026

14:00 - 15:00	*Technische Besichtigung MVV Flusswärmepumpe* *Teilnehmerzahl begrenzt*
15:30 - 18:00	*Besichtigung ABB Campus* *Teilnehmerzahl begrenzt* *Detaillierte Informationen zu den Besichtigungen entnehmen Sie bitte unserer Veranstaltungswebseite.*
17:00 - 18:30	*Registrierung im Dorint Kongresshotel Mannheim*
19:00	*Get-together* *Geselliges Beisammensein in der Fachausstellung. Für das leibliche Wohl ist gesorgt.*

MITTWOCH, 20. MAI 2026

	Plenarvorträge	Säle 1 & 2
09:00 A1	Begrüßung, Eröffnung der Konferenz *Dr. Oliver Then, vgbe energy e.V., Essen*	
09:15 A2	Gremienaktivitäten Elektrotechnik, Leittechnik, Informationstechnik *Peter Riedijk, RWE Generation NL, Geertruidenberg / Netherlands*	
09:30 A3	Überblick (nationale) Regulatorik Energieerzeugung – Wo stehen wir? (KWSG, EnWG etc.) *Timon Groß, BDEW Bundesverband der Energie- und Wasserwirtschaft e. V., Berlin*	
10:00 A4	OT-Sicherheit – KRITIS Dachgesetz, NIS-2 Richtlinie *Andreas Jambor, RWE Generation SE, Essen*	
10:30 A5	Network Codes (europäische Regelungen, RfG 2.0, nationale Umsetzungen, techn. Anschlussregeln, FNN, ...) *Rainer Fronius, vgbe energy e. V., Essen*	
11:00	*Kaffeepause – Besuch der Fachausstellung*	
11:30	Sektion S1 – **Umgestaltung von Energiestandorten** *Sektionsleitung: Prof. Dr. Jens Paetzold, Hochschule Ruhr West, Mülheim*	Säle 1 & 2

Anmeldung

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11:30 S1.1	Großwärmepumpe GWP – Integration an Kraftwerksstandorten aus Blickwinkel des Generalplaners *Olaf Thun und Sascha Schneider, INP Deutschland GmbH, Mainz*
12:00 S1.2	Demolition Lichterfelde Old – Rückbauprojekt, um Flächen für klimaneutrale Ersatzanlagen zu schaffen *Dr. Sascha Urban, BEW – Berliner Energie & Wärme GmbH, Berlin*
12:30 S1.3	Netzausbau infolge des Transformationsprozesses unter Berücksichtigung neuer Systeme zur Netzstabilität *Michael Lukas, 50 Hertz Transmission GmbH, Berlin*
13:00	*Mittagspause – Besuch der Fachausstellung*
14:00	Sektion S2 – **Technische Entwickungen in der Elektrotechnik – 1** — Saal 1 *Sektionsleitung: Frank Körnert, BEW – Berliner Energie & Wärme GmbH, Berlin*
14:00 S2.1	Drehstrom-Asynchronmotoren – neue Anforderungen – VIK Empfehlung VE 01 *Carsten Sperlich, Henkel AG & Co. KGaA, Düsseldorf*
14:25 S2.2	Vom Boom zur Balance – Typisierbare Energielösungen für Großspeicherprojekte *Lukas Didden, ABB AG, Mannheim*
14:50 S2.3	Schnellumschalteinrichtungen und Synchronisiereinrichtungen in Kraftwerkseigenbedarfsnetzen *Jonas Lipka und Jesko zum Hingste, Siemens Energy Global GmbH & Co. KG, Berlin*
15:15 S2.4	Revidierte EU F-Gase Verordnung und die Auswirkungen auf Schaltanlagen *Christian Hückler und Dr. Mark Kuschel, Siemens Energy Global GmbH & Co.KG, Berlin*
14:00	Sektion S3 – **OT-/Cyber-Sicherheit für KRITIS-Anlagen -1** — Saal 2 *Sektionsleitung: Andreas Jambor, RWE Generation SE, Essen*
14:00 S3.1	Pragmatische Angriffserkennung – schnelle Erfolge und der Weg zur kooperativen Überwachung *Richard Biala und Mustafa El-Assi, ABB AG, Mannheim*
14:25 S3.2	Stabilität von OT-Netzwerkverkehr als Grundlage für effektive Anomalieerkennung in industriellen Steuerungssystemen *Andriy Panchenko, BTU Cottbus-Senftenberg, Cottbus*
14:50 S3.3	NIS2-Implementierung bei Siemens Energy – Ein Praxisbericht *Uschi Lange und Patrick Gerginov, Siemens Energy Global GmbH & Co. KG, Mülheim an der Ruhr*
15:15 S3.4	Die Quadratur des Kreises – Compliance, Innovation und Unternehmensziele unter einen Hut bringen *John-Erik Horn, difesa GmbH & Co. KG, München, und Fabian Burkhart, GETEC Group, Dahn*
15:40	*Kaffeepause – Besuch der Fachausstellung*
16:10	Sektion S4 – **Flexibler Betrieb** — Saal 1 *Sektionsleitung: Simon Wanjek, Grosskraftwerk Mannheim AG, Mannheim*
16:10 S4.1	DA/RE – Erfahrungen aus 2 Jahren operativem Betrieb einer IT-Plattform zur Nutzung kleinteiliger Flexibilität im Redispatch *Jens Hönen, TransnetBW GmbH, Stuttgart*
16:40 S4.2	Mitregeln oder Smart Balancing – Möglichkeiten und Risiken bei der Integration der Bilanzkreisbewirtschaftung in die Maßnahmen zur Frequenzhaltung *Prof. Dr. Hendrik Lens, Universität Stuttgart, Stuttgart*
17:10 S4.3	Energietransformation am BASF-Standort Ludwigshafen am Rhein *Michael Prinz, BASF SE, Ludwigshafen*
16:10	Sektion S5 – **Technische Entwicklungen in der Leittechnik** — Saal 2 *Sektionsleitung: Heiko Kanisch, Lausitz Energie Kraftwerke AG, Cottbus*
16:10 S5.1	Moderne Planung, Gestaltung und Realisierung von Leitwarten: Spannungsfeld zwischen produktiver Arbeitsumgebung und den Anforderungen an einen attraktiven und angenehmen Arbeitsplatz aus Mitarbeitersicht *Markus Ressel, Mauell GmbH, Velbert*
16:40 S5.2	Die Evolution der Prozessleitsysteme im Kraftwerksbereich *Tobias Dezenzo und Michael Meissner, Siemens Energy Global GmbH & Co. KG, Baden-Württemberg*
17:10 S5.3	Prozesssicherheit und Qualitätsüberwachung bei der grünen Wasserstoffproduktion und -speicherung durch Einsatz innovativer Messtechnik *Jens Hundrieser, Endress+Hauser (Deutschland) GmbH+Co. KG, Weil am Rhein*

Fachausstellung

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vgbe-Konferenz

KELI 2026 – Konferenz Elektro-, Leit- und Informationstechnik in der Energieversorgung

19. bis 21. Mai 2026 in Mannheim
mit Fachausstellung

17:40	*Besuch der Ausstellung*
18:30	**Abendveranstaltung**
18:30	*Treffpunkt Haupteingang Dorint Hotel – gemeinsamer Spaziergang zum Bootshaus*
19:00	*Bootshaus Mannheim* *Detaillierte Angaben zur Abendveranstaltung entnehmen Sie bitte den organisatorischen Hinweisen.*

DONNERSTAG, 21. MAI 2026

09:00	Sektion S6 – **Batterie-Großspeicher** — Saal 1 *Sektionsleitung: Frank Genie, ENGIE Deutschland GmbH, Gladbeck*
09:00 S6.1	Großbatteriespeichersysteme – Herausforderungen der Planung, Netz- und Leittechnischen Integration *Sascha Schneider, INP Deutschland GmbH, Römerberg*
09:30 S6.2	Second-Life im Energiemarkt: Betriebsübergang und Flexibler Betrieb gealterter Batteriespeicher vom PRL- zum Intraday-Handel *Cem Ünlübayir, Iqony Solutions GmbH, Essen*
10:00 S6.3	Batteriespeicher und regenerative Energie - Aktuelle Regularien und Möglichkeiten *Daniel Scheu, ENGIE Energy Management Solutions GmbH, Berlin*
09:00	Sektion S7 – **OT-/Cyber-Sicherheit für KRITIS-Anlagen – 2** — Saal 2 *Sektionsleitung: Frank Osterholt, Uniper Technologies GmbH, Gelsenkirchen*
09:00 S7.1	Penetration Testing in OT-Systemen – Schwachstellen erkennen, bevor Hacker es tun *Jake Tran und Eduard Beberbik, ABB AG, Mannheim*
09:30 S7.2	IT/OT Security – Umsetzung Maßnahmenkatalog und Anwendung im Praxisfall. Neue Anforderungen – richtig umsetzen *Timo Clausen, ENGIE Deutschland GmbH, Flensburg*
10:00 S7.3	Sinnvolle Angriffserkennung in Stationsautomatisierung und Umspannwerken *Dr. Frank Stummer, Rhebo GmbH, Leipzig*
10:30	*Kaffeepause – Besuch der Fachausstellung*
11:00	Sektion S8 – **Technische Entwickungen in der Elektrotechnik – 2** — Saal 1 *Sektionsleitung: Thorsten Schumacher, Uniper Kraftwerke GmbH, Düsseldorf*
11:00 S8.1	Generatorableitung und Maschinentransformatoren: Effiziente Netzanbindung für Phasenschieber, BESS und Elektrolyse *Frank Genie, ENGIE Deutschland GmbH, Gladbeck*
11:30 S8.2	Neubauprojekt Pumpspeicherkraftwerken WGSPlus: Ausbau der Speicherkapazität – Erweiterung der Kraftwerkskaskade *Steffen Seydel, Schluchseewerk AG, Laufenburg*
12:00 S8.3	Schwarzstart des GuD-Kraftwerks Dradenau mit Hilfe eines Batteriespeichers *Günther Ebner, Siemens Energy Global GmbH & Co. KG, Erlangen* *Jörn Weidemann, Uniper Technologies GmbH, Gelsenkirchen*
11:00	Sektion S9 – **Steuerungs- und Regelungstechnik** — Saal 2 *Sektionsleitung: Prof. Dr. Hendrik Lens, Universität Stuttgart, Stuttgart*
11:00 S9.1	Optimale Regelung von Inselnetzen mit weitgehend regenerativer Energieerzeugung *Prof. Dr. Kai Michels, Universität Bremen, Bremen*
11:30 S9.2	Control system replacement at RWE Clauscentrale C *Vincent Lammers, RWE Generation NL, Geertruidenberg / Netherlands*
12:00 S9.3	Beitrag zur Systemstabilität bei Überfrequenz durch Vermeiden des ungewollten Abschaltens von Dampfturbinen *Martin Bennauer, Siemens Energy Global GmbH & Co. KG, Mülheim an der Ruhr*
12:30	*Mittagspause – Besuch der Fachausstellung*

Weitere Informationen und Anmeldung zur Ausstellung

SCAN ME

Anmeldung

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14:00	Sektion S10 – **KI-Anwendungen, Digitalisierung, Cloud-Lösungen** *Sektionsleitung: Dr. Sascha Urban, BEW – Berliner Energie & Wärme GmbH, Berlin*	Saal 1
14:00 S10.1	Von der Black Box zur verständlichen KI Lösung - der Einsatz von Künstlicher Intelligenz zur Unterstützung von Kraftwerksfahrern *Marcel Dix, ABB AG Forschungszentrum, Mannheim, Heiko Petersen, ABB AG Energy Systems, Mannheim, und Dr. Jan Jens Koltermann, Lausitz Energie Kraftwerke AG, Cottbus*	
14:30 S10.2	Der Weg zur autonomen Anlage *Dr. Marco Ulrich, ABB AG Forschungszentrum, Mannheim*	
15:00 S10.3	Industrielle KI: Von strengeren Anforderungen zu praxistauglicher Umsetzung *Dr. Franka Schuster und Ulrich Lieske, datablogs GmbH, Senftenberg*	
14:00	Sektion S11 **Digitalisierung und OT-/Cyber-Sicherheit** *Sektionsleitung: Dr. Daniel Lehmann, Iqony Solutions GmbH, Essen*	Saal 2
14:00 S11.1	Field Device Integration für die Energiebranche *Benjamin Baliko, ABB AG, Mannheim*	
14:30 S11.2	Secure-by-Design OT for EU Operators *Matthew Leipnik, GE Vernova, Maidstone / England*	
15:00 S11.3	Notfallübung Cyber: Vom Angriff zum sicheren Betrieb *Argyrios Chatzopoulos, Siemens Energy Global GmbH & Co. KG, Berlin* *Patrick Landwehr, RWE Generation SE, Essen*	
15:30	**Schlussworte**	Säle 1 & 2
15:45	*Ende der Veranstaltung*	

Ihr direkter Link zum aktuellen Programm

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KONFERENZSPRACHE

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