Rapid Characterization of a Solid Pipeline Residue from CO_2 Capture Processes Using a Pyroprobe

Application Note
Carbon Capture

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Abstract
This application note highlights the use of the Pyroprobe 6150 for the analysis of a solid residue collected from CO_2 capture systems, enabling swift corrective actions to resume production.

Introduction

Carbon dioxide (CO_2) capture technology is critical for reducing emissions from industrial processes, yet the formation of residues within these systems can lead to severe process disruptions, including pipe blockages and filter clogs. These issues not only hinder efficiency but can also cause costly plant shutdowns. Understanding the chemical nature of these residues is vital for identifying the root cause of process upsets and optimizing system performance.
Traditional methods for analyzing residues often require time-consuming sample preparation, making them less effective in situations where rapid results are needed. This application note demonstrates the use of the CDS Analytical 6150 Pyroprobe in conjunction with GC-MS for the analysis of process residues. By eliminating extensive sample preparation, this method provides chemical insights quickly, allowing companies to promptly address process issues and minimize downtime.

Experiment Setup

Solid Residue, collected from a flow restricted carbon capture pipeline, 100 µg, was loaded into a DISC tube for analysis at 400°C.

Pyrolysis
Pyroprobe 6150
DISC:
400°C 30 sec

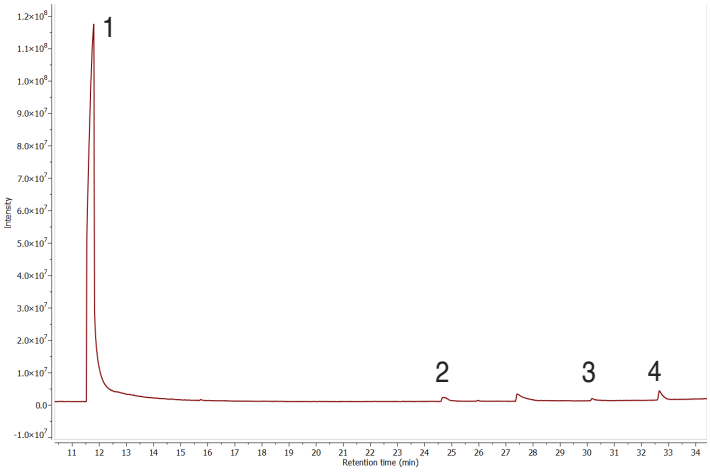
Interface: 280°C
Transfer Line: 280°C
Valve Oven: 300°C

GC-MS
Column:
5% phenyl (30m x 0.25mm x 0.25µm)
Carrier:
He 1.00 mL/min, 50:1 spl
Injector: 320°C
Oven: 35°C for 5 minutes
8°C/min to 280°C (5min)
Ion Source: 230°C
Mass Range: 10-600amu

Results and Discussion

A solid sample was collected from a pipeline that had experienced severe flow restrictions. As shown in the chromatogram (Figure 1), the analysis revealed a dominant peak of piperazine, a common amine used in CO_2 capture solvents. The presence of piperazine suggests a change in process conditions altering the solubility of the CO_2 capture liquid which results in accumulation, which was causing a blockage. This rapid identification allowed the facility to quickly determine the composition of a complex mixture without any advanced sample prep or method development. Previous attempts to analyze this material using GC-MS fell short due to problems with solubility of the solid in GC viable solvents which further highlight the benefits of this method.

The direct analysis of CO_2 capture residues using the Pyroprobe provided rapid and actionable insights. The Py-GC-MS system quickly identified key components such as piperazine and long-chain amines, which were causing process disruptions.



Peak	Identification
1	Piperazine
2	1-Dodecanamine, N,N-dimethyl-
3	1-Tetradecanamine, N,N-dimethyl-
4	N-Methyl-N-benzyltetradecanamine

Figure 1. Carbon Capture Pipeline Residue, 400°C.

This ability to analyze samples directly from process streams without extensive preparation significantly reduced analysis time, allowing chemical companies to make immediate adjustments to their operations.

The results confirmed that direct pyrolysis analysis is an effective method for characterizing complex residues in CO_2 capture systems, helping companies reduce costly downtime and optimize their processes.

Conclusion

The CDS Analytical 6150 Pyroprobe combined with GC-MS offers a robust solution for the rapid characterization of residues in CO_2 capture processes. Pyrolysis systems enable companies to use already existing GC-MS systems and turn them into a virtual universal material analyzer. The direct analysis capability eliminates the need for extensive sample preparation, delivering quick, high-quality data essential for troubleshooting chemical processes and expediting process optimization. This technique empowers chemical companies to respond swiftly to process upsets which minimizes downtime and improves overall operational efficiency.