

**TECHNOLOGY FOR PRODUCING MODIFIED ROAD BITUMEN FROM
NATURAL BITUMINOUS ROCKS OF THE CHIMYON DEPOSIT**

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Understanding the thermal behavior and pyrolysis characteristics of natural bitumen within rock matrices is critical for optimizing its extraction and utilization in industrial applications. This study investigates the thermogravimetric and differential scanning calorimetry (TG-DSC) profiles of bitumen-bearing rock samples to assess decomposition patterns, phase transitions, and hydrocarbon release temperatures. The results reveal distinct thermal zones, including moisture evaporation, bitumen volatilization, and mineral decomposition. Pyrolysis initiated around 300°C, with peak volatile release near 420°C. These findings provide valuable insights into the thermal dynamics of natural bitumen and inform the design of efficient thermal recovery techniques.

Natural bitumen is a complex, viscous hydrocarbon mixture found in association with various rock formations, including oil sands, shales, and asphaltites. Its extraction and processing have garnered increasing interest as global energy demand rises and petroleum resources become more limited [1-3]. Among various extraction techniques, thermal methods such as pyrolysis and in-situ heating have shown promise due to their ability to release bound hydrocarbons from mineral matrices [4-5].

The thermal behavior of natural bitumen within its host rock significantly influences the efficiency and outcome of these methods [6-7]. Therefore, characterizing the thermal decomposition patterns of bitumen-bearing rocks is essential for developing optimized recovery strategies [8]. This paper aims to analyze the pyrolysis characteristics and thermal behavior of natural bitumen through laboratory-based thermogravimetric and calorimetric analysis [9-10].

Sample Collection and Preparation Bitumen-bearing rock samples were collected from a known natural deposit in [insert region name]. The samples were air-dried, crushed, and sieved to obtain a uniform particle size (<1 mm) suitable for thermal analysis. *Thermal Analysis Techniques* Thermal analysis was performed using a simultaneous TG-DSC analyzer. Approximately 10 mg of powdered sample was placed in an alumina crucible and heated from room temperature to 800°C at a rate of 10°C/min under a nitrogen atmosphere to prevent oxidation. Weight loss (TG) and heat flow (DSC) were recorded in real-time. *Pyrolysis Profile Interpretation* the TG curve was used to identify weight loss stages, while the DSC curve provided insights into endothermic and exothermic events. The temperatures corresponding to moisture evaporation, bitumen volatilization, and mineral decomposition were recorded and analyzed.

Thermal Decomposition Zones The TG-DSC analysis identified three distinct thermal zones:

- *Zone I (30°C to 150°C):* Corresponds to the evaporation of physically bound moisture. A small endothermic peak was observed.

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- **Zone II (150°C to 500°C):** Represents the pyrolysis of organic matter and volatilization of bitumen. This zone showed significant mass loss (~40%) and a pronounced endothermic peak at around 420°C.
- **Zone III (Above 500°C):** Associated with the decomposition of mineral matter such as carbonates or sulfates.

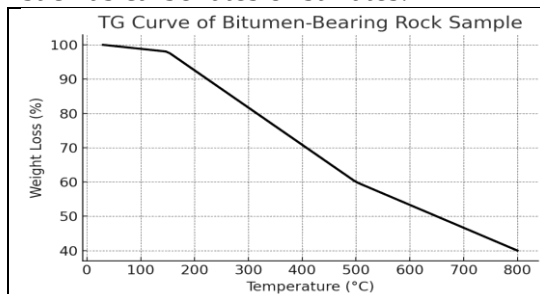


Figure 1. TG curve of bitumen-bearing rock sample

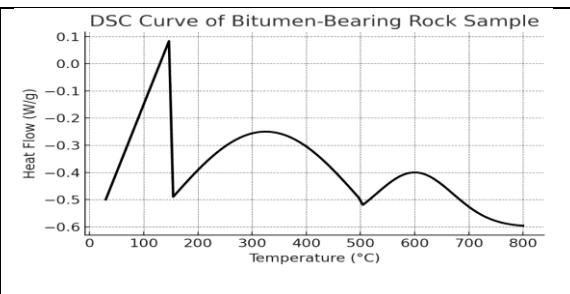


Figure 2. DSC curve of bitumen-bearing rock sample

Pyrolysis Behavior Pyrolysis initiated at approximately 300°C, with the maximum rate of mass loss occurring near 420°C. This indicates that most hydrocarbon release occurs within this temperature range, aligning with literature on heavy oil and kerogen decomposition. The exothermic peak at higher temperatures (>600°C) suggests secondary cracking of residual organic matter.

Implications for Thermal Recovery The thermal analysis results highlight the optimal temperature range for bitumen volatilization and hydrocarbon recovery. Heating systems for in-situ recovery or ex-situ retorting can be designed to target the 300–450°C range for maximum efficiency. Additionally, knowledge of mineral decomposition helps in avoiding structural damage to the rock during heating.

This study provides a detailed thermal profile of natural bitumen contained within rock matrices, using TG-DSC techniques. The findings confirm that bitumen pyrolysis begins around 300°C and peaks near 420°C, offering valuable guidance for thermal extraction methods. Understanding these behaviors allows for the design of more effective and energy-efficient recovery technologies. Further studies involving kinetic modeling and pilot-scale testing are recommended to support industrial-scale implementation.

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