

OIL AND GAS POTENTIAL OF SILURIAN AND ORDOVICIAN SHALE FORMATIONS IN POLAND: HYDROUS PYROLYSIS APPROACH

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Introduction

Silurian and Ordovician organic-rich black shale formations in the Baltic Basin are the main target of shale gas and shale oil exploration in Poland. The richest in organic matter (OM), horizons of suitable thickness were recorded in Wenlock and Llandovery (Silurian) and Caradocian (Ordovician) strata. Their maturity increases from NE to SW, encompassing from the early oil window, up to the overmature stage in the vicinity of the Teisseyre-Tornquist Zone.

The purpose of the present study is estimation of oil and gas potential of selected Polish Lower Palaeozoic gas shale formations using hydrous pyrolysis (HP) technique in relation to their maturity and organic carbon content.

The core and outcrop samples of Wenlock, Llandovery and Caradocian age were examined in this study. TOC ranges from 1.34 to 6.5 wt% and HI from 25 up to 379 mg HC/g TOC, respectively. Reflectance of vitrinite-like macerals varies from 0.60 to 1.39% (Fig. 1A). Series of HP experiments were performed in 1 dm³ Hastelloy-C vessels at temperatures 330°C and 355°C for 72h using samples: L-1O, L-3S, BoS, and PcS and 380°C and 400°C for 72h using samples B-1O, B-1S, W-1O and W-1S (Figs. 1A and C). Also a series of experiments were conducted in temperatures 330, 340, 350 and 355°C for 24 to 144 h using sample B3S (Figs. 1B and D) (in the name of each sample: S means Silurian and O – Ordovician, respectively).

Results and discussion

Quantitative results of the HP experiments are shown in Figs. 1A to D. The maximum immiscible oil yield (217 mg/g TOC) was recorded for sample B3S (355°C/72h). Similar result was obtained for the PcS sample (355°C/72h). These samples contain the less mature OM, however, the first one contained 6.5 wt% TOC and the second – only 1.6 wt%. Another early mature sample (BoS, TOC = 1.34 wt%) has generated much lower quantities of oil. The lowest oil yields at a temperature of 330°C and 355°C reveals the L-3HS sample. Generally experiments conducted at 355°C lead to a higher yield of oil than 330°C. The exception is the high mature L-3HS sample (Fig. 1A). The highly transformed B-1O, B-1S, W-1O and W-1S samples generated a negligible amount of liquid hydrocarbons, maximally 17 mg/g TOC at 380°C and less than 1 mg/g TOC at 400°C (Fig. 1A), which may be due to significant cracking of liquid hydrocarbons. Yields of generated gaseous hydrocarbons range from 6.6 mg/g TOC (L-3HS, 330°C/72h) to 57 mg/g TOC (B-1S, 400°C/72h). The yields of generated hydrocarbon gases for all samples are higher at higher temperatures. The initial degree of OM transformation significantly influences the yields of generated oil and gas.

A set of HP experiments conducted for B3S sample indicate continuous increase of generated oil (from 32 at 320°C/24h to 223 mg/g TOC at 350°C/72h) and gas yield (from 16 at 320°C/24h to 42 mg/g TOC at 350°C/72h) with increasing maturity up to 1.35 % Ro (Figs. 1B and D). Results of these experiments allows one to estimate the gaseous and liquid hydrocarbons quantity generated at given maturity level.

The gas-oil ratio (GOR) values take the minimum values (ca. 200 kg of gaseous HC/ton of oil) at the maturity corresponding to the final stage of oil window, and then rises to above 10^5 kg of gaseous HC/ton of oil at maturity higher than 2% Ro (Figs. 1E and F).

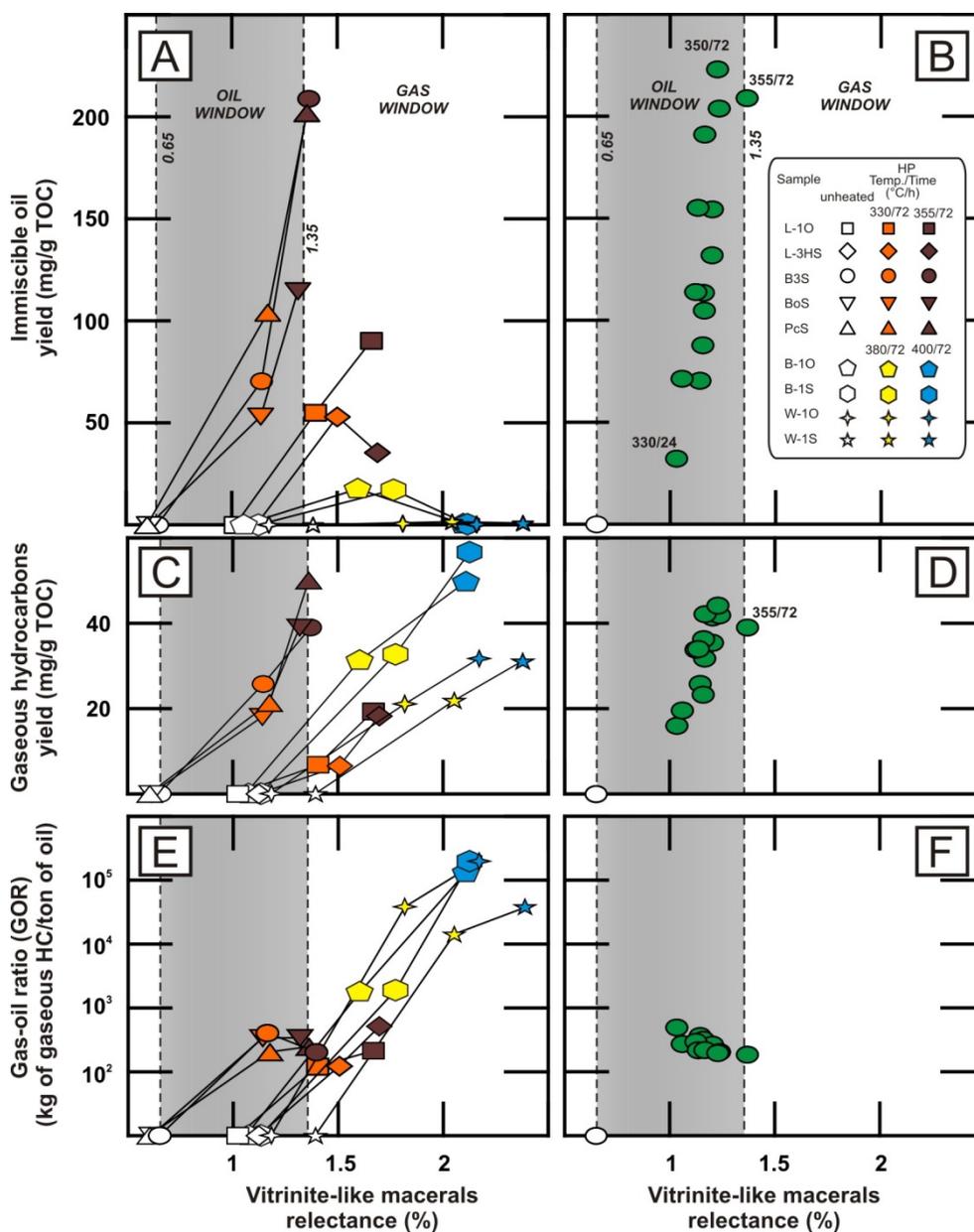


Figure 1 Immiscible oil (A and B) and gaseous hydrocarbons (C and D) yields generated during hydrous pyrolysis experiments, and respective gas-oil ratios (E and F) versus vitrinite-like macerals reflectance for (A, C and E) all samples heated to 330, 355, 380 or 400°C for 72 hrs and (B, D and F) sample B3S heated to 330, 340, 350 and 355°C for 24 to 144 hrs.

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