

**Semenenko D. S., Master in Specialty 185 Oil and Gas Engineering and Technologies**  
**Supervisor: Korovyaka Ye. A., Ph.D. in Technical Sciences, Head of the Department of Oil and Gas Engineering and Drilling**  
(Dnipro University of Technology, Dnipro city, Ukraine)

## INVESTIGATION OF COMPREHENSIVE METHODS FOR COMBATING ASPHALTENE-RESIN-PARAFFIN DEPOSITS IN OIL PRODUCTION OPERATIONS

In the context of developing multilayer hydrocarbon reservoirs in Ukraine, particularly in the Dnieper-Donets Basin, the simultaneous-separate exploitation (SSE) technology enables efficient extraction from multiple horizons through a single wellbore, reducing capital expenditures on drilling and infrastructure. However, this approach is complicated by the intensive formation of asphaltene-resin-paraffin deposits (ARPD), which accumulate in tubing, near-wellbore zones, and surface equipment. These deposits lead to a 50% reduction in flow rates within 3–6 months, increased energy consumption, and frequent failures, with inter-cleaning periods as short as 45–150 days in high-paraffin oils (paraffin content >6% by mass) and flow rates below 50 t/day [1, 2].

ARPD formation is a complex physicochemical process initiated by paraffin precipitation when fluid temperature drops below the paraffin saturation point (typically 25–35 °C). Paraffins, comprising 20–70% of ARPD by mass, are linear hydrocarbons ( $C_nH_{2n+2}$ ,  $n=16-64$ ) with melting points of 45–65 °C, soluble in aliphatic, naphthenic, and aromatic hydrocarbons. Asphaltenes (molecular weight 2000–4000) and resins (600–1000) form 20–40% of the structure, acting as aggregation centers. Asphaltenes, with high density (>1140 kg/m<sup>3</sup>) and reactivity, stabilize emulsions and facilitate paraffin adhesion without melting below 300 °C, transitioning to coke and gas at higher temperatures. Resins oxidize and condense into asphaltenes under thermal or chemical influence [3, 4].

The mechanism involves four stages: radial temperature gradient, concentration gradient of dissolved paraffin, molecular diffusion toward pipe walls, and crystallization. Degassing during pressure drops shifts thermodynamic equilibrium, promoting aggregation. ARPD classification by component ratios (asphaltenes: paraffins:resins) aids in method selection, with high melting points indicating dominance of high-molecular compounds. Density is lower in paraffin-rich oils (810–860 kg/m<sup>3</sup>), while adhesion is assessed via the "cold rod" method, evaluating pour point and viscosity increase [5, 6].

Key influencing factors include paraffin content (>1.5% raising saturation temperature), fluid velocity (optimal >6.5 m/s to shear deposits), water cut (>45% reducing intensity via higher heat capacity and lower adhesion), degassing (below saturation pressure), temperature gradients (intensified in cold seasons), equipment surface roughness (promoting vortices and deposition), and material hydrophilicity (higher polarity like glass minimizes adhesion). Component composition affects solubility: naphthenic and aromatic hydrocarbons reduce risk, while resins promote linear structures for adhesion, and asphaltenes (>5%) inhibit it. Mechanical impurities and microbubbles enhance aggregation via cohesion and adsorption. Reservoir interventions (e.g., fracturing, acidizing) disrupt equilibrium, potentially depositing ARPD in pores and reducing permeability [7, 8].

Comprehensive control methods integrate preventive and reactive strategies. Preventive approaches include protective coatings like ESBT-9 glass-enamel or Majorpack polymer-zinc, increasing inter-cleaning periods 4–10 times (up to >1200 days) by enhancing polarity and smoothness, reducing adhesion by 40–60%. Magnetic treatment (e.g., AMS-73M) alters fluid properties without chemical impact, extending periods 3–8 times (from 21 to 79 days) by disrupting paraffin-asphaltene interactions [9, 10]. Physical methods, such as well heating units

(e.g., "FONTAN" with heating cables), maintain temperatures above saturation, boosting flow rates by 9–14 t/day in trials on Vankor field wells.

Reactive methods involve hot flushing with solvents (e.g., light gasoline, benzene, acetone) catalyzed by surfactants, or inhibitors that modify crystal morphology and prevent aggregation. Combined systems (e.g., ESBT-9 + AMS-73M + inhibitors) optimize for high-paraffin oils in multilayer fields, integrating with SSE to minimize reservoir impact.

Field data from Ukrgazvydobuvannya reservoirs demonstrate that integrated models extend inter-cleaning periods 3–10 times, increase production by 9–15 t/day, and enhance oil recovery by 10–15%. Novelty lies in magnetic-SSE integration, providing non-chemical adhesion reduction.

In conclusion, comprehensive ARPD control through analyzed mechanisms and tailored methods addresses challenges in SSE for multilayer reservoirs, improving operational efficiency and sustainability.

#### References:

1. Voytenko, V.S., Vitryk, V.H., Yaremiychuk, R.S. & Yaremiychuk, Ya.S. (2012). *Tekhnologiya i tekhnika buryinnya. Uzahal'nyuyucha dovidkova knyha*. Lviv: Tsentr Yevropy. 708 s.
2. Boyko, V.S., Kondrat, R.M. & Yaremiychuk, R.S. (1996). *Dovidnyk z naftohazovoyi spravy*. Kyiv; Lviv. 620 s.
3. Lopatenko, V.S. (2023). *Pidvyshchennya efektyvnosti ekspluatatsiyi elektrovodivstrovoho nasosa v uskladnennykh umovakh*.
4. Kravchenko, V., Hankevich, V., Pashchenko, O. & Kuts, O. (2020). *Some effective method of processing copper concentrate*.
5. Hankevich, V.F., Pashchenko, O.A. & Kyba, V.Y. (2015). Impact of vibrations on the drilling tool. *Vibrations in engineering and technology*, (4), S. 132–135.
6. Shapoval, V.H., Pashchenko, O.A., Zhylynska, S.R., Khomenko, V.L. & Ivanova, H.P. (2021). Application of criterion Shashenko to predicting the strength of sandy loam soils during horizontal directional drilling. *Instrumental materials science*, (1), S. 114–120.
7. Pashchenko, O., Khomenko, V., Korovyaka, Ye. & Medvedovska, T. (2024). *Strategies for managing intellectual property rights and the process of commercialization of technology transfer. Creation, protection, protection and commercialization of intellectual property rights*.
8. Suyarko, V.H. (2015). *Prohnozuvannya, poshuk ta rozvidka rodovyshch vuhlevodniv*. Kharkiv: Folio. 413 s.
9. Potetenko, O.V., Shevchenko, N.H., Myronov, K.A. ta in. (2013). *Naftohazova mekhanika*. Kharkiv: NTU «KhPI». 160 s.
10. Korovyaka, Ye.A., Khomenko, V.L. & Pashchenko, O.A. (2024). Features of protection of copyright and related rights in the era of digital technologies. *BBK*, (304.3), S. 98.