

Retos Econova #SosTECnibilidad®

Concept Brief of Open Innovation Challenges

Challenge #1:

¿How could we determine online the diameter of suspended particles in injection water, in order to make faster decisions aimed at mitigating the risk of well plugging?

➔ Vice Presidency of Exploration, Development, and Production



Apoya:



CONNECT

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Organizan:



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Meta y Amazoninoquia

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ECONOVA

Challenge	¿How could we determine online the diameter of suspended particles in injection water, in order to make faster decisions aimed at mitigating the risk of well plugging?	Type	Tactical
		Segment	Corporate / Upstream / Downstream / Midstream / Industry / Low Emissions
		Status	Under construction / Under validation / Approved for call for proposals / Launched
		Date of approval GNN	26/08/2025

BASIC CHALLENGE DATA

Short description of the challenge	Proposals are required for digital technologies with a sufficient level of maturity (TLR≥ 4) to enable the implementation of a prototype capable of analyzing flow rates between 3,000 and 5,000 BWPD (barrels of water per day) in a relevant operating environment in the Orinoquia Region, with the capacity to determine the diameter of suspended particles online, thus enabling rapid operational decisions to be made in order to avoid or reduce the obstruction of pores and pore throats in the reservoir. The solutions must determine, online, the probabilistic distribution of suspended particle diameters in injection water and reduce analysis time. Robust solutions with high industrial scaling potential are expected, which strengthen asset management alternatives under the principles of SOSTECnibility and Circular Economy. Although the proposed solutions should focus on determining the diameter of solid particles, it is desirable that the solution be extended to analyze other non-solid targets, such as oils and/or hydrocarbons in injection water. In addition, it may be extended to allow for the mineralogical characterization of particles, identify the clogging index of detected particles, and provide information related to their origin, measured in terms of their petrographic characteristics. Finally, a technological scalability analysis is expected, along with the corresponding financial analysis for a possible subsequent stage, once the pilot has been completed.
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Subsidiaries and/or Strategic Allies

N/A

Source of funding	Innovation Portfolio - Outsourced operation with ParqueSoft	Total value	A maximum of \$240,533,333 million Colombian pesos (COP) as an incentive to be given to the innovator for the purposes of executing the field pilot.
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DESCRIPTION OF THE PROBLEM

Affected Population	Ecopetrol Group's upstream operating processes, specifically employees who perform water injection processes for enhanced recovery.	Baseline	Baseline 1: Current particle diameter, determined in-lab Baseline 2: Current in-lab analysis time Baseline 3: Current reading frequency.
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In water injection processes as an enhanced oil recovery mechanism, water quality control is important. Water quality must cover a variety of physicochemical parameters such as pH, turbidity, suspended solids, particle size, dissolved gases, fat and oil content, and sulfate-reducing bacteria, among others.

In the Orinoquía fields, bimodal and trimodal particle size distributions are observed, with groups of particles ranging in size from 0.5-50 µm (microns), another group ranging in size from 50-200 µm (microns), and another group ranging in size from 200-400 µm (microns). The prevalence of each group depends on the field and the point of the system analyzed.

Particles that are too large in the injection water, that is, above 5 µm (microns) for the Orinoquía fields, can obstruct the pores and pore throats of the reservoir, reducing permeability and, therefore, the capacity of the well to receive water. This decreases the efficiency of secondary oil recovery, since obstruction of the pores of the receiving formation results in reduced permeability and formation damage, increasing the pressure (and energy) requirements of the injection system and reducing the flow rate received in the injection wells.

These impacts, when accumulated, cause the loss of injectivity to compromise the performance of the injection pattern, requiring intervention in the injection well to restore it. An early diagnosis of the streams with larger particle sizes would allow operations to focus their chemical injection efforts on the wells at greatest risk of sustaining damage.

Background	Currently, a sample is taken at the request of the injection engineer, which is sent to the laboratory where, among other variables, particle size is determined. The result takes approximately one month, which poses a restriction when enabling chemical collection points to counteract the plugging point.
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SCOPE			
General Objective	Contribute to operational efficiency through a technology that enables the diagnosis of particle diameters in a faster manner, allowing for more agile decision-making.	Indicator and Target	Baseline 1. Current particle diameter determined in-lab. Target: 100% reproducibility of data obtained online and in-situ, compared to in-lab analysis results. Baseline 2. Current in-lab analysis time. Target: Online. Baseline 3. Current reading frequency. Target: Higher reading frequency (online and in-situ), ensuring at least one measurement per day.
Specific Objectives	E1. Determine online the probabilistic distribution of particle diameters suspended in injection water.	Indicator and Target	Indicator: Current particle diameter determined in-lab. Target: 100% reproducibility of data obtained online and in-situ, compared to in-lab analysis results.
Specific Objectives	E2. Reduce the analysis time in the determination of particle diameter.	Indicator and Target	aa) Indicator: Current in-lab analysis time: 2 months Target: Online, < 2 months And, b) Indicator: Current reading frequency Target: Higher reading frequency (online and in-situ), ensuring at least one measurement per day
Specific Objectives	E3. Project the technology toward scalability through a differentiated proposal	Indicator and Target	Indicator: Background of implemented and/or scaled solutions Target: Technological scalability analysis
Target Audience	Upstream operational processes of the Ecopetrol Group, specifically the collaborators carrying out water injection processes for enhanced recovery.	Location	At least one of the wells in the department of Meta (Apiay, Castilla, and/or Chichimene), depending on the type of technology to be piloted.
Stakeholders	Stakeholder 1: Companies in the hydrocarbons sector. Scope: National Position: Competitor Expectations: Consolidation of competitive advantage in asset management Contribution: Future client of technology Stakeholder 2: National Hydrocarbons Agency Scope: National Position: Oversight entity Expectations: Effectiveness in well management, achieving fewer plugging events Contribution: Monitoring the performance of the well monitoring process		

PDS - Product Design Specifications	The technology must be TRL 4 or higher. For the selection of the technology, minimal environmental impact must be considered in the event of spills or accidental releases into the environment. The pilot must maximize the energy efficiency required for its operation. Likewise, evaluation criteria will consider that the energy used by the proposed technology be sourced from renewable sources. Pilot designs must contemplate the potential for scalability of the technology, ensuring that Capex/Opex costs are competitive compared to benchmark technologies in the market. The available infrastructure for the pilot must allow for adequate experimentation, ensuring that the testing system has a dedicated water line for validating the technology. It is important that the solution provider generate an action plan under controlled conditions similar to real scenarios, such as testing in isolated systems, in the event operational restrictions exist. Ecopetrol must ensure the availability of updated physicochemical water analyses prior to the execution of the pilot. The efficiency of the proposed technology must be evaluated in comparison with traditional processes, demonstrating potential savings in operating costs. The proposed technologies to address the challenge must be able to guarantee: • Online results of the probabilistic distribution of particle diameters suspended in injection water. • Achieving daily data reading frequency (ensuring results are reproducible in contrast with laboratory analyses). • Counting the detected particles with at least one grouping in relation to the detected sizes. • Capability to operate efficiently under the following conditions: Temperatures: between 25°C and 50°C. Flow rates: between 3,000 and 5,000 bbl/day (barrels of water per day). Pressures: between 30 and 200 psi. Pipe diameters: between 3 and 5 inches. • Digital-type solutions are expected, such as Artificial Intelligence (AI), Internet of Things (IoT), Machine Learning, Big Data, AI-enabled sensors, among others (e.g., Cauty Vision Intelligent Analysis or Computer Vision). • It is desirable for the technology to be extensible to determining, in real time, the concentration and/or droplet size of other non-solid targets, such as heavy oils and/or hydrocarbons. • The technology must control the effect of radiation (if applicable), ensuring no harm is caused to workers or the environment . Optional: • Mineralogical characterization of the particles and identification of the plugging index of the detected particles. • Providing information regarding the provenance of the measured particles through their petrographic characteristics. • Identifying the type of particle analyzed .
Requirements	<u>HSE Requirements for Proponents</u> To apply for the call and participate in the selection process, proponents and their partners must demonstrate that they have an Occupational Health and Safety Management System in place, in accordance with Colombian legislation. This must be evidenced by a certification issued by their Occupational Risk Administrator (ARL) within the last year. This requirement applies only to companies operating in Colombia. ParqueSoft reserves the right to verify the information submitted . <i>Enabling Requirements for the Development of the Pilot Implementation and Experimentation Phase in Ecopetrol S.A.'s Operations</i> In addition to the aforementioned requirements, the following requirements must only be submitted and fulfilled by the proponent selected to carry out the pilot experimentation phase. HSE Requirements for Selected Proponents (Annex 5) For the implementation and experimentation phase of the pilots (<i>Section 8.3 of the Terms and Conditions</i>) in facilities where Ecopetrol S.A. has operational control, the following considerations must be followed:

a). If the pilot operation does NOT involve execution of critical HSE tasks

The proponent must read, follow, and comply with Annex 5: HSE Control 2 Requirements, as described by Ecopetrol S.A

To sign the Start of Contract/Agreement Act for experimentation with ParqueSoft, the proponent must submit:

- An HSE Plan consistent with the activities of the contract or agreement, ensuring:
 - Legal compliance in HSE.
 - Risk identification and controls.
 - Hazard identification matrix.
 - Risk assessment and evaluation.
 - Promotion, prevention, and control of the health of workers engaged under the contract/agreement.
 - Environmental aspect identification matrix and impact assessment.
 - Comprehensive emergency management.
 - Other requirements described in Annex 5: HSE Control 2 Requirements.
- Certificate of completion of pre-employment and aptitude occupational medical exams for the workers in charge.
- Certification of compliance with Phases I and II of Ecopetrol S.A.'s Safe, Clean, and Healthy Work Training course, or the document that modifies or repeals it; as well as competence certifications for specialties requiring them, issued by nationally or internationally accredited institutions, in accordance with Colombian legislation.
- Environmental permits or licenses required to carry out the pilot .
- Evidence of the Company's or Workplace's Risk Level classification in accordance with the contract/agreement to be executed (ARL Certification, pursuant to Article 2 of Decree 1607 of 2002), as described in *Section 6.8 of the Terms and Conditions*

b). If the pilot operation includes the execution of one or more of the following activities, considered critical HSE tasks :

- Work at heights
- Confined spaces
- Excavations
- Mechanical lifting of people and/or loads
- Work in bodies of water
- Entry into or intervention in low, medium, or high-voltage electrical systems
- Intrusive activities interfering with an operational process that could cause loss of containment of a substance

In addition to the above, the proponent must also submit the following certifications :

- RUC with a minimum rating of 80%, issued by the Colombian Safety Council, or ISO 45001 Certification issued by a certifying entity, or Certification under other standards recognized by the oil industry, such as IGS/ISM Code, Norsok S-006, or STOW, issued by a certifying entity.
- Read, follow, and comply with the recommendations described in Annex 6: HSE Control 1 Requirements, established by Ecopetrol S.A

c). If the pilot operation does NOT involve execution within Ecopetrol S.A.'s operational areas :

Legal Compliance: The proponent is solely responsible before Ecopetrol S.A. and before international, national, and local authorities for compliance with HSE requirements and obligations arising from this call, which will also extend to its contractors and suppliers.

Cybersecurity Requirements and Risks

Technological solutions derived from open innovation challenges must include comprehensive measures to ensure safe, efficient operation aligned with Ecopetrol S.A.'s corporate guidelines. This includes ensuring information protection, guaranteeing that the data generated is consistent, traceable, and useful for decision-making, and delivering a robust, clear, and well-defined technical architecture that allows integration with the segmented network infrastructure provided by Ecopetrol S.A.

Within the framework of this call, and solely for application purposes, the proponent must:

Read, comply with, and complete Annex 6: Risks, Considerations, and Cybersecurity Requirements, in order to classify the vulnerability level of the solution in terms of cybersecurity.

If selected, and solely for purposes of pilot execution and experimentation phase:

The proponent must incorporate into the development of its proposals the technical requirements described in Section 2. Proposed Architecture Concept of Annex 8: Digital Architecture Concept. Cybersecurity: Open Innovation Challenge Requirements; and, as applicable, the corresponding technical aspects of Section 4.1 of the same document.

Restrictions	To operate correctly, the solution must take into account the following restrictions: • The solution must not cause recurrent shutdowns or disruptions of the operation (for the purposes of pilot implementation and closure, only two shutdowns will be permitted: one for installation and one for the removal and closure of the technology) • It is not possible to withdraw water samples, as the measurement must be conducted online (unless there is a force majeure operational restriction). • Radioactive sources must not be used in intensities and/or quantities that could affect the health of workers or the environment. • Other restrictions identified during the experimentation process.
Expected Impact	The development of a technological solution tested in a relevant environment (TRL ≥ 4) is expected to determine online the probabilistic distribution of particle diameters suspended in injection water. This prototype should reduce the analysis time for particle diameter determination, contributing to operational efficiency through faster decision-making. It must ensure energy efficiency in the process, protect asset integrity, and project the technology toward scalability through a differentiated proposal. The technological proposal should strengthen Ecopetrol's current capabilities in asset management and agile decision-making.
Value Levers	<i>Operational continuity: Increased revenue through production and secondary recovery efficiency, enabled by agile decision-making.</i>