HUB TECH IA

Deliverable report 24

AI and IAGEN Application Use Case

Machinery fault detection - Diagnostics in Vaca Muerta

I. Introduction

Vaca Muerta, located in the province of Neuquén, Argentina, is one of the formations of the world's largest shale oil and shale gas reserves. Its development has driven Argentina as a global player in the energy sector, attracting important investments.

This development requires the intensive use of specialized drilling machinery, hydraulic fracturing and transportation. These operations require a high level of maintenance and technical diagnosis to ensure efficiency and safety.

The machinery involved includes:

- Drilling rigs: These rigs use advanced technologies to drill wells accurately and efficiently, including downhole motors that allow achieve specific geological objectives.
- Fracturing pumps: Used in the hydraulic fracturing process, these pumps inject fluids at high pressure to fracture the rock and release oil and gas. New fracturing pumps, such as those developed by QM Equipment, use natural gas turbines to reduce costs and emissions.
- Pipelines and Transportation Systems: An extensive network of pipelines transports oil and gas from wells to processing plants and points of distribution. The integrity of these pipelines is crucial to prevent leaks and ensure the

continuity of operations. Since 2010, direct evaluation has been used to detect and prevent problems such as corrosion and coating failures in these pipes.

II. Challenge: Rapid Diagnosis and Problem Detection

The maintenance of this equipment in the oil industry is critical to avoid unplanned downtime and reduce operating costs. The methods traditional fault diagnosis methods, based on manual reports from operators and technical reviews, can be slow and inefficient.

In a complex environment, where machinery operates under demanding conditions, the Early detection of problems is essential for:

- Minimize production losses: Equipment failures can cause unplanned stops that interrupt production and generate losses significant economic.
- Optimize maintenance costs: Early detection of faults allows perform preventative maintenance and avoid costly repairs emergency.
- Increase operational safety: A fast and accurate diagnosis helps prevent incidents that may put the safety of personnel and the environment at risk atmosphere.

III. Using IAGEN for Rapid Fault Diagnosis

Generative Artificial Intelligence (GENAI) is a branch of artificial intelligence that focuses on creating new content, such as models, images, code, or text, from existing data. This technology uses advanced algorithms to analyze large amounts of information, identify patterns and generate new content and original that is often indistinguishable from that created by humans.

IAGEN, by integrating with operational databases and maintenance records, offers capabilities that overcome the limitations of traditional methods:

- Detect failure patterns: IAGEN models, such as ChatGPT, can

analyze large volumes of technical data, including information from sensors, operational records and maintenance history, to identify patterns that indicate possible failures.

- Suggest solutions in real time: Based on data analysis, IAGEN can generate automatic reports on the status of the machinery, including fault diagnoses and recommendations for correction.
- Predict future failures: By analyzing historical data and learning Automatically, IAGEN can predict the probability of future failures, allowing more effective preventive maintenance.
- Improve safety and environmental protection: IAGEN can analyze signals satellites to detect pipeline leaks early, avoiding pollution and environmental impact. This analysis can also be applied to effluent treatment reactors to optimize their disposal and mitigate the environmental impact.

IV. Technologies and Models Used

The implementation of IAGEN in Vaca Muerta requires the integration of various technologies and models:

- Advanced language models: GPT-4 and other specialized parsing versions technicians can interpret sensor data, operating logs and reports maintenance to generate accurate diagnoses.
- Machine learning models: Trained with historical failure data mechanically, these models can identify patterns and predict the probability of future failures. Machine Learning, a branch of artificial intelligence, allows Machines learn without being expressly programmed to do so, a skill essential for making systems capable of predicting actions.
- Integration APIs: APIs allow IAGEN to connect with systems SCADA, ERPs and other platforms used in the oil industry to access real-time data.
- Automation with RPA: Robotic Process Automation (RPA) can

can be used to extract data from different sources and formats, facilitating analysis and reporting.

- Specialized tools: There are tools such as the application developed in VBA that simplifies corrosion analysis in pipelines, automating anomaly matching, calculating corrosion rates and projecting its evolution under international standards. This tool can integrate with IAGEN to improve diagnostic accuracy.
- Data Science: Data science plays a crucial role in the implementation of IAGEN. Combines statistics, mathematics and computer science to analyze data and convert them into valuable information for decision-making.

V. Application of agents driven by IAGEN in the activity

1. Concept of IAGEN agents

In recent years, generative artificial intelligence (GAI) has revolutionized the way we interact with technology, enabling the development of systems capable of generating content, answering complex questions and assisting with tasks high-demand cognitive skills. From this capacity, a new architecture emerges Technological: IAGen-powered agents. These agents are not simple conversational interfaces, but autonomous systems that can interpret instructions, make decisions, execute tasks and learn from their interactions with the around.

An IAGen agent combines large language models with components additional features such as external tools, memory, planning and autonomous execution. This allows them to operate in complex environments, with the ability to break down objectives in steps, coordinate multiple actions, interact with digital systems (such as databases, APIs or documents) and adapt to changes in context in real time. These qualities distinguish them from traditional chatbots, and open up a spectrum of more sophisticated and customizable applications.

At the organizational level, these agents are being used to automate

processes, generate data analysis, assist in decision making and improve the user experience, both internally and externally. For example, they can assume human resources, legal, financial or logistical tasks, and even those linked to the technical areas of production processes, acting as intelligent assistants that collaborate with human teams. This ability to integrate knowledge and execute tasks autonomously transforms the way organizations can scale your operations without losing quality or control.

In addition, agentic workflows—structures where multiple agents collaborate with each other to solve complex problems—allow responsibilities to be distributed between different agent profiles, each with specific functions. This generates Hybrid work environments where humans and agents coexist, optimizing times, costs, and results. The ability to connect agents with tools such as Google Drive, CRMs or document management platforms further expands its capabilities.

The development of IAGen-powered agents represents a crucial step towards a new era of intelligent automation.

Among the benefits of authentic workflows driven by business models generative artificial intelligence, the possibility of automating processes is found complete, end-to-end production systems, and even add value from the leveraging the skills of language models based on these technologies.

However, its implementation also poses technical, ethical and legal challenges, from responsible design to human oversight. Therefore, understanding your architecture, its operational logic and its potential impacts is fundamental to its effective and safe adoption in various professional contexts.

2. Agentic Flow Design Proposal for Implementation

a. Workflow Phases

The implementation of IAGEN for fault diagnosis in oil machinery
You can follow a workflow that includes the following phases:

- Data extraction: Data is extracted from various sources, such as sensors machinery, maintenance history records, SCADA systems and ERPs. The Internet of Things (IoT) plays an important role in this process, as it enables the connection and exchange of data between devices and systems.
  via the Internet. In Vaca Muerta, this could include sensors on equipment drilling, pumps and pipelines that transmit real-time data to the IAGEN platform.
- Processing with IAGEN: Data is processed using IAGEN models to detect patterns, anomalies and potential failures.
- Diagnosis generation: A diagnosis is generated with indications for the preventive or corrective maintenance.
- Automatic notification: An automatic notification is sent to the teams maintenance and operators.
- Corrective action record: Corrective actions taken are recorded. to optimize IAGEN models.

b. Hypothetical Concrete Example

A drilling rig experiences an abnormal variation in pump pressure.
mud. With IAGEN:

- The Extraction Agent detects the anomaly and sends it to the AI model.
- The Analytical Agent analyzes the information and predicts that the problem is a partial obstruction in the valve.
- The Report Agent generates a report with the description of the failure and adjustment recommendations.
- The Integration Agent sends an alert to the technicians with precise instructions.

VI. Direct Benefits in Operations and Strategy

The implementation of IAGEN in Vaca Muerta offers significant benefits in terms of efficiency, costs, safety and sustainability:

- Reduction in diagnosis time: IAGEN can reduce the time of diagnosis from days to minutes, allowing a rapid response to failures and minimizing production interruptions.
- Cost reduction: By avoiding unforeseen stops and urgent repairs, the IAGEN contributes to reducing operating and maintenance costs.
- Increased operational safety: Early detection of faults through IAGEN allows you to take preventive measures and avoid incidents that could put you at risk. risk to the safety of personnel and the environment.
- Decision-making optimization: IAGEN provides accurate information and timely for strategic decision-making, such as project planning maintenance and resource allocation.
- Transition to proactive and predictive maintenance: IAGEN enables a paradigm shift in maintenance, moving from a reactive approach to a proactive and predictive. This involves the ability to anticipate failures and perform the maintenance before they occur, optimizing equipment availability and reducing costs.
- Contribution to sustainability: IAGEN can contribute to more sustainable operations. sustainable by optimizing resource use and reducing emissions. For example, Optimizing the performance of fracturing pumps using IAGEN can reduce fuel consumption and greenhouse gas emissions [5].

VII. Concrete Opportunities and Benefits

Comparison with Traditional Methods

Feature	Traditional methods	IAGEN
Fault detection	Based on reports manuals and visual inspections	Automated analysis of sensor data and historical patterns
Response time	Slow, it can take hours or days	Fast, with timely diagnoses real
Precision of the diagnosis	Subject to errors humans and subjective interpretation	Greater precision thanks to to data analysis goals
Predictive capacity	Limited	Failure prediction future through Machine Learning
Integration with others systems	Generally limited	Integration with SCADA, ERPs and others platforms through APIs
Cost	It may be high due to the need of inspections and repairs of emergency	Cost reduction to long term thanks to maintenance preventive and the optimization of resources

Short-term investment in agent deployment equipment is recommended.
of AI in technology and training.

Investment in proof of concept and pilot testing is required. The focus here is on
be the training of talent to implement, since a trend is verified
cost reduction in systems that enable “no code” and “low code” automation.
For the first stage, it is also recommended to use teams with experience in
design and implementation of AI agents. Finally, it is key to form an “in” team
"house" for the accompaniment and appropriation of an agentic culture that redefines
human-machine interaction.

IX. Conclusion

The implementation of IAGEN in Vaca Muerta for the diagnosis of problems in
Oil machinery offers an opportunity to optimize operations and ensure
competitiveness in the global market. IAGEN not only enables detection
early detection of failures and prediction of potential problems, but also drives a
paradigm shift in maintenance, moving from a reactive approach to a
proactive and predictive.

This transformation benefits all stakeholders: operators can reduce
costs and increase production, maintenance teams can work together
more efficiently and safely, and the environment benefits from the optimization of
resources and emissions reduction.

The key to success lies in a strategic implementation that considers the
staff training, data quality and integration with systems
existing. In addition, it is crucial to address the specific challenges of the Vaca environment

Dead, like bacteria-induced corrosion.

In the future, IAGEN is expected to continue to evolve, with more sophisticated and greater integration with other technologies, such as IoT and robotics. This will allow for even more accurate diagnosis, greater automation of the maintenance and a significant contribution to the sustainability of operations in Dead Cow.

Sources cited

1. Vaca Muerta 4.0: AI and Big Data in the Energy Fields, access date: March 16, 2025, https://mase.lmneuquen.com/vaca-muerta/vaca-muerta-40-ia-y-big-data-los-yacimientos-n801572

2. Petro-4-24.pdf - IAPG, access date: March 16, 2025, https://iapg.org.ar/petrotecnia_notas/424/Petro-4-24.pdf

3. There is still time to finish the year and we are still at IAPG - Petrotecnia, access date: March 16, 2025, https://www.petrotecnia.com.ar/324/Petro_3-24.pdf

4. Seminar: "Vaca Muerta: new technologies in directional drilling and geosteering", date of access: March 16, 2025, https://www.youtube.com/watch?v=llr34h1kFmI

5. Argentina develops cutting-edge technology for Vaca Muerta, access date: March 16, 2025, https://www.argentina.gob.ar/noticias/argentina-desarrolla-tecnologia-de-punta-para-va dead body