Microbial Monitoring

Problem Definition

Microorganism-Induced Corrosion: A Multivariable Challenge

- Common corrosion issue in production fields.
- Attacks all materials (metals and polymeric compounds).
- Once the microbiological growth process starts, it must be controlled quickly to prevent its spread.
- Control should combine techniques:
  - Internal cleaning (PIG),
  - Chemical treatment (biocides),
  - Continuous monitoring (ATP).

ATP Monitoring. How does it work?

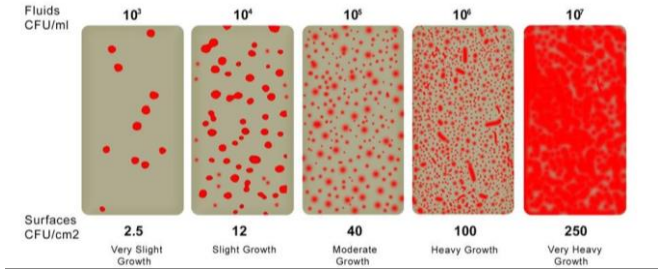
ATP is the molecule associated with cellular energy in all living cells.

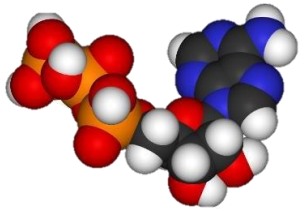
Since ATP is present in all living cells, quantifying it allows you to determine the total microbial population size."

If you have seen a firefly light up at night, you have seen this reaction!

1. ATP is recovered through a chemical extraction
2. The extract is mixed with a complex reagent containing Luciferase to produce light.
3. The light is measured using a luminometer.
4. By using numerical models, the microbial count is determined.

"Comparison chart: Bacteria"





ATP

Luciferase Enzyme (Luminase™)

Light

Microbial Monitoring - ATP

Advantages:

- Results in minutes.
- Compact field equipment that is easy to use.
- Allows quantification of microbial content in multiphase mixtures (crude-water) regardless of proportions.
- Low cost.
- Wide range for microbiological mapping, including dead legs.
- High sensitivity: Detects low levels of microbial contamination.

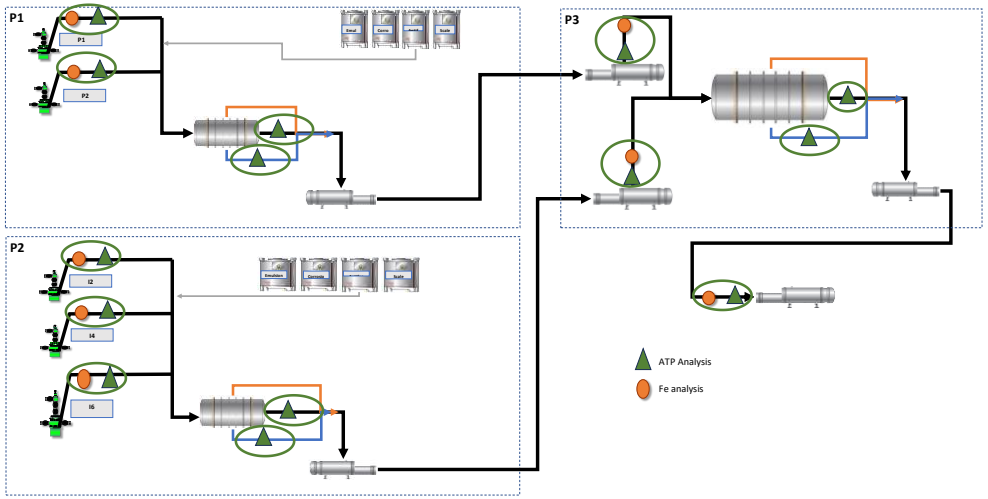
ATP Measurement Devices

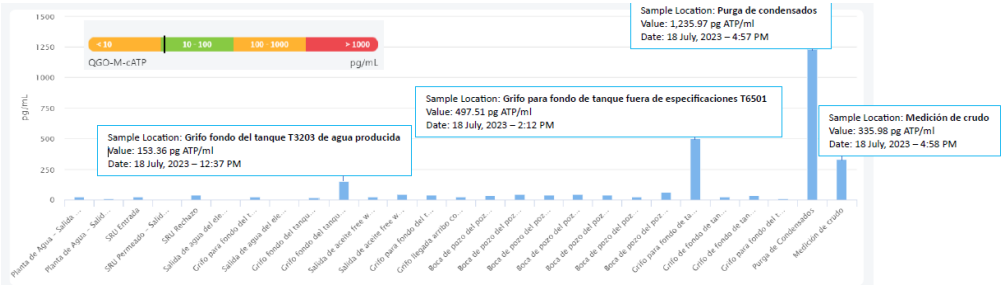
- Second generation matured technology,
- Optimized reagent system and testing procedure.
- Extraction capabilities have been improved.
- Improvement
  - The chemical reagents neutralize inhibitory compounds;
  - Dilution removes remaining interferences before the assay;
  - The steps are separated to provide complete extraction and removal of interferences.

Test Methods

ATP Monitoring Method

1. **Test point definition.**
   - ✓Flowchart
2. **Determine sampling facilities.**
   - ✓Isometric
3. **Perform liquid sampling**
   - ✓Use new containers, take the target sample, mitigate contamination.
4. **Perform ATP Analysis**
   - ✓Validate results with high microbial counts by duplicate testing.
   - ✓Assess risk with MIC and create an action plan.





Puntuación (riesgo)	Color	Acción Recomendada
0		Continuar tratamiento/monitoreo actual
1		Prioridad moderada para mejorar tratamiento/monitoreo
2		Prioridad moderada para mejorar tratamiento/monitoreo
3		Prioridad alta para mejorar tratamiento/monitoreo
4		Prioridad alta para mejorar tratamiento/monitoreo
5		Prioridad alta para mejorar tratamiento/monitoreo

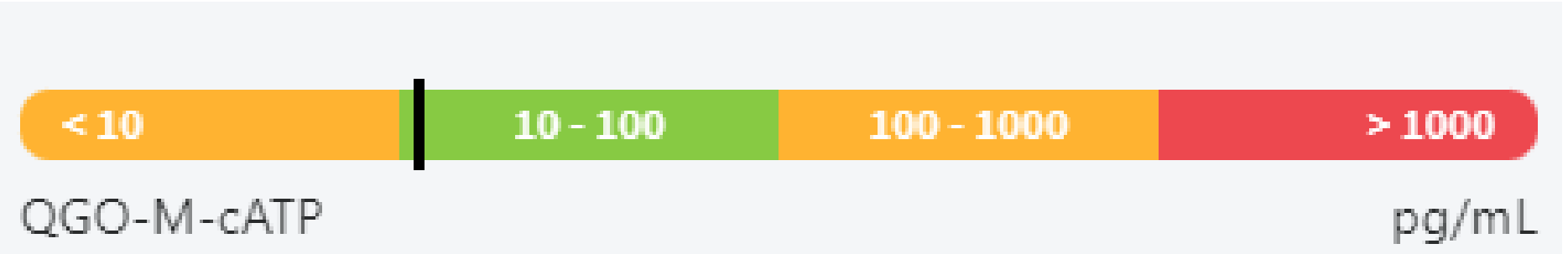
ATP Monitoring Results

- ATP results are recorded as microbial equivalents (ME).
- Basis: Each cell has 1 femtogram (unit of measurement) of ATP (average amount for a typical E. coli cell).

No	QGO-M-cATP	ME/ml
1	60.59	6.06E+04
2	22.89	2.29E+04
3	39.05	3.91E+04
4	47.13	4.71E+04
5	39.05	3.91E+04
6	43.09	4.31E+04
7	36.35	3.64E+04
8	20.67	2.07E+04
9	13.73	1.37E+04
10	20.33	2.03E+04
11	7.61	7.61E+03
12	42.41	4.24E+04
13	20.06	2.01E+04
14	39.11	3.91E+04
15	10.2	1.02E+04
16	21.54	2.15E+04
17	43.09	4.31E+04
18	7.54	7.54E+03
19	2.49	2.49E+03
20	21.54	2.15E+04
21	21.54	2.15E+04
22	33.47	3.35E+04
23	497.51	4.98E+05
24	16.02	1.60E+04
25	153.36	1.53E+05
26	335.98	3.36E+05
27	1235.97	1.24E+06

Microbial Equivalent (ME/mL):

$$cATP\ (ME/mL)\ = cATP\ (pg\ ATP\ /\ mL)\ x\ 1ME/0.001\ pg\ ATP$$



SUMMARY

- ATP monitoring provides a fast and accurate measurement of microbiological content.
- Microbiological levels are determined in minutes, and the risk of Microbially Induced Corrosion (MIC) is assessed
- Immediate results on the effectiveness of MIC control measures are obtained.
- Technological improvement over dilution techniques, plate inoculations, and BAR-S.
- Cutting-edge technology for effective monitoring of Microbially Induced Corrosion in oil fields.

Technical Support: The AccuCount Test Kit complies with the following standards:

- ASTM Standard D4012: Measurement of Adenosine Triphosphate (ATP) Microbial Content in Water.
- ASTM Standard E2694: Measurement of ATP in Metallurgical Fluids.
- ASTM Standard D7687: Measurement of ATP in Fuels, Water/Fuel Mixtures, and Water Associated with Fuels.
- NACE Manual TM0194: Field Monitoring of Bacterial Growth in Oil and Gas Systems.
- NACE Manual TM0212: Detection, Testing, and Evaluation of the Influence of Microorganisms on Internal Pipeline Corrosion.

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