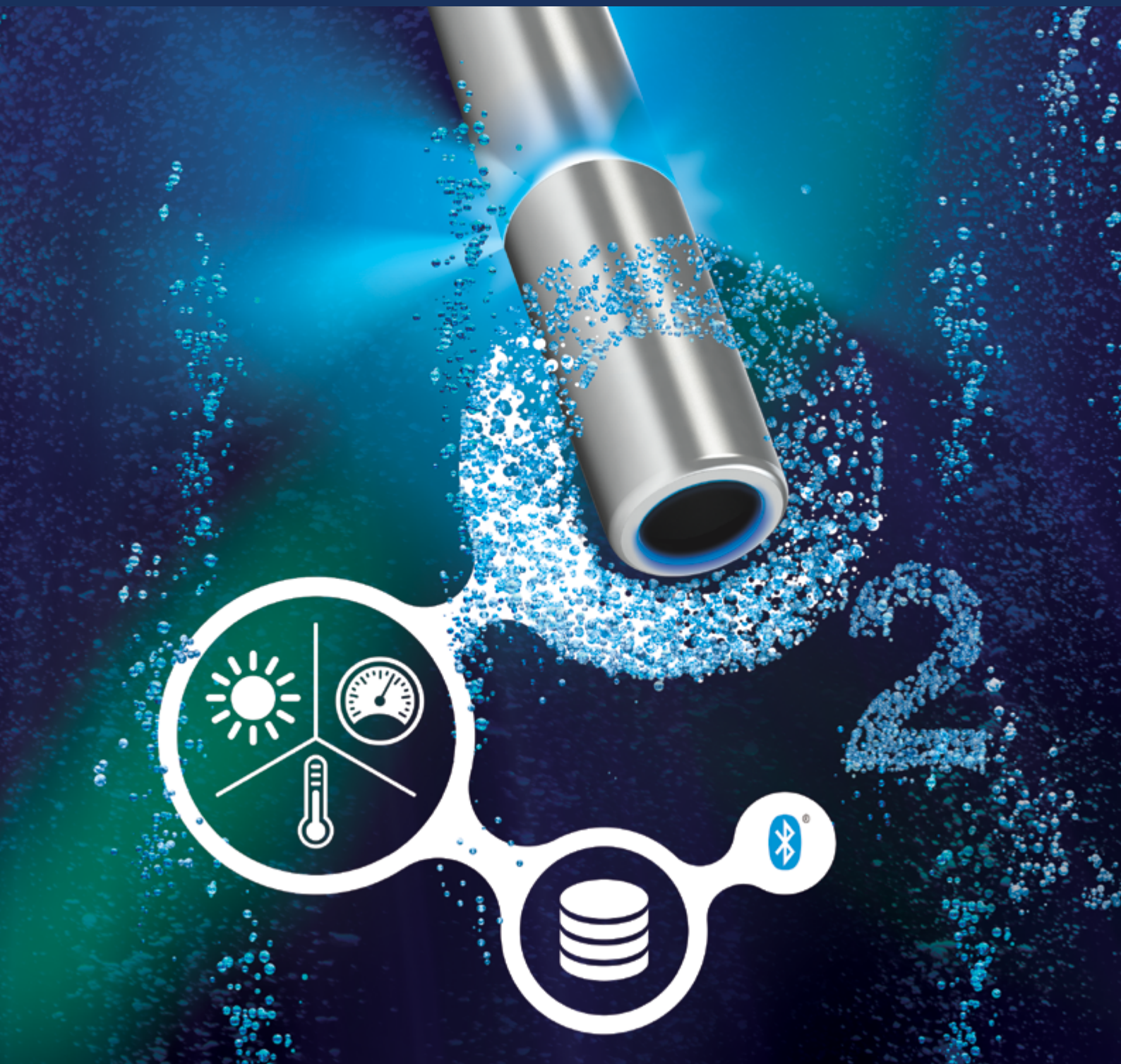
HAMILTON

Optical Dissolved Oxygen Sensors

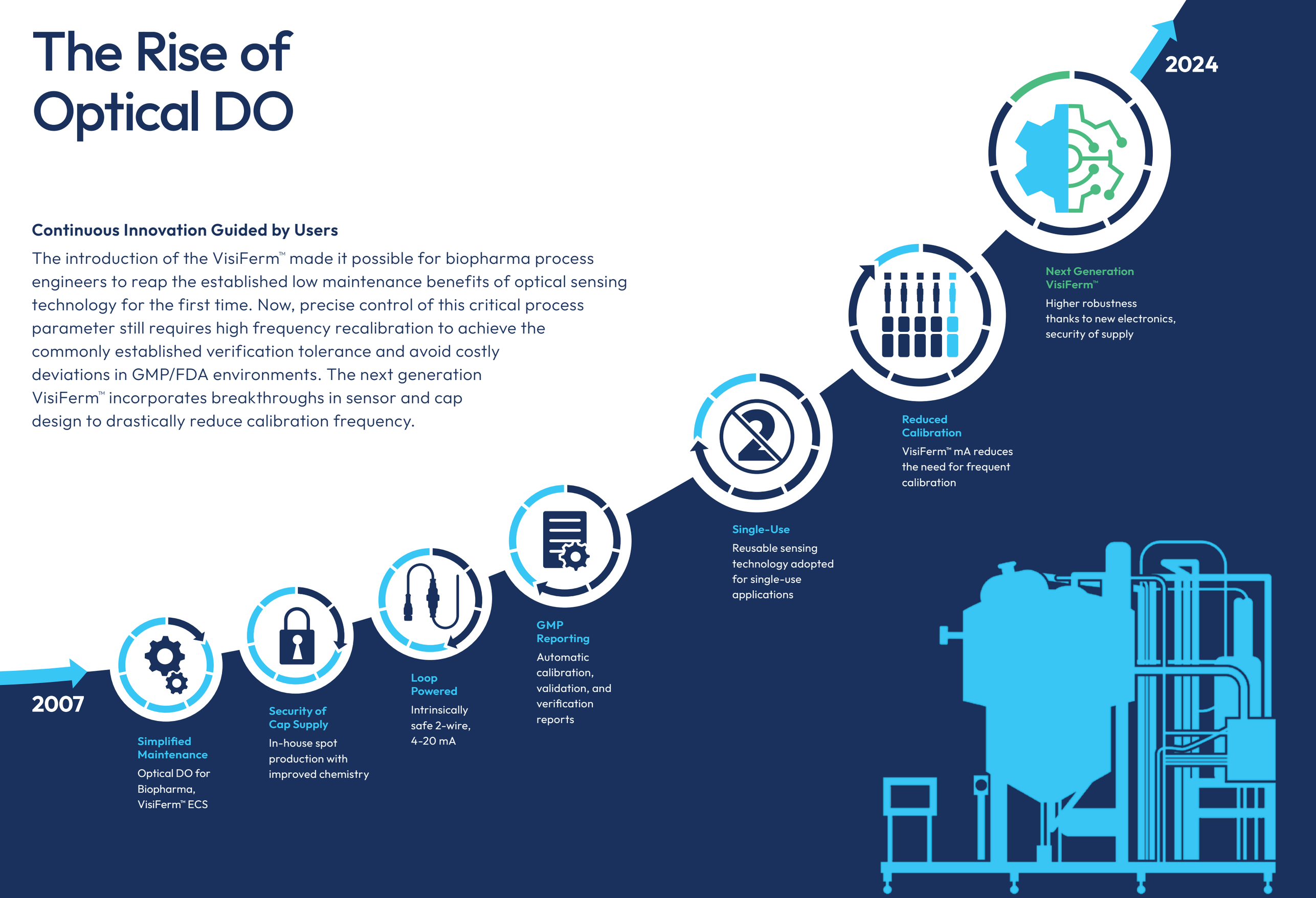
DO Sensors for Biopharma



The Rise of Optical DO

Continuous Innovation Guided by Users

The introduction of the VisiFerm™ made it possible for biopharma process engineers to reap the established low maintenance benefits of optical sensing technology for the first time. Now, precise control of this critical process parameter still requires high frequency recalibration to achieve the commonly established verification tolerance and avoid costly deviations in GMP/FDA environments. The next generation VisiFerm™ incorporates breakthroughs in sensor and cap design to drastically reduce calibration frequency.



Analyzing The Impact

Finding Hidden Contributors to Measurement Error

Hamilton extensively investigated the effects of the bioprocess on measurement accuracy. Analysis of sensor aging, chemical attack, and physical damage yielded the necessary understanding for development of a next generation VisiFerm™ which reduces the need for frequent calibration.

1 Aging

Photobleaching of the luminophore and aging of the electronics lessen measurement accuracy over time.

2 Temperature

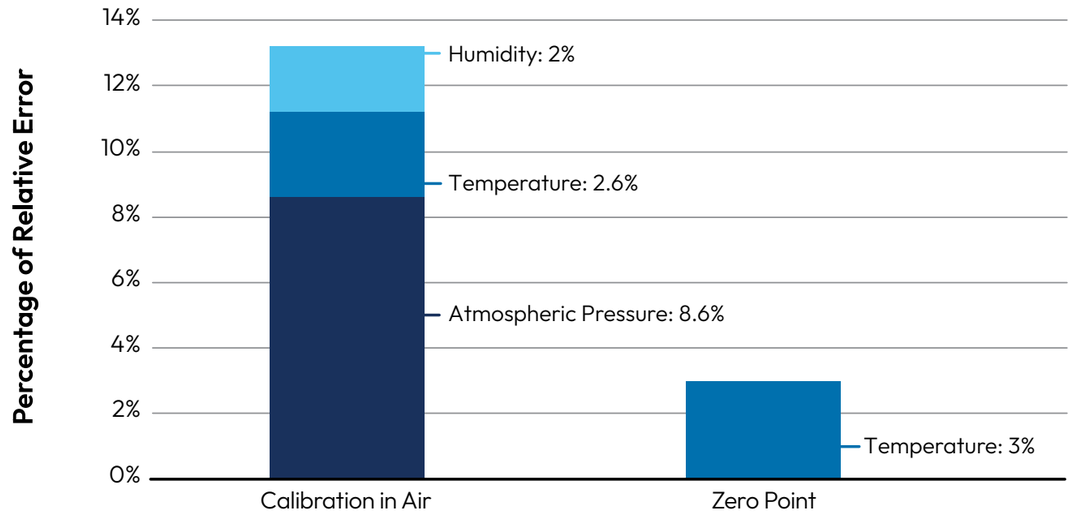
Elevated temperature during SIP/CIP damages the luminophore and accelerates chemical impact.

3 Calibration

Failure to compensate for humidity, temperature, and pressure can result in large measurement error.

Calibration is Critical

Up to 13.2% verification error can be introduced by changes in temperature, relative humidity, and atmospheric pressure from the time of calibration to the time of verification. Accounting for these environmental factors reduces the frequency of unnecessary deviation reports.



Temperature

Heat transfer is less efficient in air than in liquid, so care should be taken in sensor handling to ensure the sensor is at equilibrium before calibration and verification.

Humidity

Humidity is always 100% in dissolved oxygen measurement but can vary widely when calibrating in air, causing inaccuracies.

Pressure

Verification errors can result from uncontrolled calibration environments, which can change by as much as 80 mbar from the time of calibration to the time of verification.

Compensating for Calibration Errors with ArcAir

Calibration Wizard

The built-in calibration wizard in ArcAir accepts inputs for relative humidity and atmospheric pressure to provide a perfect calibration every time.

Next-Generation VisiFerm™

Reducing The Impact of Aging and Temperature

Every application is unique, so standard compensation algorithms for the temperature effect of SIP and the aging effect of photobleaching have limited utility. Hamilton's vision to fully overcome the influence of SIP/CIP and photobleaching required innovation in both sensor and cap design. This development effort resulted in the next generation VisiFerm™.

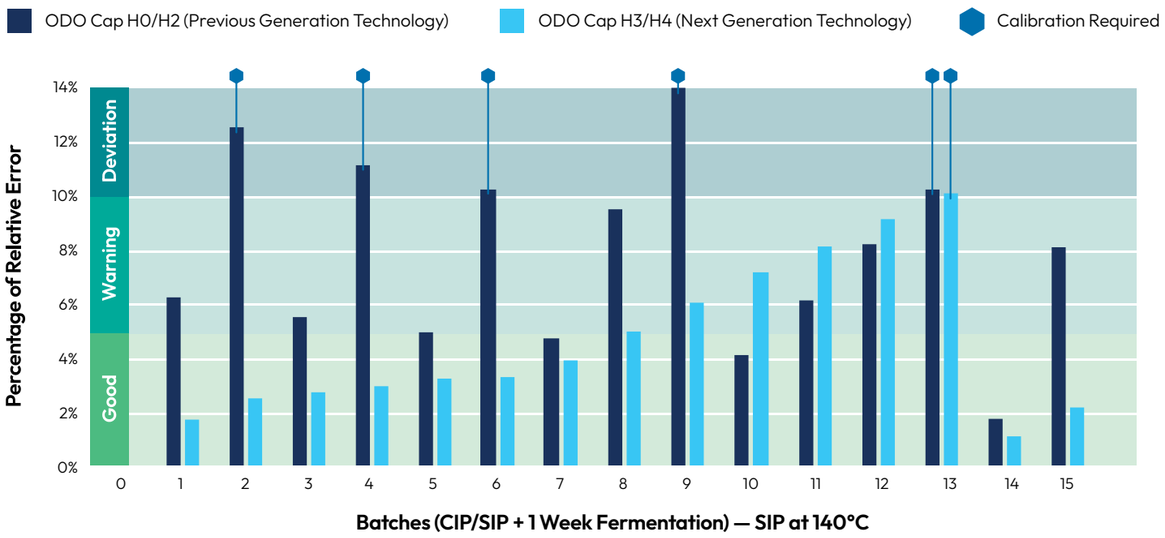
50%
Longer Sensor Life

80%
Fewer Calibrations

3X
Longer Cap Life

Realization of The Vision

The need for calibration is determined by a post-run verification. A relative verification error of 5% triggers calibration, while an error of 10% requires a deviation report. To avoid deviations, DO sensors using the previous generation's ODO Caps H0/H2 require calibration after almost every run. **The VisiFerm™ extends the time between calibrations and significantly reduces the chance of deviation.**



Making A Better Sensor

Hamilton improved upon both sensor and cap design to create the most robust VisiFerm™ yet. Upgrading both key pieces allowed the VisiFerm™ to have less frequent calibration, less measurement drift, and longer lifetime than previous optical DO sensors.

Cap Stability

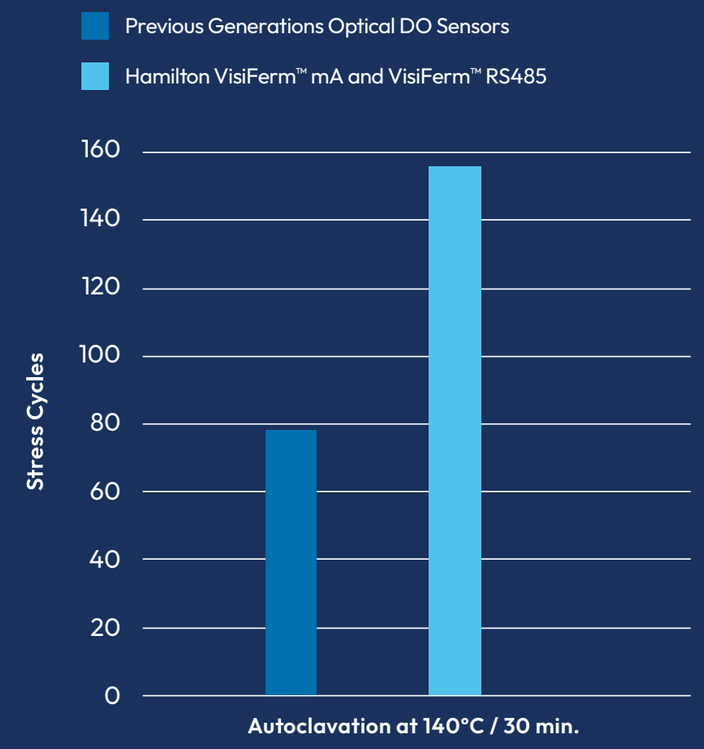
Next Generation ODO Caps H3/H4 have improved formulation and construction:

- Strengthened luminophore matrix for better temperature stability
- Enhanced luminophore chemistry for resistance to photobleaching
- Stronger mechanical stability for higher process resilience

Sensor Robustness

VisiFerm™ has the ability to withstand more temperature cycles than ever.

- Tougher electronic components for higher temperature stability
- LED intensity adjustment to reduce the impact of aging
- Increased memory for storage of enhanced diagnostic data
- All sensor connectors (M12, VP8) are resistant to temperature and mechanical stress



How VisiFerm™ Arc Works

Generation VisiFerm™ Arc

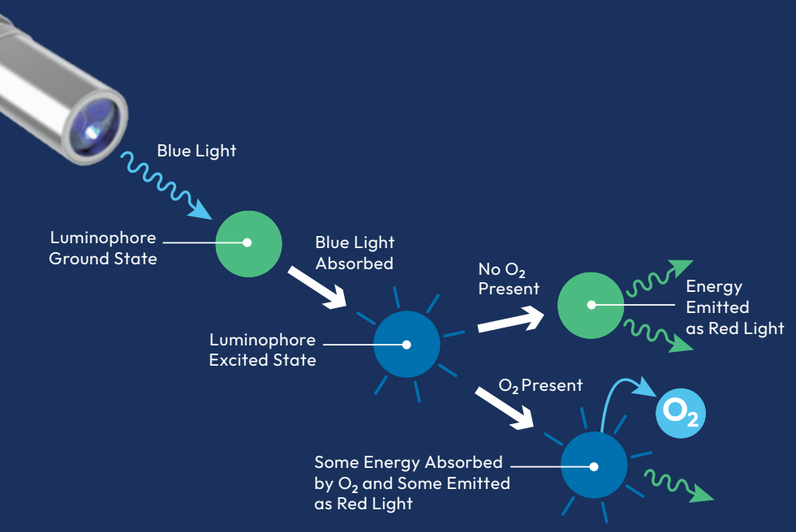
Take advantage of the VisiFerm™ Arc's benefits with no changes to existing infrastructure. The sensor has all relevant certifications for GMP production environments and connects to existing installations.

Arc

Hamilton's Arc technology streamlines access to all sensor information, including health, measurement, and settings.

Measuring Principle

Blue light excites a fluorescent dye (luminophore) in the sensor cap. In the absence of oxygen the energy is fluoresced as red light. In the presence of oxygen some energy is transferred to the oxygen molecule and less red light is emitted. The partial pressure of oxygen is reliably given by the phase shift between excitation and emission.



VisiFerm™ RS485

1 LED Indicator

- Ready to operate, no sensor errors or warnings
- Sensor in warning state
- At least one sensor error

2 Connectivity Options

VisiFerm™ RS485

VP8
4-20mA*, Modbus RS485 RTU, PROFINET®, PROFIBUS®, OPC UA, FOUNDATION Fieldbus
Backwards compatibility to existing Arc installations.**

***with Arc Wi 2G Adapter**
****with ODO H0 and ODO H2 caps**

VisiFerm™ mA

M12
4-20mA, HART™
Optimized power consumption and a 2-wire configuration allow you to connect instantly to existing infrastructure.

Bluetooth 5
Utilize the integrated benefits of Bluetooth 5 for a faster, more secure and robust sensor connection.

3 Label Options

VisiFerm™ RS485

USP CLASS VI · GMP

VisiFerm™ mA

USP CLASS VI · GMP · Ex · HART COMMUNICATION PROTOCOL

4 Cap Options

VisiFerm™ RS485

ODO Cap H3
ODO Cap H4
ODO Cap H0
ODO Cap H2

VisiFerm™ mA

ODO Cap H3
ODO Cap H4

Previous Generation Caps

ODO Cap H0
The fastest response time and compatibility with most fermentation and culture media.

ODO Cap H2
Chemically resistant with hygienic design to simplify cleaning and minimize bubble accumulation.

Next Generation Caps

ODO Cap H3
Strengthened luminophore matrix for better temperature stability with fast response time. The perfect cap for most biopharmaceutical applications.

ODO Cap H4
Strengthened luminophore matrix for better temperature stability with chemically resistant and hygienic design to simplify cleaning and minimize bubble accumulation.

VisiFerm™ mA

Tools for Predictive Maintenance

Arc technology in the VisiFerm™ mA and VisiFerm™ RS485 pairs with the newest ArcAir software to automatically store all sensor activities, diagnostic data, and health indicators throughout the life of the sensor. Calibration, verification, and maintenance data are readily available to facilitate predictive maintenance planning.

Automatic History

- Calibration Reports
- Cap Change Recognition
- Verification Reports
- Audit Trail

VisiFerm™ Quality Indicators

1. **Sensor**
   Installation of a new cap triggers automatic evaluation of the sensor electronics and updates the sensor health indicator.
2. **Measurement**
   Measurement quality is an indicator of the combined health of sensor and cap.
3. **Cap**
   Luminophore intensity is continuously monitored and used to calculate a cap health metric.

Part 11

GMP

Sensor Audit Log

VisiFerm™ mA and VisiFerm™ RS485 with ArcAir now comes with a built-in audit log to track all changes to the sensor from a simple setting change to automatically recognized cap replacements.

Explore Hamilton's Field Services

We offer various Hamilton field service options to fit your facility's needs. Our Field Service Team is factory trained and ready to help you at any stage, from installation to long-running maintenance. See which Hamilton field service fits your needs.

- **INSTALLATION SUPPORT**
- **MAINTENANCE AND CALIBRATION SERVICES**
- **QUALIFICATION IQ/OQ**
- **ON-SITE TRAINING**

Learn More: www.hamiltoncompany.com/field-services

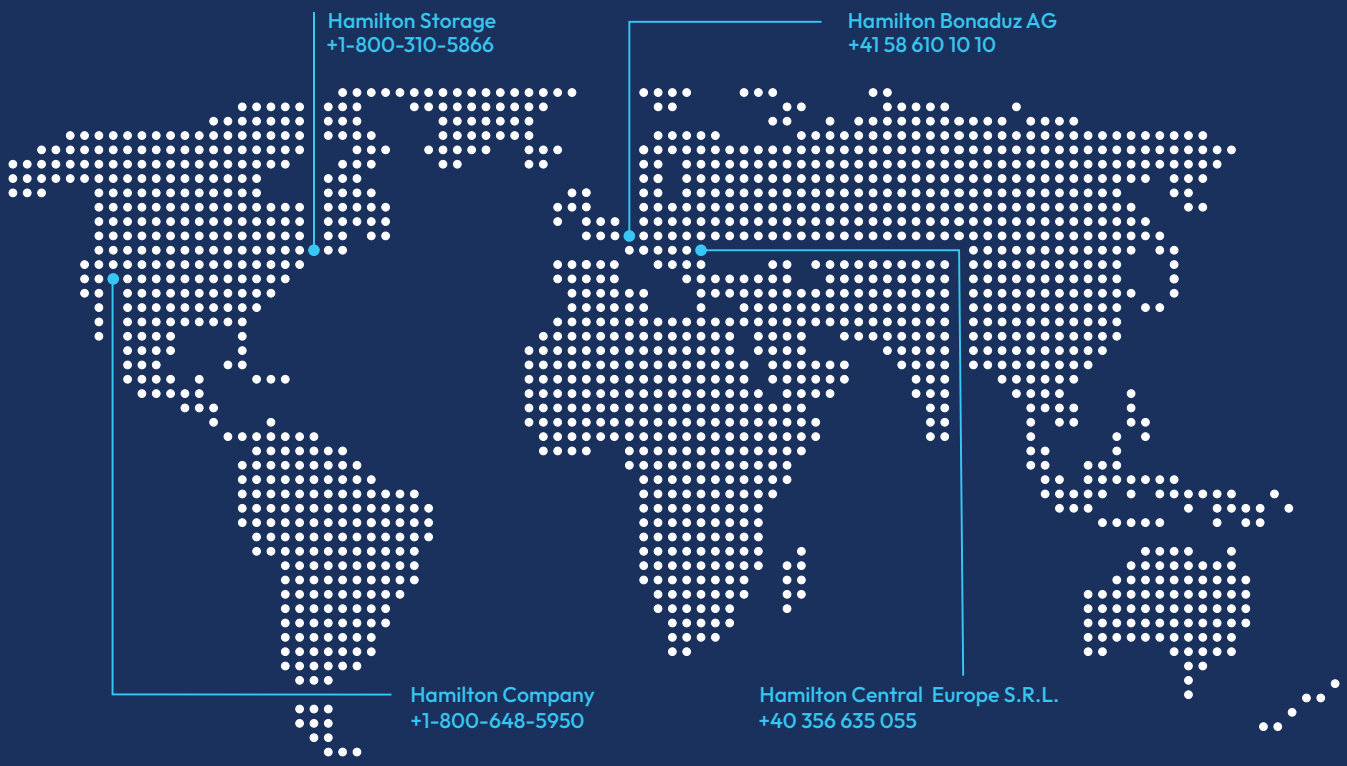
Note: Our sensors are made to last. To increase sensor lifetime and avoid down-times, Hamilton suggests maintaining their sensors at least once a year by a Hamilton factory trained technician.

Unlock the Secrets of Bioprocessing Excellence

Download and Find Out More

- **WHITE PAPER**
  Measurement Challenges with Optical Dissolved Oxygen Sensors
- **GUIDE**
  O_2 Measurement Guide
- **CATALOG**
  Complete Process Analytics Catalog
- **BROCHURE**
  Arc Intelligent Sensors

We invite you to join us in our commitment to environmental responsibility by embracing digital documentation.



Years of Experience
75+

Locations Worldwide
22+

Employees Internationally
3,000+

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