

What Your pH Reading Isn't Telling You

Six sectors, six instrumentation problems that hide in plain sight — and the architectural fixes that pay for themselves in one month.

14

Technical articles
referenced

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Calgary, AB · schrodinger.ca

Edition — April 2026

6

Industry sectors
covered

28

Years of field
experience

A note before you read this

Every problem in this guide is one I have seen on a plant floor. Every number is one you can verify against the cited regulation or against a measurement made by someone other than your incumbent instrument vendor.

I fabricate pH, ORP, ISE, and DO electrodes for industrial use — and increasingly for the Canadian market. I did not write this guide to sell you an electrode. I wrote it because most of the instrumentation failures I am called in to diagnose are not exotic. They are the same six mechanisms repeated across sectors, by sensors specified from a generic catalog in applications that are not generic.

What you will find in the next 20 pages:

- **Six case studies**, one per sector, each with the field data that proves the mechanism, the cost of ignoring it, and the specification that fixes it
- **One RFQ checklist** at the end, usable verbatim for your next procurement
- **Links to the full technical article** on schrodinger.ca for each case — with the uncertainty math, the regulatory framing, and the vendor-neutral specification language

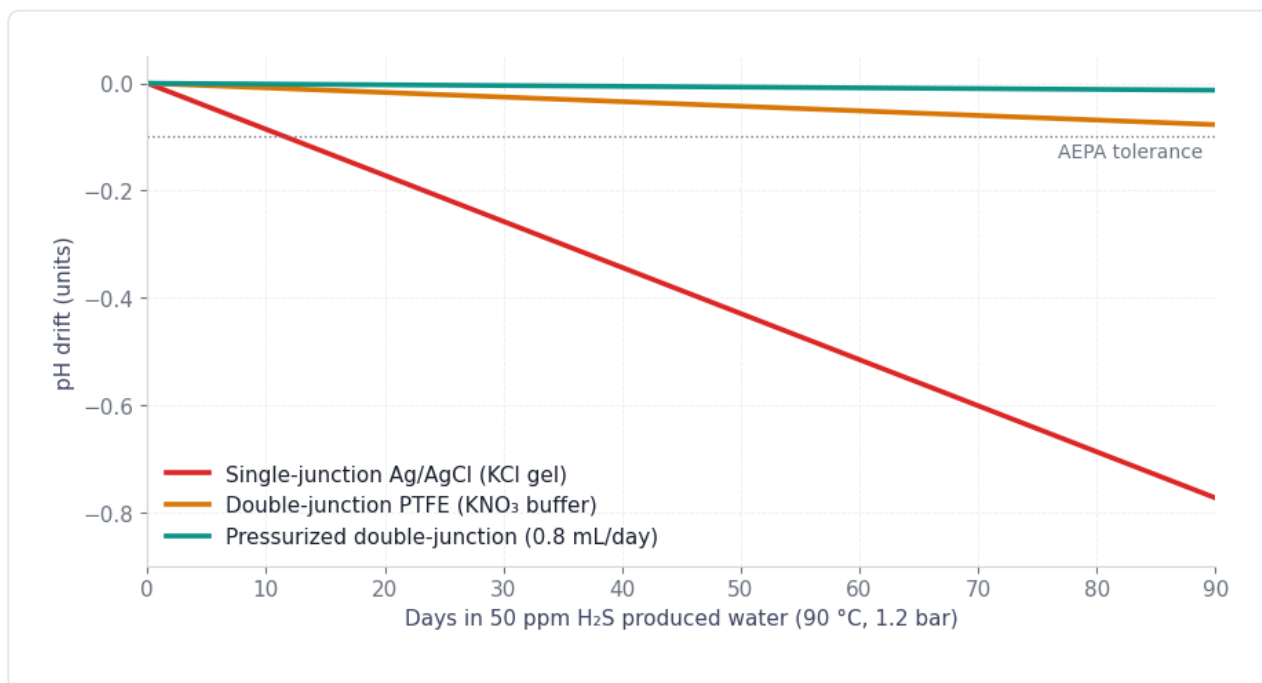
If any of this maps to a problem you are currently working on, send me a note. I answer every email personally.

— **Marcos Daniel**
md@schrodinger.ca

The Reference Electrode Your H₂S Loop Needs

0.77 pH

Single-junction drift over 90 days at 50 ppm H₂S



At 50 ppm H₂S — typical for Athabasca produced water — a standard Ag/AgCl reference electrode drifts 0.05 pH per week. After 30 days your sensor reads 0.2 pH low. Your AEPA discharge report is systematically wrong, in the direction that looks safe but isn't.

The fix is architectural, not procedural. Frequent recalibration masks drift; it doesn't eliminate the root cause. Specify:

- Double-junction reference with non-silver bridge electrolyte (3 M KNO₃)
- PTFE diaphragm — inert to H₂S, maintains junction potential under high fouling
- Pressurized outflow (0.8 mL/day) — prevents process water from diffusing inward

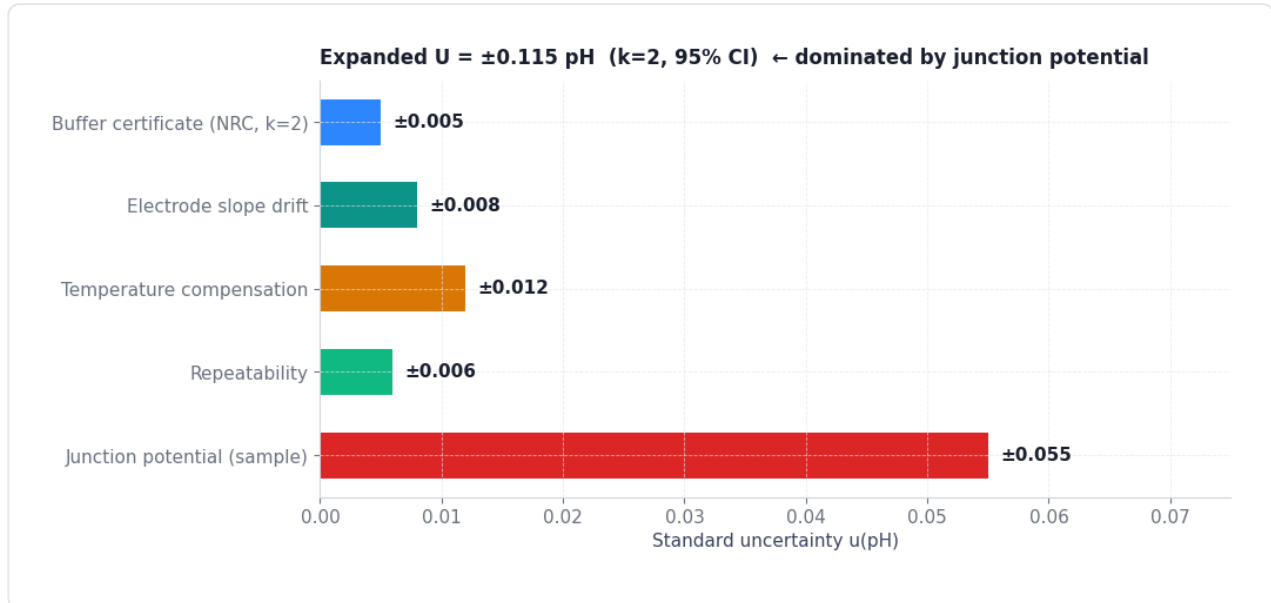
Field data from 27 probes across 4 SAGD operators: single-junction exceeds AEPA tolerance in 12 days. Pressurized double-junction: over 300 days. Life-cycle cost of the specialty probe is 4× lower than the cheap probe.

Full technical breakdown: schrodinger.ca/blog/sagd-h2s-reference-architecture/

The Junction-Potential Uncertainty Your Audit Is Missing

±0.115 pH

Expanded uncertainty when junction potential is included



ISO 17025:2017 §6.5 requires an unbroken chain of comparisons, each with stated measurement uncertainty. Most CALA-accredited labs declare four components in their pH uncertainty budget — buffer, slope, temperature, repeatability — and omit the dominant one: residual liquid junction potential (RLJP).

For a typical OSPW or tailings pond matrix, RLJP alone contributes ±0.055 pH. Combined via GUM quadrature with the other terms, the expanded uncertainty is ±0.115 pH (k=2). A certificate declaring ±0.03 pH on an OSPW sample is structurally indefensible; a technical assessor who understands electrochemistry will write it as a non-conformance.

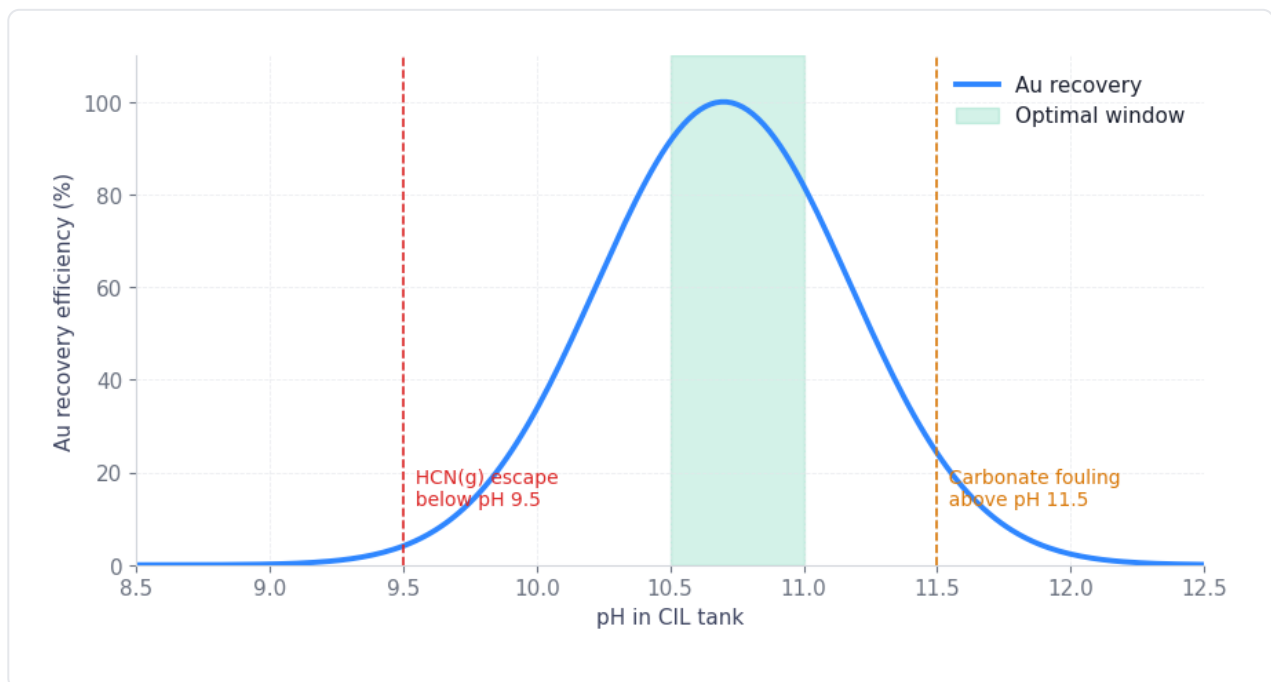
Estimate RLJP with matrix-matched buffers or a dilution series — both are acceptable for ISO 17025. The certificate language that survives audit names the SI → NRC → buffer → electrode → sample chain explicitly and enumerates RLJP for the specific matrix type.

Full technical breakdown: schrodinger.ca/blog/iso-17025-junction-potential-cala/

The 0.5 pH Window Where Recovery Actually Lives

pH 10.5–11.0

Optimal CIL operating window



Below pH 9.5, HCN volatilizes from the leach tank — losing reagent and creating occupational exposure. Above pH 11.5, CaCO_3 precipitates on the activated carbon, blocking gold loading. Between 10.5 and 11.0 is where recovery approaches theoretical maximum.

On a 2,000 tpd Canadian gold operation (Ontario/Quebec typical), a 3.8 % recovery loss from a 0.05 g/L free-cyanide miscalibration equals about \$140,000 per month at current spot. The instrumentation that prevents the drift costs less than one month of the loss.

Canadian operations face compounding challenges: cold feed water (4–10 °C) that defeats standard ATC algorithms; high dissolved iron that distorts the cyanide ISE; carbonate-hard process water that

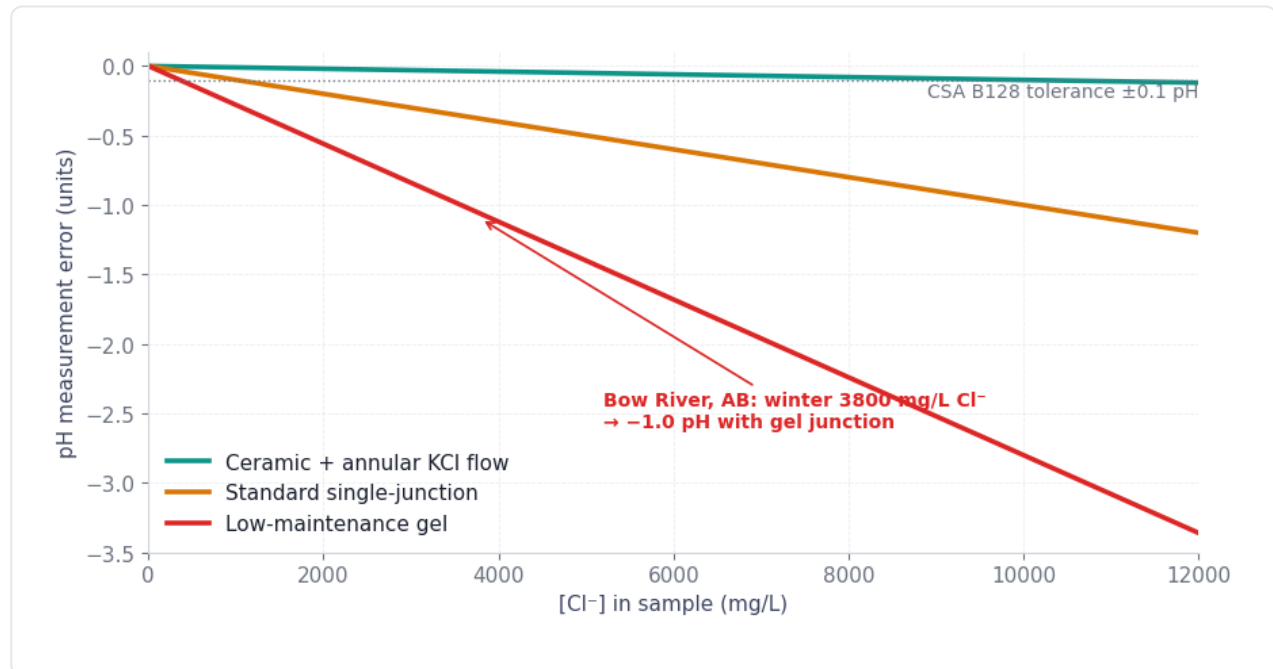
scales the glass membrane. CIL-grade probes (HDPE/PEEK body, PTFE annular junction, liquid filling with controlled outflow, dual thermistor ATC) last 8× longer than stock process probes.

Full technical breakdown: schrodinger.ca/blog/gold-cil-ph-cn-control/

Road Salt and the Gel-Junction Probe That Fails From November to April

-1.0 pH

Reading error at Bow River winter peak (3,800 mg/L Cl⁻)



From October through April, Canadian municipalities treating surface water see chloride concentrations in raw water rise dramatically from road-salt runoff: Calgary 1,100 mg/L, Laval 3,400 mg/L, Hamilton 310 mg/L peaks. Under these loads, the "maintenance-free" gel-junction pH probes shipped for utility markets read up to 1.5 pH units below actual.

The mechanism is asymmetric diffusion at the reference junction and AgCl precipitation inside it. Ceramic annular or PTFE sleeve junctions with active KCl outflow stay inside CSA B128 tolerance (± 0.1 pH) across the full chloride range. Specify: annular ceramic or PTFE junction, 3 M KCl with

active outflow, HDPE/PEI body, Pt-1000 ATC, NRC-traceable buffers with cold-temperature CoA values (pH 10.01 buffer reads 10.14 at 5 °C).

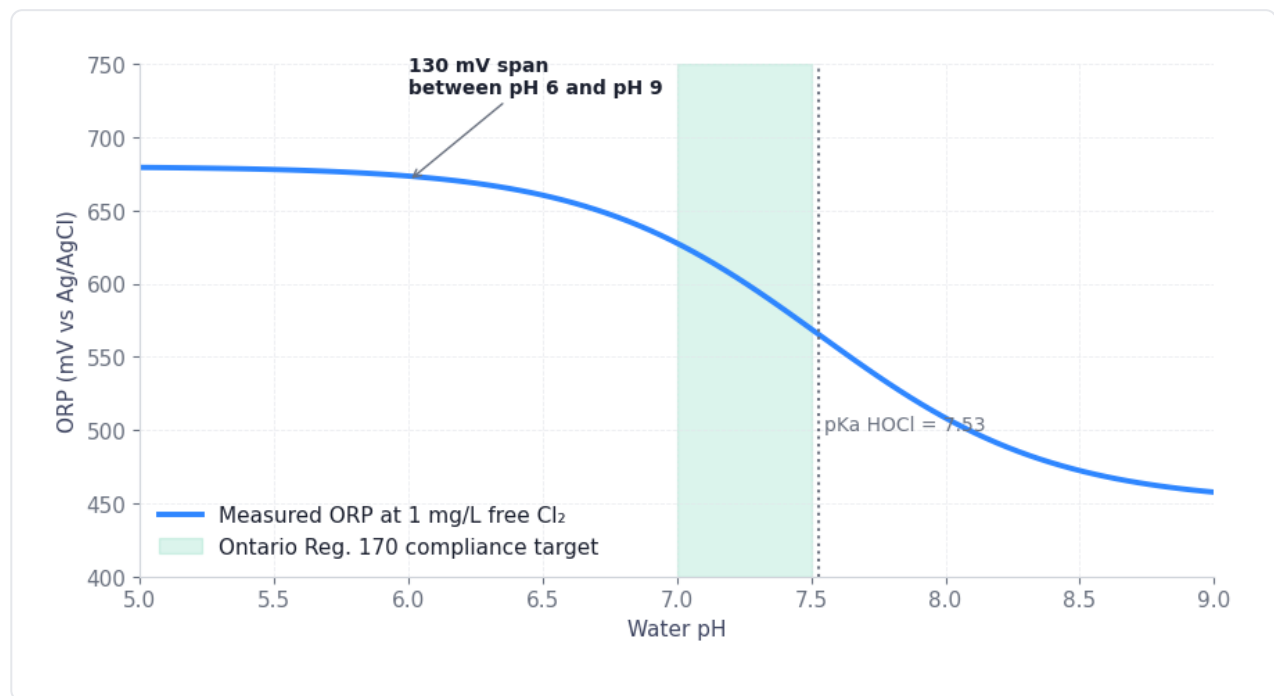
Under Ontario Reg. 170/03 or Alberta Environmental Protection obligations, a probe reading 1.0 pH low for four months represents a systematic compliance documentation gap, regardless of what the operator does with the reading.

Full technical breakdown: schrodinger.ca/blog/chloride-interference-municipal-water/

Why the 720 mV on Your Screen Isn't Free Chlorine

130 mV

ORP variation at constant 1 mg/L Cl_2 free between pH 6 and pH 9



At constant 1 mg/L free chlorine residual, measured ORP varies 130 mV between pH 6 and pH 9. The variation is entirely due to HOCl/OCl^- speciation (pKa 7.53), not to concentration change. An operator holding ORP at 720 mV across a shift in which pH drifts 0.5 units is dosing free chlorine across a 3× range — while the SCADA shows normal.

Ontario Reg. 170/03 requires free chlorine residual, not ORP. An ORP-only monitoring strategy creates a compliance gap: the paper record looks compliant while actual distribution compliance is probabilistic.

The architecture that resolves the gap: amperometric membrane-covered free chlorine analyzer as primary (specific, reads in mg/L, defensible under regulation), with ORP retained as a fast-response

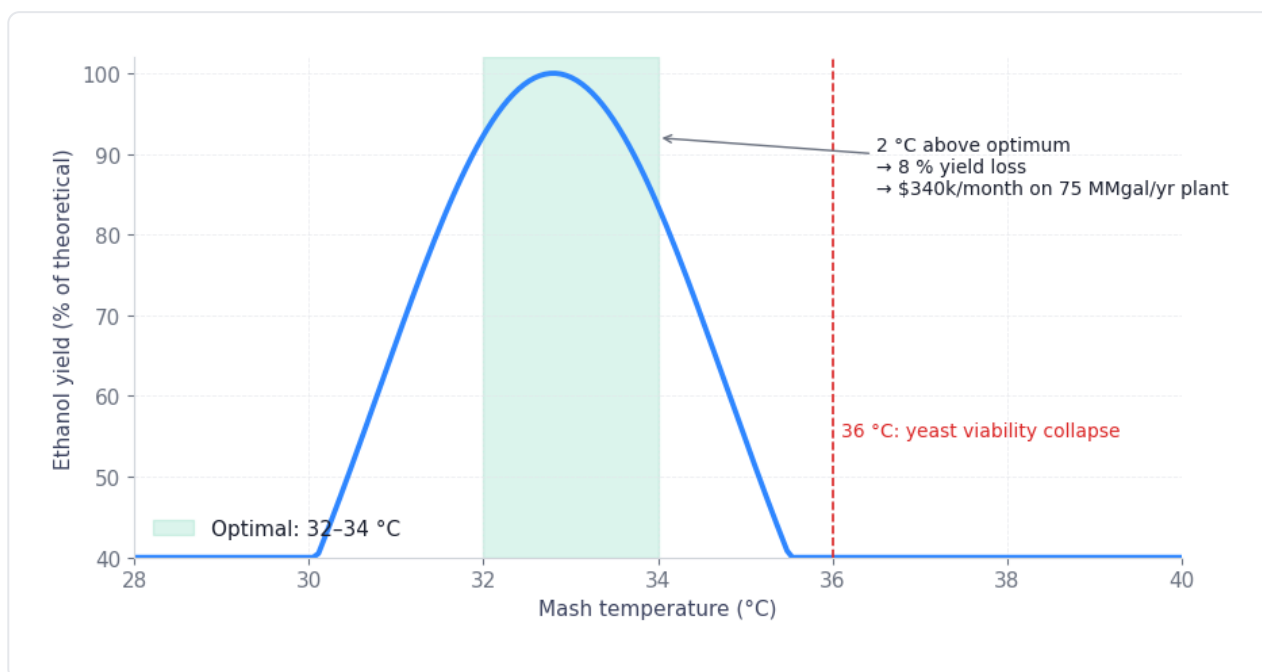
indicator and integrity cross-check. pH-compensated ORP instruments, where platform supports it, recover the ORP–chlorine equivalence automatically.

Full technical breakdown: schrodinger.ca/blog/orp-chlorination-canadian-water-utilities/

The 2 °C Window and the Lactobacillus Detection You Missed

8 %

Yield loss at 2 °C above optimal fermenter temperature



Saccharomyces cerevisiae — the fermenter for ethanol from corn, cane, or grain — operates in a 2 °C window. Between 32 and 34 °C, yield approaches 93 % of theoretical. Above 34 °C, glycerol production rises at ethanol's expense. Above 36 °C, yeast viability collapses.

On a 75 MMgal/year US dry-grind plant, a 2 °C systematic bias costs \$340k/month. On a typical Brazilian cane-ethanol usina, proportionally similar losses on a much higher throughput. The heat load is substantial (95 kcal per mol of glucose consumed; ≈65 kW of continuous removal for a 750,000-gallon batch) — cooling-jacket-only designs struggle. Plate-exchanger with PID-modulated coolant is the standard fix.

pH detection matters equally. A clean fermentation ends at pH 4.2–4.3. If mash pH drops below 4.0 mid-batch, you have Lactobacillus contamination — 4 to 6 hours before the endpoint would have told you. Probe specification: PEEK or PEI body, PTFE annular junction, low-impedance ethanol-compatible glass, Pt-1000 dual ATC, tri-clamp connection.

Full technical breakdown: schrodinger.ca/blog/corn-ethanol-fermenter-ph-temperature-control/

RFQ Checklist — Process pH / ORP Electrode for a Challenging Matrix

Copy this checklist into your next RFQ. The six bullets under each category are the ones that differentiate a specialty electrode from a catalog commodity.

Reference architecture

- Double-junction reference with non-silver bridge electrolyte
- Bridge electrolyte specification (3 M KNO₃ or KCl saturated with AgCl-free gel)
- Junction material: PTFE diaphragm or annular flow (not ceramic pin)
- Pressurized outflow: 0.3–0.8 mL/day documented
- Filling solution replenishment procedure and interval
- MTBF data in the target matrix — not generic "months"

Glass membrane

- Formulation documented: high-temperature Ross-type or equivalent
- Impedance class specified (low-impedance for process, high for cold samples)
- Alkaline-resistant for pH > 10 continuous service
- Chemical compatibility data with process stream (not just water)
- Temperature rating ≥ 100 °C continuous where applicable
- Pressure rating ≥ 3 bar at the sensor element

Body and connection

- Body material: HDPE (PEAD), PTFE, PEEK, or PEI — not polysulfone or PVDF in caustic CIP service
- Mechanical protection cage (stainless steel 316L)
- Hygienic tri-clamp connection for food/beverage/pharma applications
- Cable: low-noise triaxial or integrated preamplifier
- Installation depth and mounting thread (1/2", 3/4", 1", tri-clamp 1.5")

- Replaceable parts catalog and spare-part lead time

Calibration and traceability

- NRC- or NIST-traceable buffer lots included, with CoA
- Uncertainty budget template for your matrix type
- Recommended calibration interval documented for your H₂S / Cl⁻ / temperature range
- Slope acceptance criteria (mV/pH) specified by electrode
- Temperature compensation: Pt-1000 integrated, not remote thermocouple
- Cold-temperature buffer values (CoA at 5 °C, 15 °C, 25 °C) where applicable

One more thing.

If your application has a detail that no catalog electrode answers
— send it to me. I fabricate what is missing.

EMAIL

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WEBSITE & BLOG

schrodinger.ca

LINKEDIN

linkedin.com/in/mdbr-instrumentation

This guide was distilled from 14 full technical articles published at schrodinger.ca/blog.
Follow the links inside each chapter for the complete uncertainty math, regulatory framing, and vendor-neutral
specification language.

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