Getting pH Right

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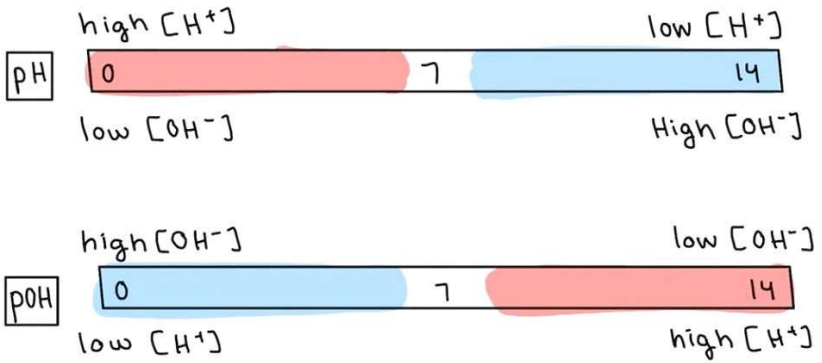
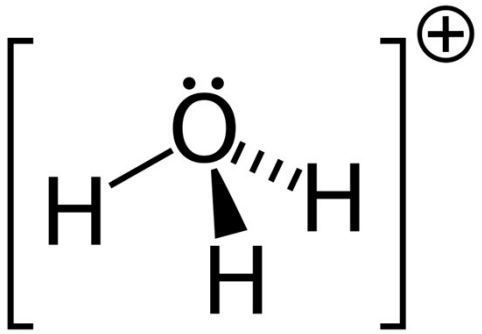
Outline

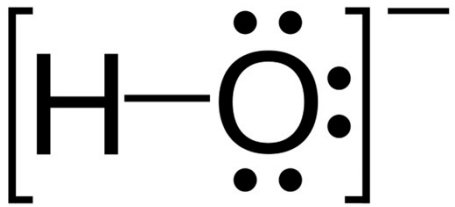
- What is pH and why do we care
- pH proficiency testing
- Waters ERA pH products
- pH analysis
  - Measurement
  - Calibration
  - Probe care and troubleshooting



Hydronium Ion (H^+)



Hydroxide ion (OH^-)

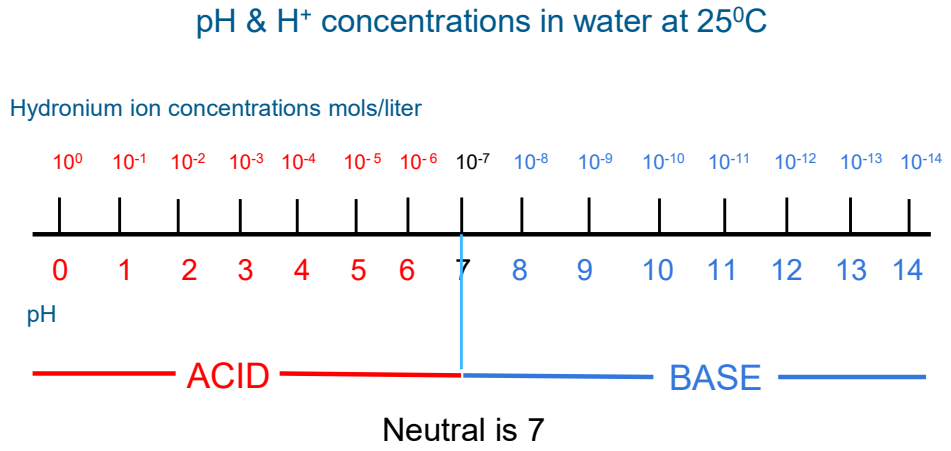


What is pH?

- pH denotes the “potential of hydrogen”
- **p** is mathematical notation for -log
- **H** is the elemental symbol for Hydrogen
- pH = -log[H^+]
  - Concentration of H^+ is expressed in molar

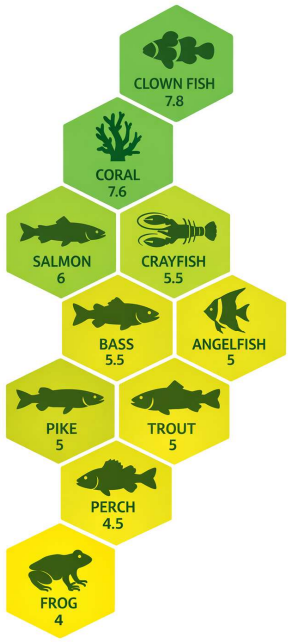
  $10{,}000 = 10^4 \rightarrow \log_{10}(10{,}000) = 4$

  $0.0001 = 10^{-4} \rightarrow -\log_{10}(0.0001) = 4$
- If [H^+] = 1 x 10^{-4} M, then pH = 4



Why does pH matter?

Minimum pH levels



pH Proficiency Testing

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Wastewater manufacturing range: 5.0 to 10.0 units

Wastewater acceptance limits: ± 0.2 units

NELAC FoPT Tables | PT Ranges and Limits | Waters ERA (eraqc.com)

eraqc.com → Support → NELAC FoPT tables

Example:

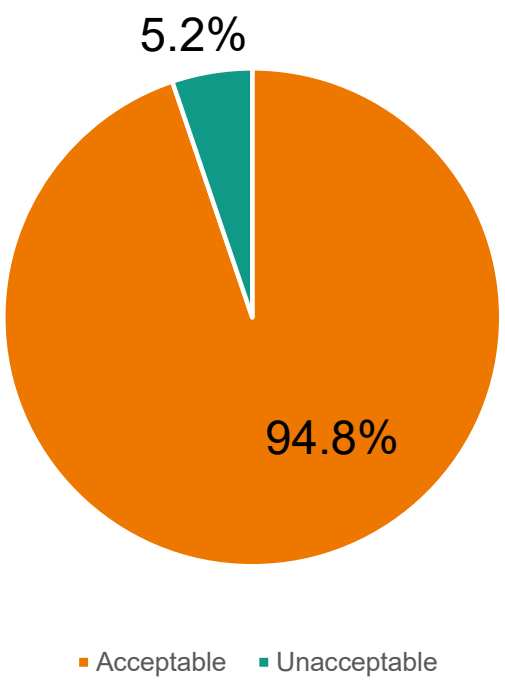
DMR-QA 44
pH made-to: 6.49 units
Acceptance limits: 6.29 – 6.69
Outside this range is evaluated as unacceptable

Past DMR-QA results

DMR-QA 44

2,579 Reported values

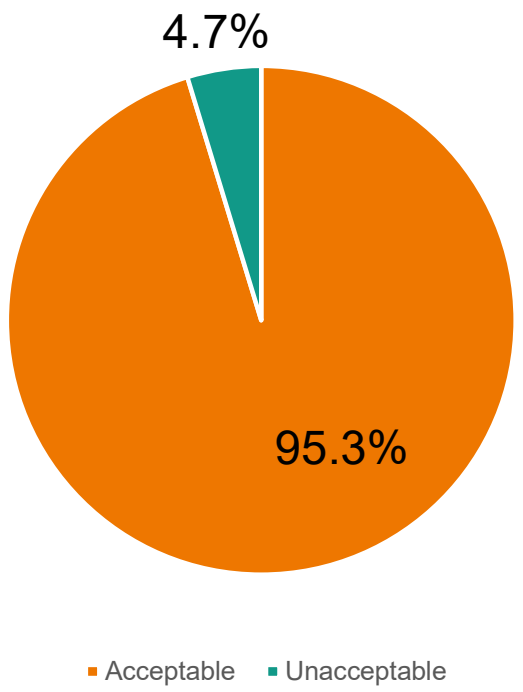
135 Unacceptable values



DMR-QA 45

2,631 Reported values

124 Unacceptable values



Calibration buffers

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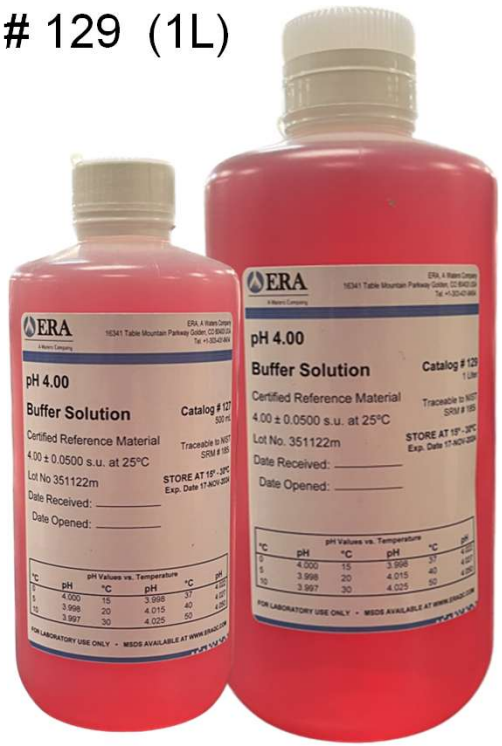
pH 4 buffer

Cat # 127 (500mL)
Cat # 128 (6 x 500mL)
Cat # 129 (1L)



pH 7 buffer

Cat # 131 (500mL)
Cat # 132 (6 x 500mL)
Cat # 133 (1L)

pH 10 buffer

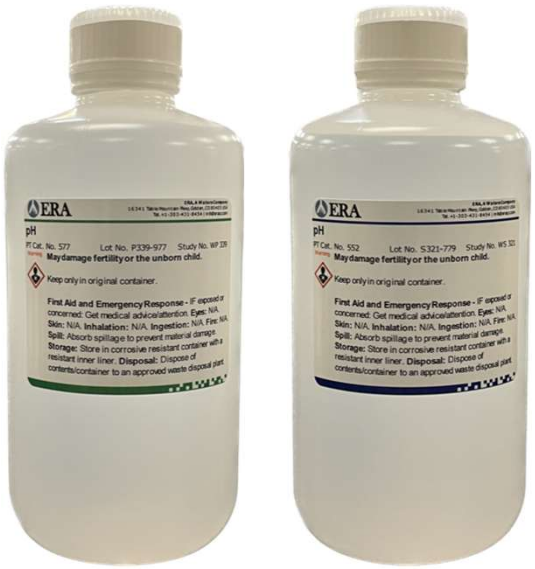
Cat #135 (500mL)
Cat #136 (6 x 500mL)
Cat #137 (1L)

Waters ERA products

Proficiency Testing products

Wastewater Cat # 577

Drinking water Cat # 552



Quality Control Products

Wastewater Cat # 977

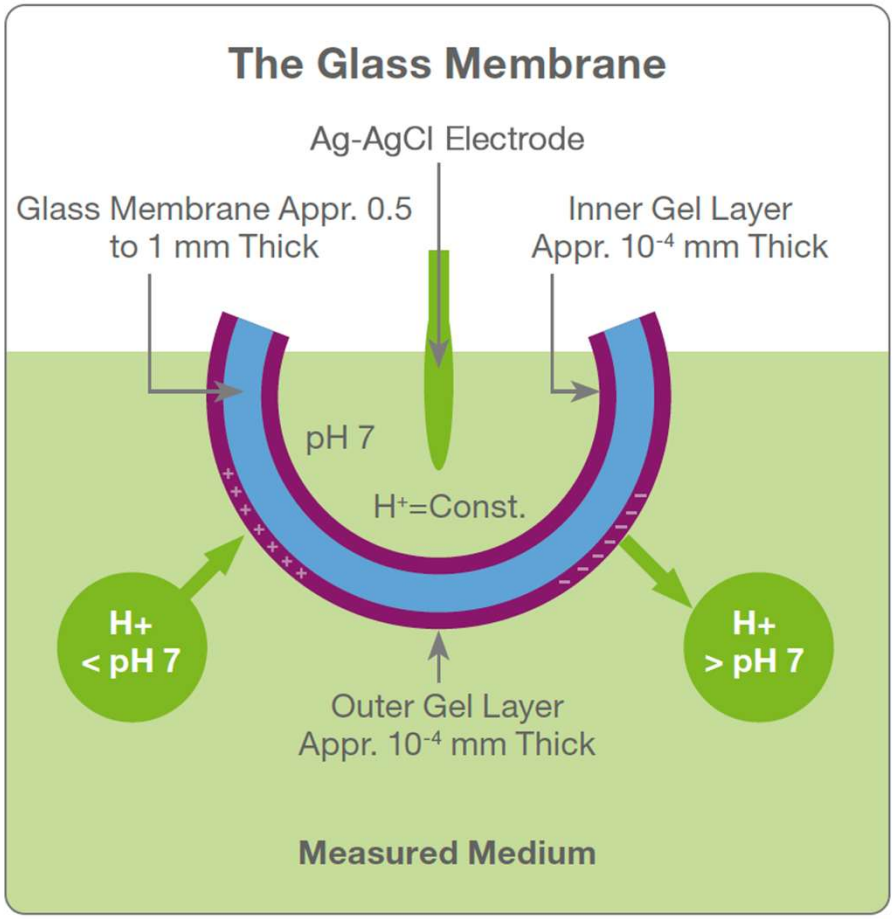
Drinking water Cat # 779

pH analysis

- Analysis
  - Pre-measurement checks
  - Proper measurement techniques
- Calibration
  - Use two calibration points
  - Account for temperature effects
  - Verify results with a third-party standard or QC check
- Proper probe care
  - Correct storage practices
  - Routine cleaning
  - Knowing when to replace the probe

Images: https://assets.fishersci.com/TFS-Assets/CCG/Thermo-Scientific/product-images/20-2003944-13641780-STD-03.jpg-650.jpg https://assets.fishersci.com/TFS-Assets/CCG/product-images/F161471~p.eps-650.jpg

Before you begin pH analysis



- Check probe condition
  - Confirm the probe was stored in an appropriate solution
  - Inspect for crystal buildup
  - Verify internal solution level is sufficient
- Ensure all solutions are at the same temperature
- Check that the fill hole is open
- Confirm Automatic Temperature Compensation (ATC) is enabled

$$E = E^0 - \frac{2.303RT}{F}pH$$

Image: https://www.hamiltoncompany.com/process-analytics/ph-and-orp-knowledge/the-ph-measurement-system/the-measurement-electrode

Probe close-up

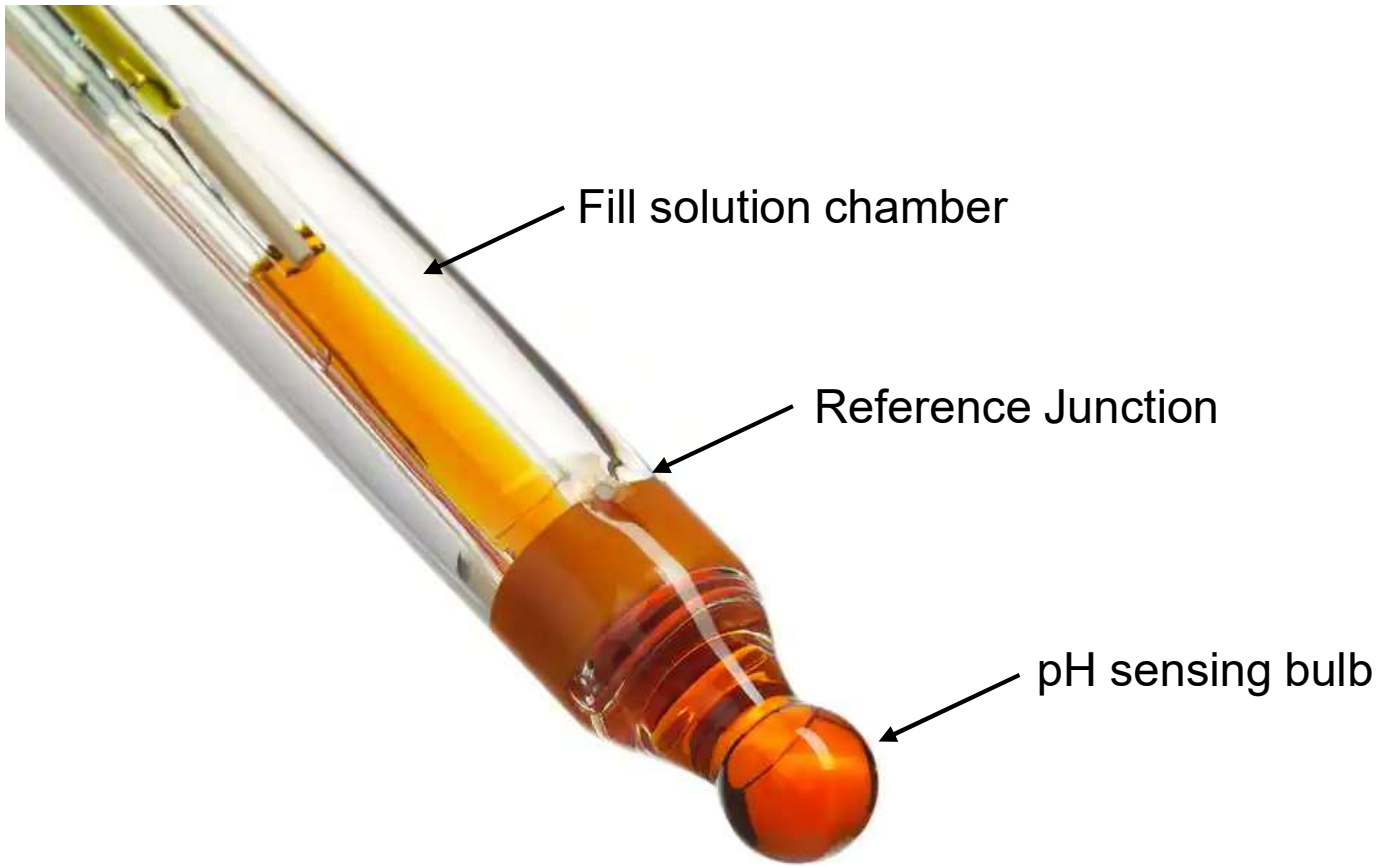
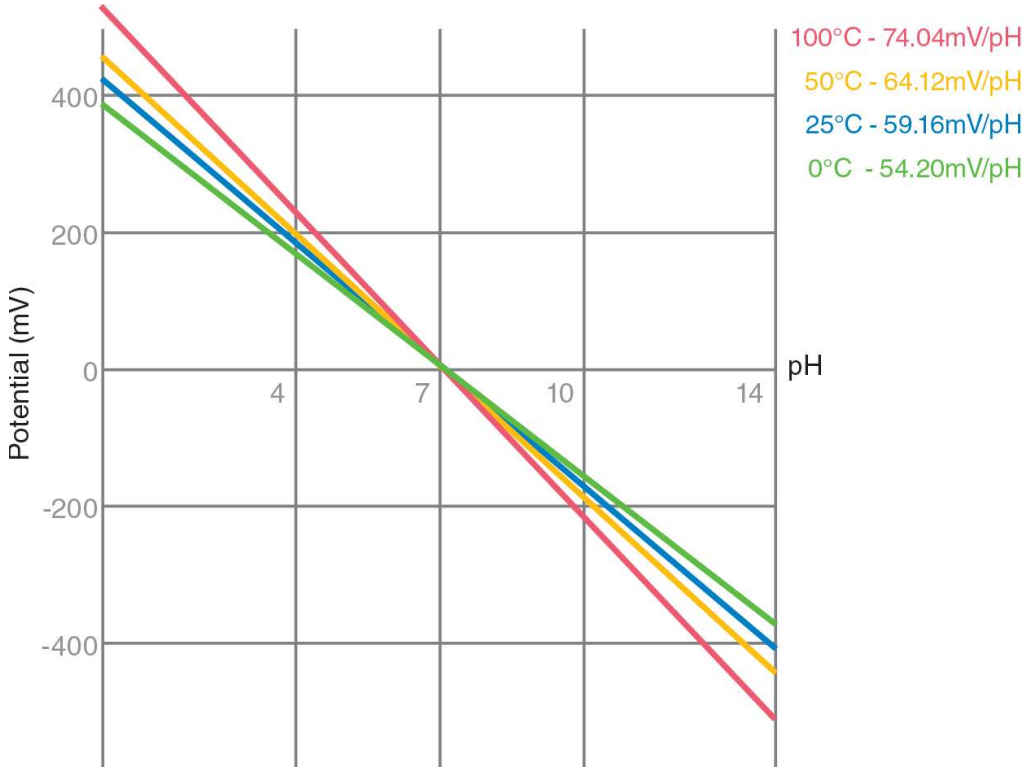


Image: https://assets.fishersci.com/TFS-Assets/CCG/Thermo-Scientific/product-images/20-2003944-13641780-STD-02.jpg-650.jpg

pH measurement best practices

- Calibrate on the day of PT analysis
- Submerge probe past the reference junction
- Stir all samples consistently
- Allow readings to stabilize before recording
- Do not wipe the probe dry
- Gently blot or condition the probe between samples

Calibration of the pH probe



- Use fresh calibration solution
- Perform a two-point calibration only
  - Always include pH 7
  - Use pH 4 or pH 10 as the second buffer
  - Estimate sample pH with pH paper before calibration
  - Enter temperature-corrected buffer values from the bottle
- Enable Automatic Temperature Compensation (ATC), if available

Calibration checks

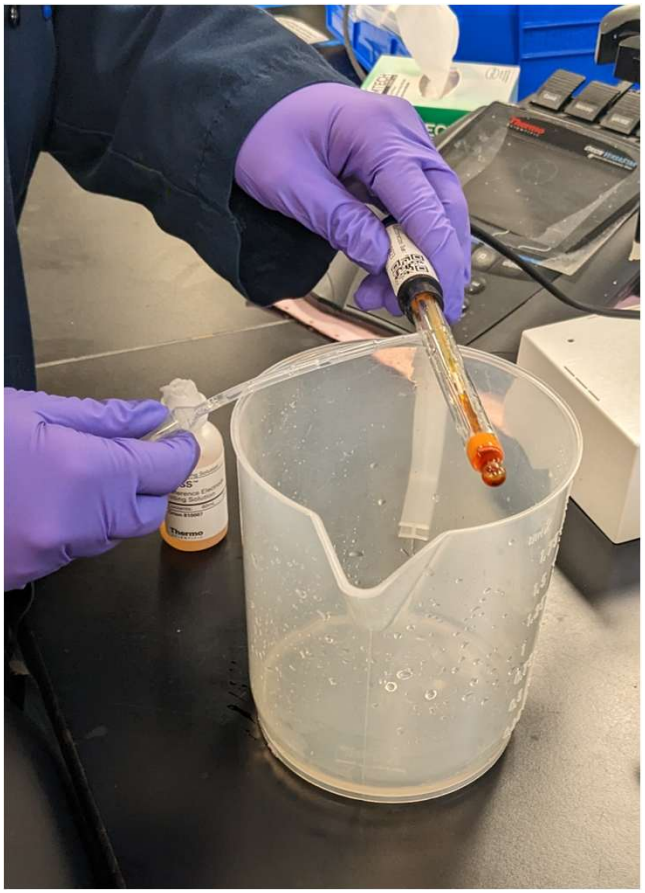
- Verify calibration slope is between 92% - 102%
  - Target 96% - 101% for PT testing
- Confirm calibration using QC
  - Use a purchased QC sample
  - Sodium tetraborate (pH 9.2) may be used as a check standard
  - Verify with a second source pH buffer
  - Use an additional buffer within the calibration range

Probe storage

- Follow the probe manufacturer's instructions
- Do **not** store the probe in DI water
- Do **not** allow the probe to dry out
- Keep the bulb fully immersed in manufacturer-recommended storage solution
- If the probe dries out, rehydrate in storage solution for at least 30 minutes

Probe cleaning

- Between samples
  - Do **not** wipe the probe with a tissue
  - Gently blotting is acceptable
- If crystals are present
  - Empty the probe chamber
  - Do **not** add DI water
  - Rinse with probe solution to condition
  - Refill internal solution to the fill line
- Probe-specific notes
  - Gel-filled probes do **not** have replaceable solution
- Cleaning contamination
  - If slime or buildup is present, soak probe in 0.1M acid for 30 minutes
  - Replace internal solution after soaking (when applicable)



pH probe troubleshooting flow

Start → Check mV at pH 7

Is reading within ± 30 mV of 0?

Yes → Proceed to next check

No → Clean and/or rehydrate probe → Recheck

↓

→ Check mV at pH 4 or pH 10

Has mV changed 160-180 mV from pH 7?

Yes → Probe is performing correctly

No → Clean and/or rehydrate probe → Recheck

↓

→ After cleaning/rehydration

Did performance improve?

Yes → Return probe to service

No → Replace probe

Conclusions

Waters™ | ERA

pH is measuring a H^+ in solution on a log scale

Proficiency testing for pH has tight limits

pH measurements

- Check probe prior to starting
- Temperature matters
- Calibrate

Probe care

- Store properly
- Cleaning may help
- Sometimes new is the way to go

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THANK YOU!