HydroGap

Collo’s standardized measurement unit

Collo Oy
Visiokatu 4, 33720 Tampere
Finland

Executive Summary

Like turbidity sensors measure in NTU and refractometers measure in Brix, Collo Analyzer measures liquids in HydroGap.

HydroGap quantifies electromagnetic distance from pure water, providing a single value that works across all liquid types – clear or opaque, thin or thick, food or chemical – without product-specific calibration. This whitepaper explains the science behind HydroGap and its applications in process automation and quality control.

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1 The liquid fingerprint

Every liquid has a unique electromagnetic signature – its fingerprint. Collo Analyzer captures this fingerprint using Radio Frequency resonator technology, measuring how liquids interact with radio-frequency electromagnetic fields.

The fingerprint comprises of two primary parameters:

Collo Permittivity (CP) reflects the liquid's phase composition. It measures how the physical structure – phases, emulsions, dispersions, particle size – interacts with the electromagnetic field. Lower polarity means lower CP.

Collo Ion Viscosity (CIV) measures energy lost in the movement of charge carriers. CIV is sensitive to dissolved chemicals – ions, impurities, and surface charges. Fewer charge carriers means lower CIV.

Together, CP and CIV detect both chemical and physical changes in any liquid. Every product, process, or batch has its own fingerprint.

2 What is HydroGap?

HydroGap is a single index calculated from the liquid fingerprint. It quantifies how far a liquid is from pure water—whether because of dissolved substances or dispersed phases.

Pure water is the reference point — HydroGap 0. Any dissolved or dispersed substance shifts the liquid's CP and CIV values, moving it away from water's electromagnetic signature. The further from water, the higher the HydroGap value.

Collo Analyzer measures CP and CIV in real-time through its inline radio frequency (RF) sensor and calculates HydroGap continuously, with sub-second update rates.

HydroGap	Category	Examples
0	Pure water	Reference point
0–50	Rinse water	Post-CIP rinse, dilute salt solutions
500-1100	Typical product range	Milk (~920), cream (~980), orange juice (~640) at 20°C
1100-1800	CIP chemicals	Caustic solutions typically seen in processes, depending on concentration (~1100–1800)

3 Applications

HydroGap enables simple threshold-based automation. Rather than programming complex multi-parameter logic, operators set single-value thresholds: "switch valve when HydroGap < 50."

3.1 Changeover (pushout) optimization

HydroGap can be used to optimize product pushout during changeovers. It clearly distinguishes between product and water phases, making transition points easy to detect. By setting a threshold between product (high HydroGap) and water (HydroGap ~0), valve switching can be automated at the optimal transition point. This helps maximize product recovery while minimizing losses to drain and avoiding unnecessary dilution.

3.2 CIP verification

HydroGap can be used to monitor rinse performance. It enables evaluation of whether the rinse volume reaches the water baseline (HydroGap 0) or if impurities remain in the water. This makes it possible to identify cleaning targets where rinse performance may be insufficient. Unlike conductivity, which only detects ionic residues, HydroGap responds to both ionic and non-ionic substances—providing a more comprehensive indication of rinse quality.

3.3 Concentration monitoring

Dilution processes can be monitored by tracking HydroGap as it decreases from the concentrate value toward water. However, the relationship between HydroGap and concentration can be non-linear for some liquids. For accurate concentration determination, it is recommended to model the liquid-specific concentration behavior using Collo’s full liquid fingerprint rather than relying on HydroGap alone.

3.4 Quality Control

Each product can have a defined HydroGap range, and values outside this range may indicate a deviation from specification. This approach of quality control is suitable for simple use cases. For more reliable quality assessment, it is typically preferable to use Collo’s full liquid fingerprint, as HydroGap alone simplifies the signal and may not reveal the root cause of deviations.

4 HydroGap vs. Traditional Sensors

Technology	Limitation	HydroGap
Conductivity	Ionic substances only	Responds to non-ionic substances and dispersed phases
Turbidity	Fails in opaque liquids	RF-based; works in any liquid
Refractometry	Optical windows foul	No optical surfaces to clean
Density	Lower sensitivity to composition	Distinguishes compositions at identical density
Multiple sensors	Complex integration, multiple calibrations	Single measurement, no product-specific calibration

5 Conclusion

HydroGap brings to electromagnetic liquid measurement what NTU brought to turbidity and Brix to refractometry: a standardised unit that simplifies automation, enables comparison across products, and eliminates per-product calibration.