Providing favorable conditions for inline monitoring of Ceria slurry quality in Slurry Delivery Systems

European CMP Users Group meeting 2022-11-11 Amsterdam

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Public reports on colloidal silica slurry dilution and blending adopting inline refractive index measurement technology

micromachines

MDPI

Article

Characterization of CMP Slurries Using Densitometry and Refractive Index Measurements

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Received: 2 October 2018; Accepted: 22 October 2018; Published: 24 October 2018

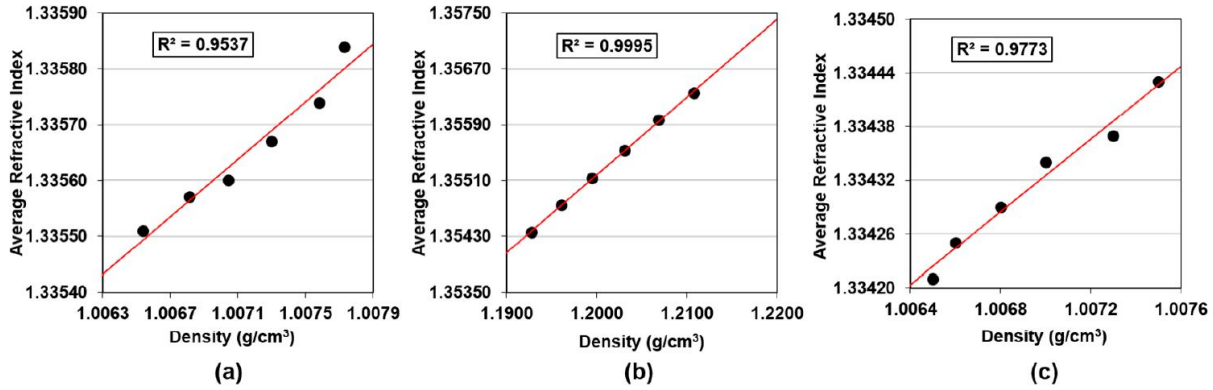
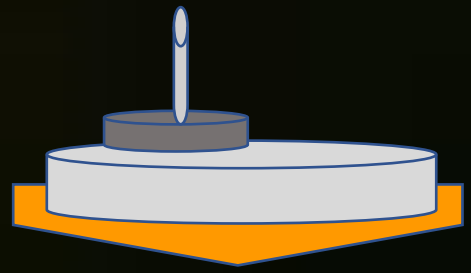


Figure 5. Correlation between density and average refractive index for (**a**) Fujimi PL-7106; (**b**) Klebosol 1501-50; and (**c**) CMC W7801.

Table 2. Calculation of the approximate minimum detectable change in UPW concentration.

Slurry	Fujimi PL-7106		Klebosol 1501-50		CMC W7801	
Instrument	Densitometry	Refractive Index	Densitometry	Refractive Index	Densitometry	Refractive Index
Slope ($\frac{1}{\%\ UPW}$)	$1.33 \times 10^{-4}\ \frac{g}{cm^3}$	3.52×10^{-5}	$1.98 \times 10^{-3}\ \frac{g}{cm^3}$	2.21×10^{-4}	$1.15 \times 10^{-4}\ \frac{g}{cm^3}$	2.37×10^{-5}
Approximate LOD (% UPW)	0.752	0.284	0.050	0.045	0.870	0.422

Typical elements in a Slurry Delivery System



Polisher

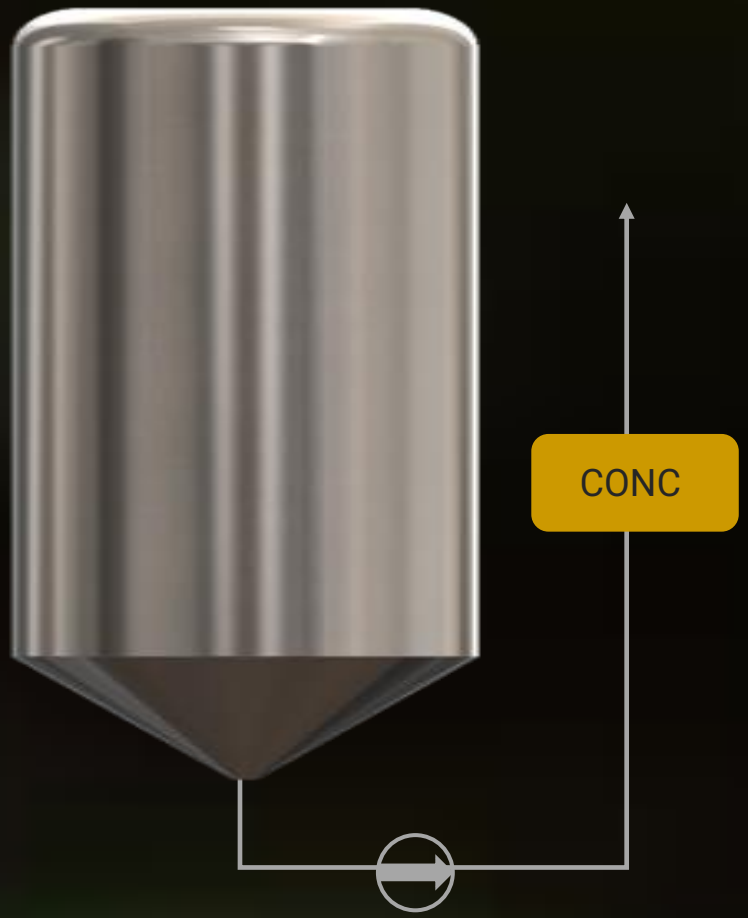
Concentration monitor (refractive index)

UPW/Additive/H2O2 depending on application

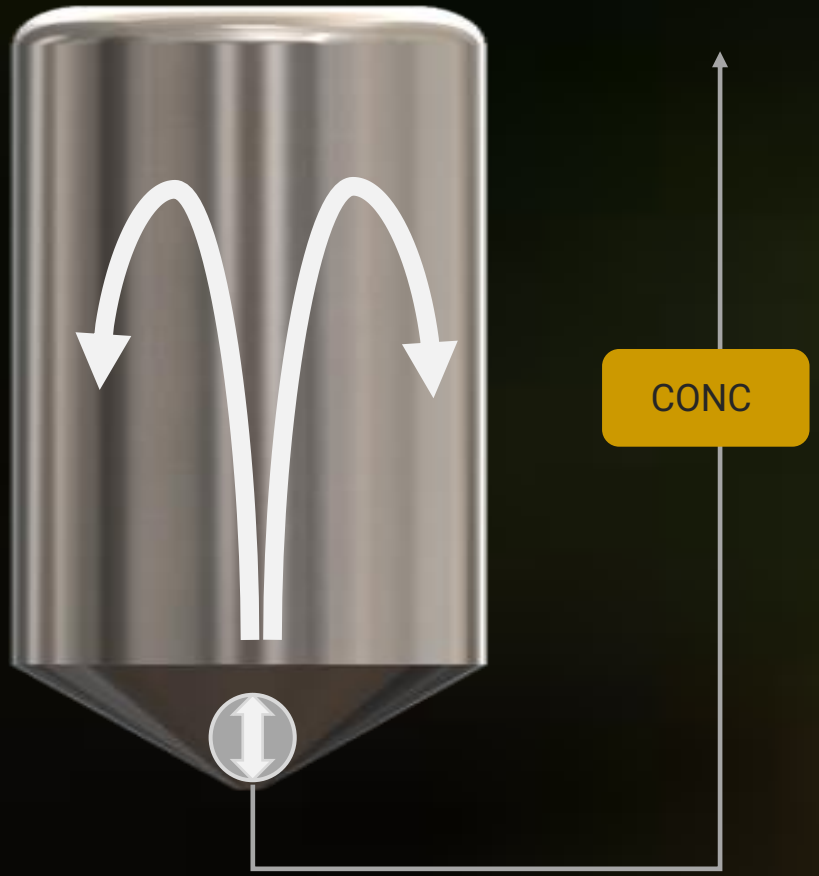
Slurry

Ensure well dispersed Ceria slurry

Problem



Solution



Design rules

Our recommended design rules to ensure uniform Ceria slurry quality:

1. Ensure sufficient mixing and flowrate in all tanks and lines where Ceria slurry is present.
2. Pump tank mixer and conical shape tank combination has been proven to work.
3. Inner surface of tank should be as smooth as possible.
4. Ensure balanced slurry flowrate at every branch of the slurry delivery loop.
5. Minimize number of valves with correct flow calculations or simulations to avoid slurry agglomeration in slurry loops.
6. Good premixing of drum with suppliers recommended mixer.

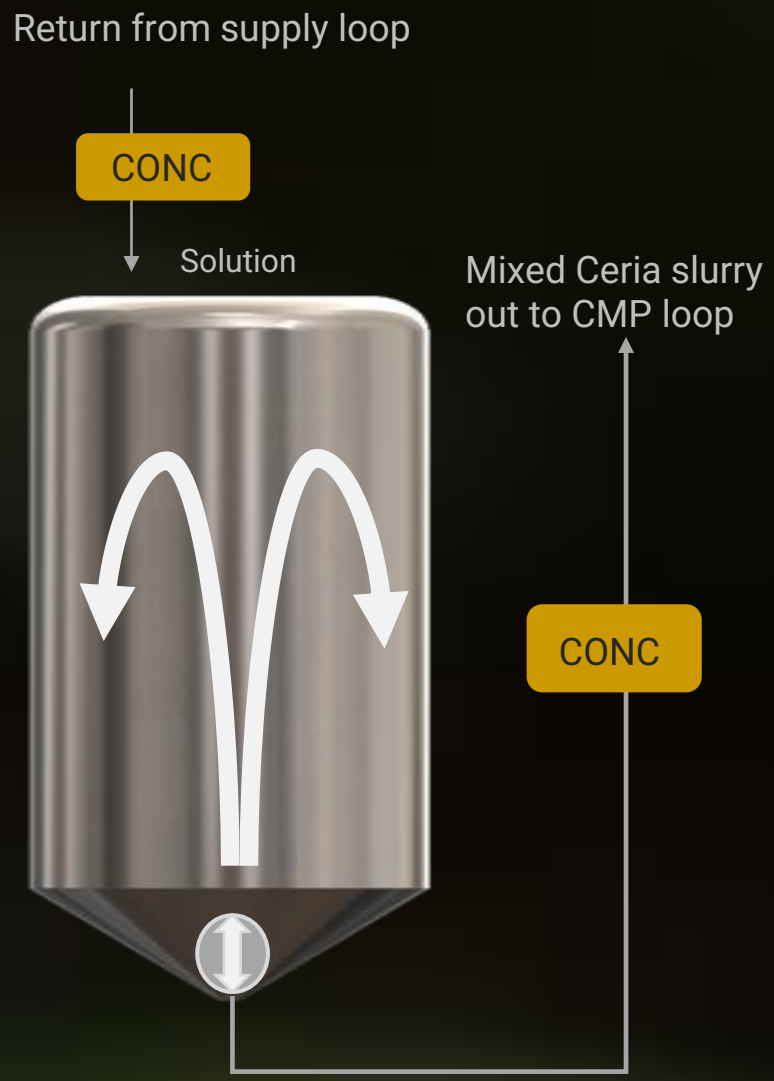
Design rules

- Before upgrading our slurry system with above mentioned design rules the inline refractometer slurry concentration measurement was not stable.
- We also experienced variation in polishing removal rate. After upgrade work the polishing removal rate variation has decreased.

- We have also achieved cost savings in ceria slurry consumption by changing the design of drum station. We prefer to first premix the slurry drum and then transfer it with barrel pump to fixed conical shaped delivery tank.
- In fixed slurry delivery tank, we use a pump tank mixer to mix and deliver slurry. This way we can utilize full volume of transferred slurry to the delivery tank where it also remains well dispersed.

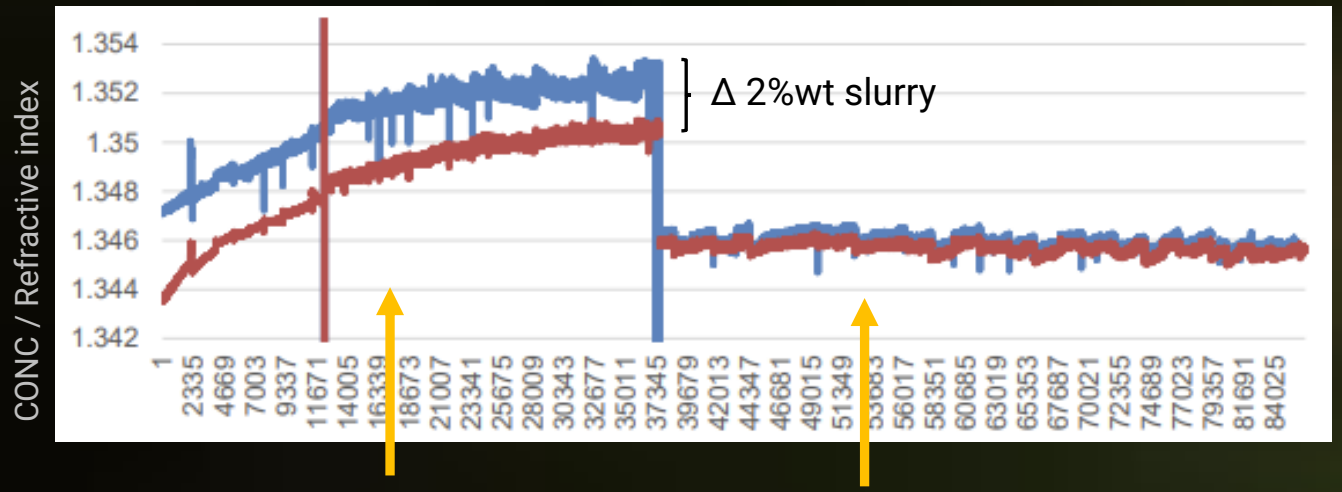
- Annual slurry cost savings from these improvements is estimated to 5-10%.

Before and after



Ceria slurry out to CMP loop

Ceria return from supply loop

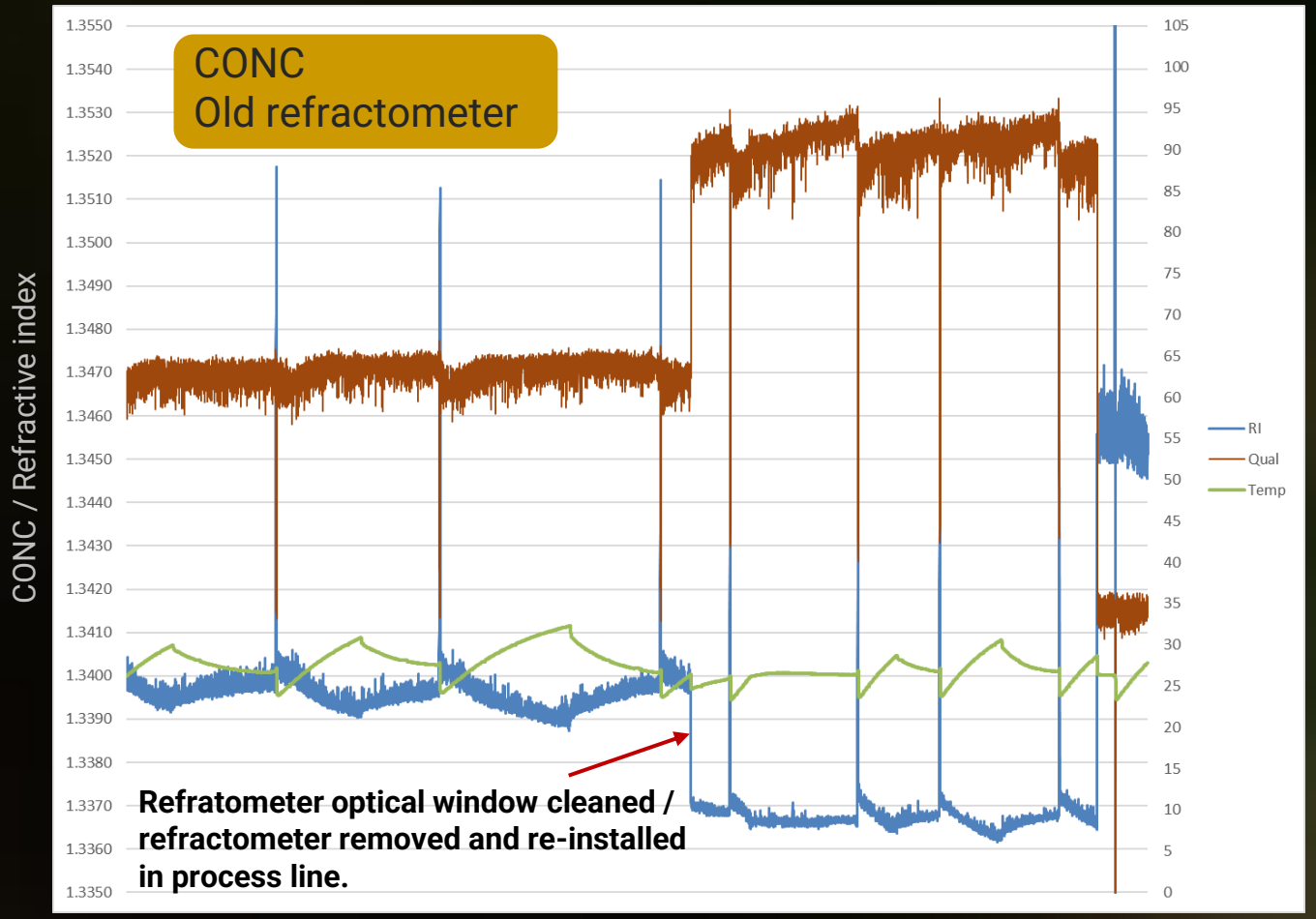


Previous system
without pump-tank-mixer

New conical tank system
with pump-tank-mixer

Further obstacles

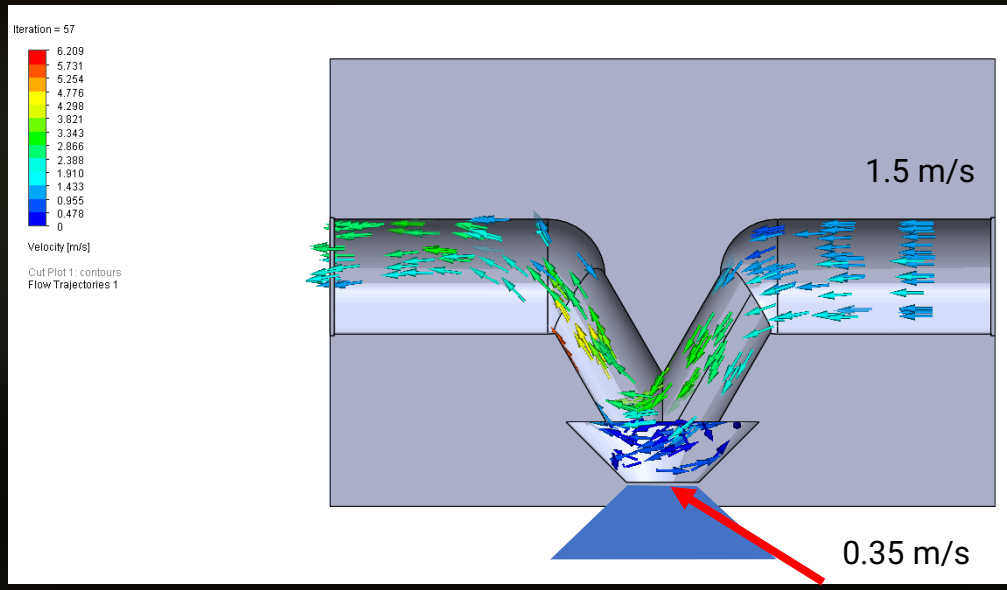
- Start-up of inline refractometer with old design of sensor internal flow path.
- Output signal from concentration monitor not repeatable.
- Significant RI level changes after removing and reinstalling old refractometer in process line.



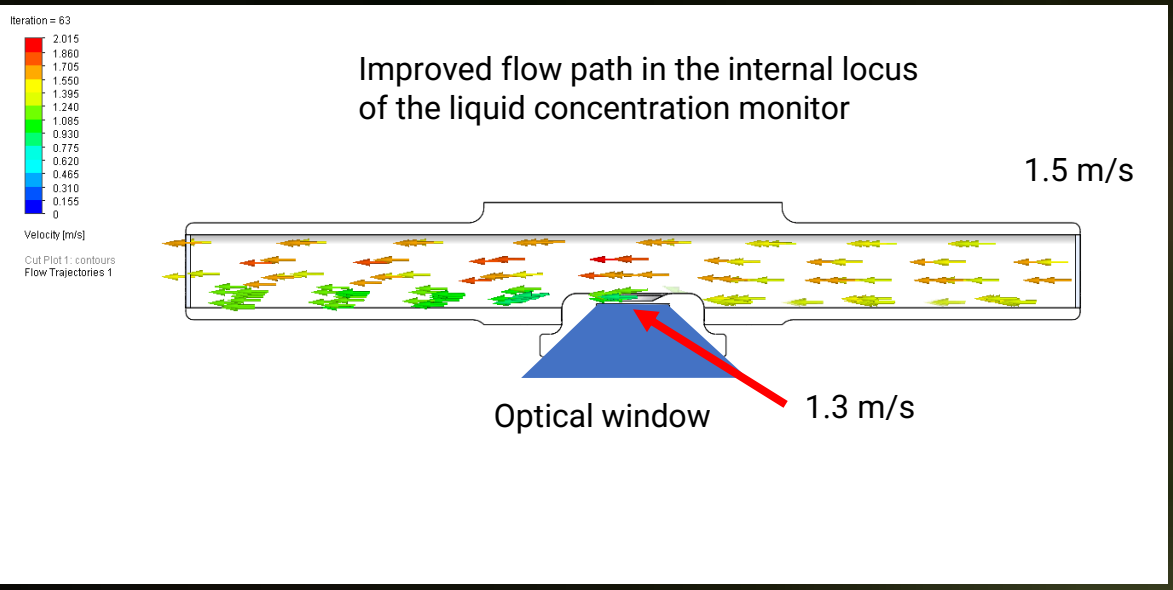
Time: 7 days

From innovation to solution in 2021

Old refractometer



New refractometer



Normal Operation

CMP-Slurry Concentration

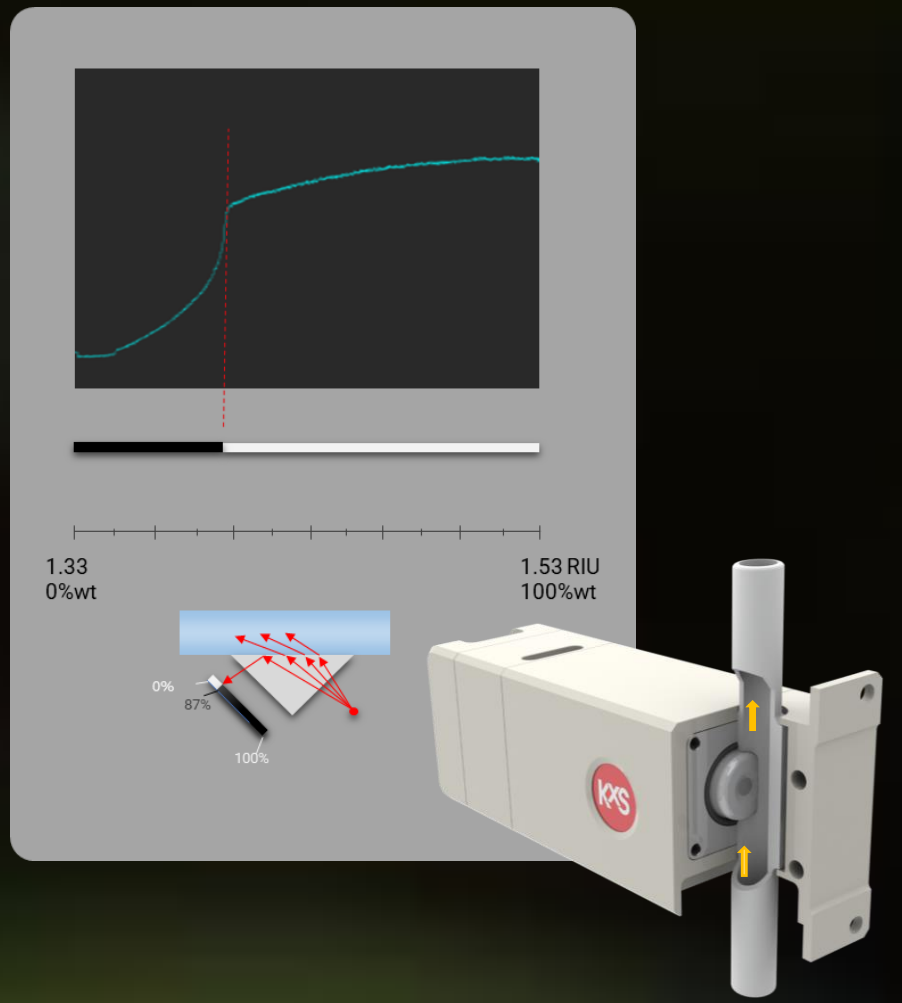
1.02% H2O2

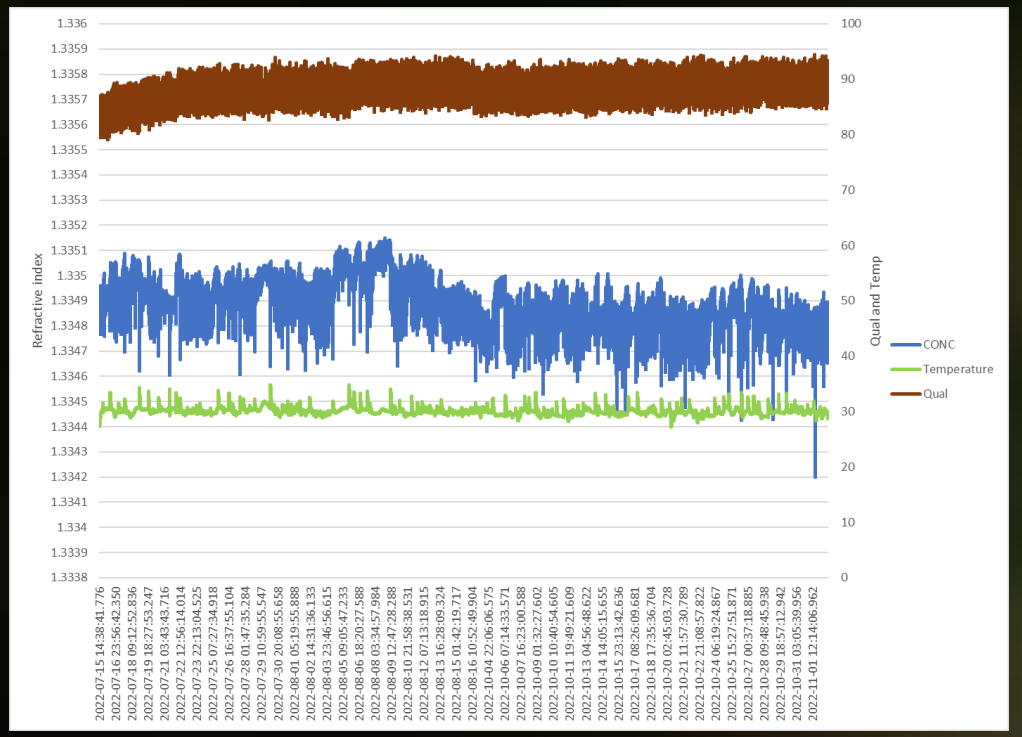
CMP-Slurry Temperature

26.12°C

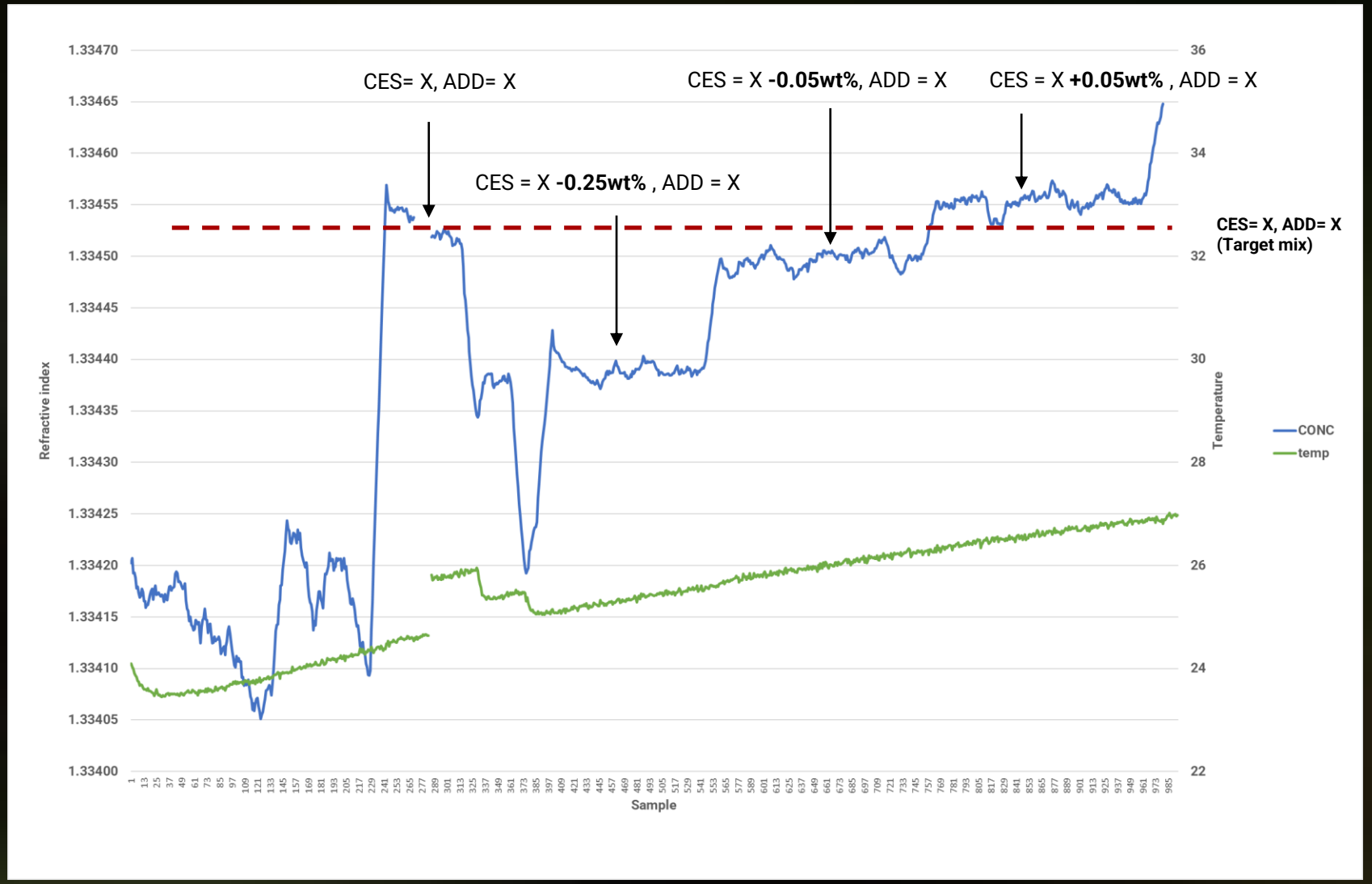
The Next generation Inline Concentration Monitor

Improved liquid flow path and optical image detection algorithm yields a stable refractive index measurement quality

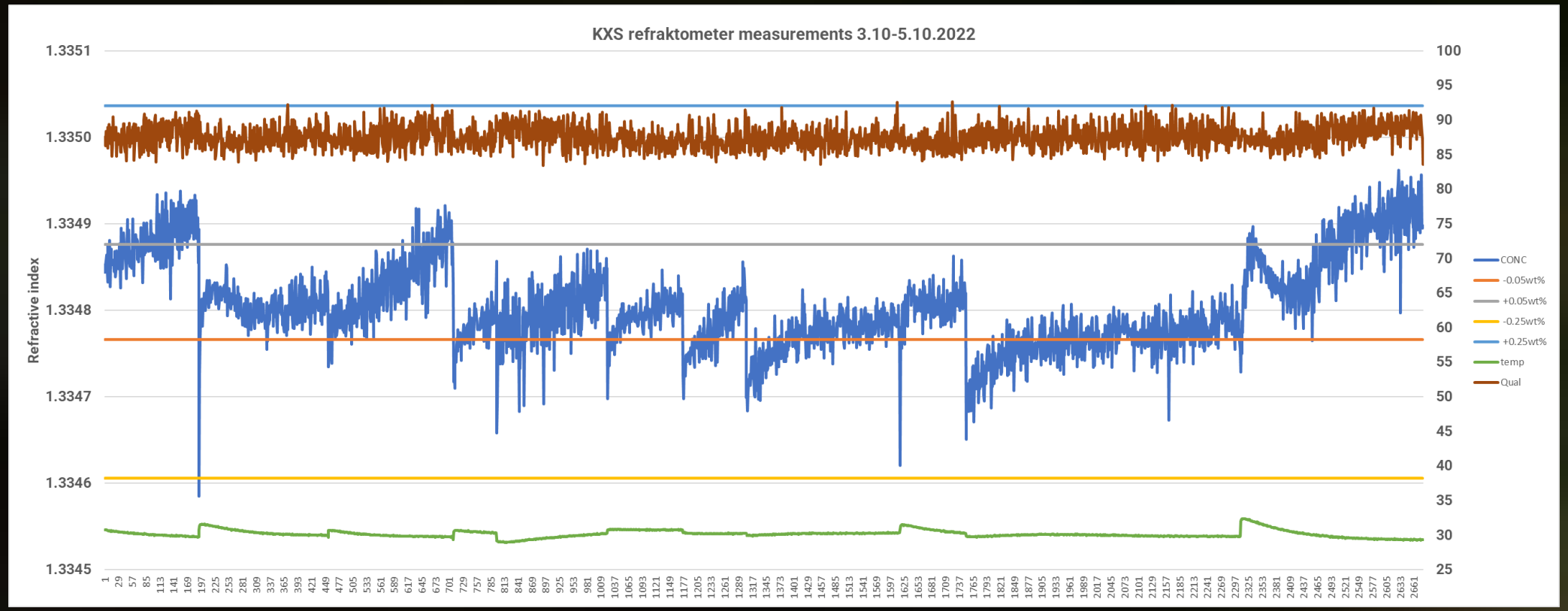




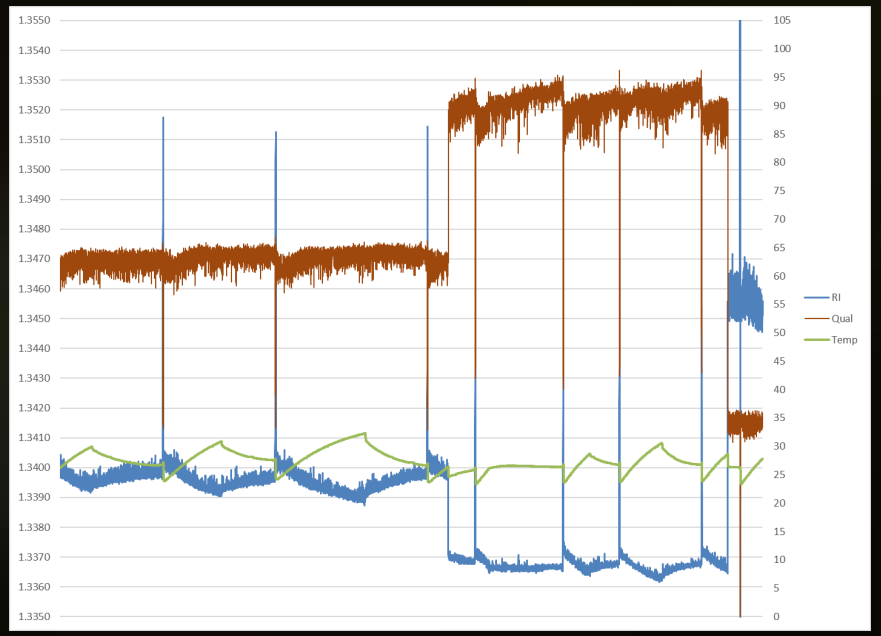
Smallest detectable change



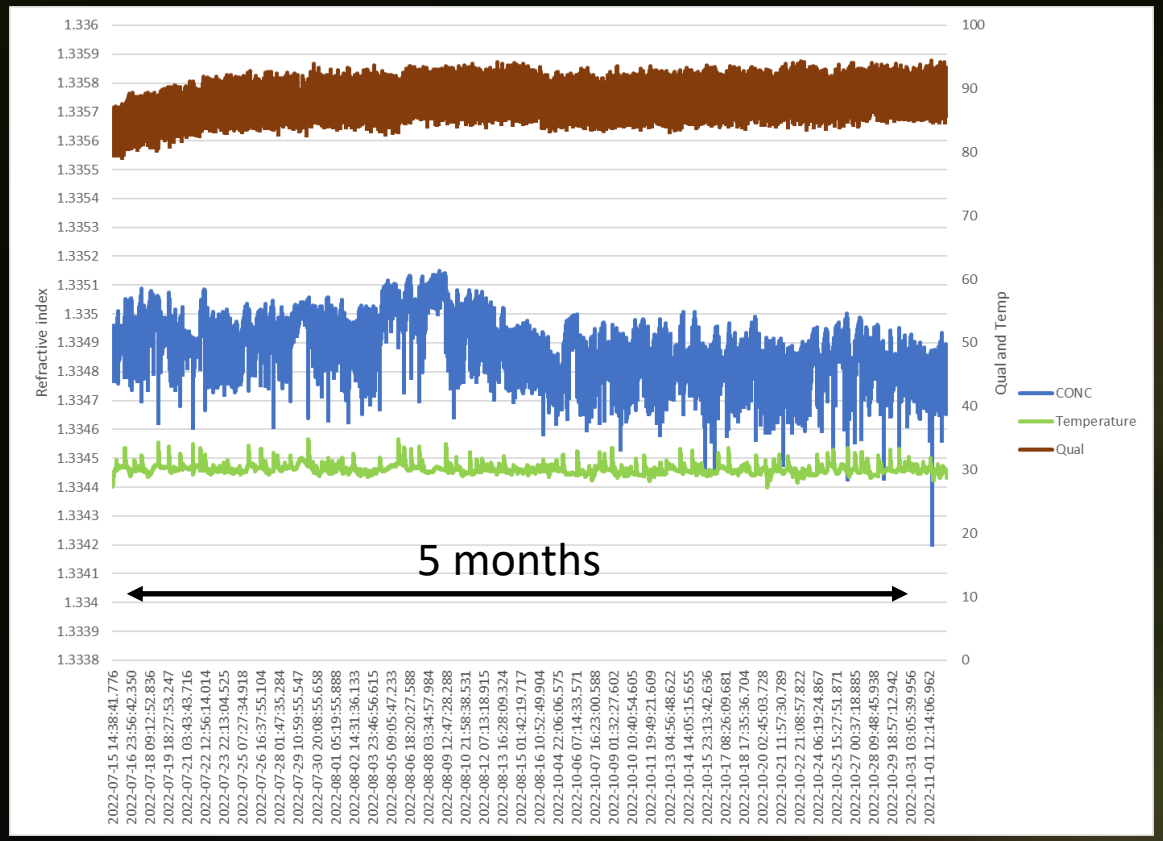
Zoom of consecutive batches



New concentration monitor in service for five (5) months



Old refractometer:
Measurement not repeatable



New refractometer with improved liquid flow path:
Data representing 5 months - Nov 2, 2022

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