ChemTreat, Inc.

Investigation of Real Time Sugar Detection in Boiler and Cooling Water

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ChemTreat, Inc.

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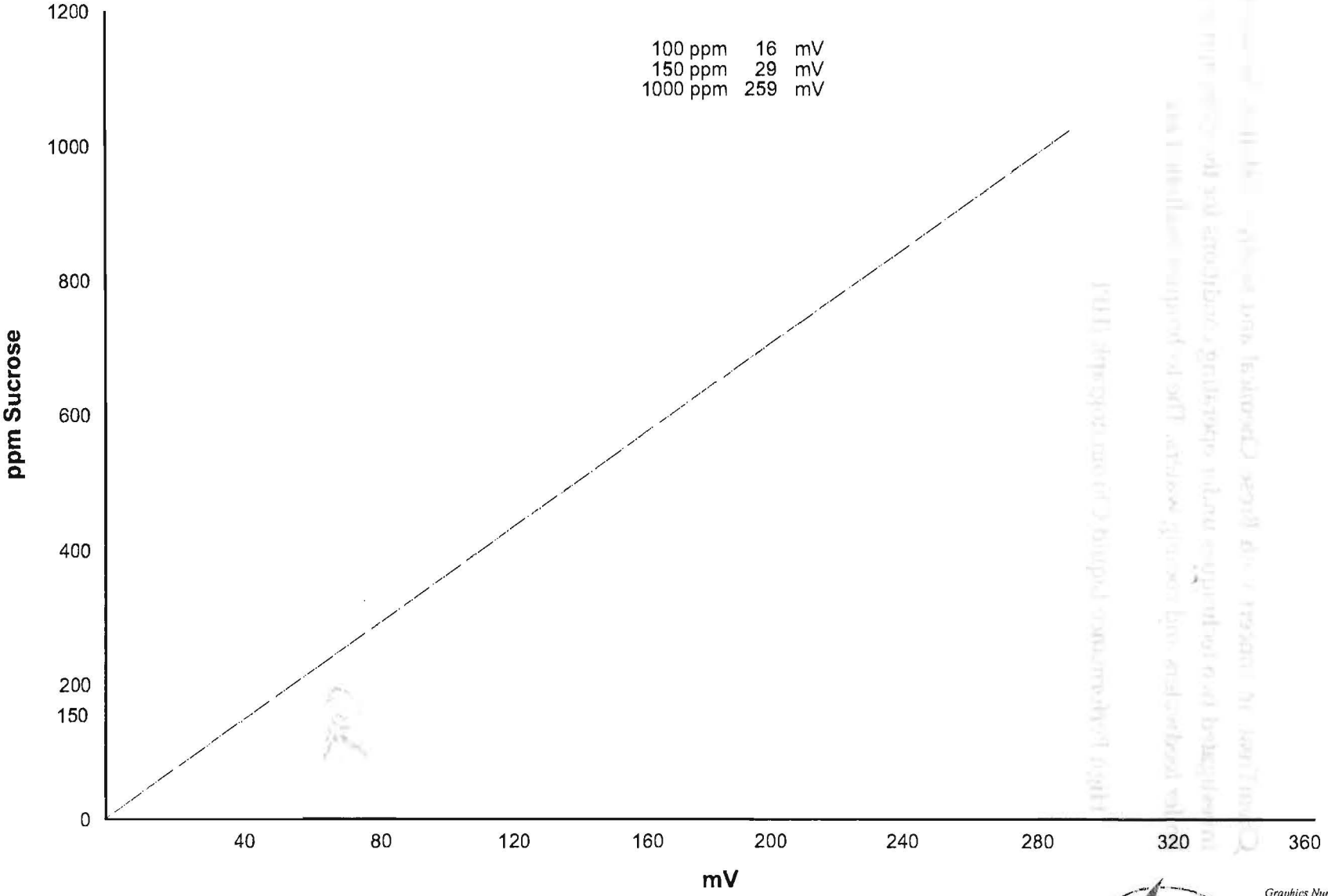
Section I. Introduction

ChemTreat, in concert with Brose Chemical and several customer factory sites, we investigated two techniques under operating conditions for the detection of sugar in boiler feedwaters and cooling waters. The techniques evaluated are:

- High Performance Liquid Chromatograph (HPLC)
- Refraction Index

HPLC mV



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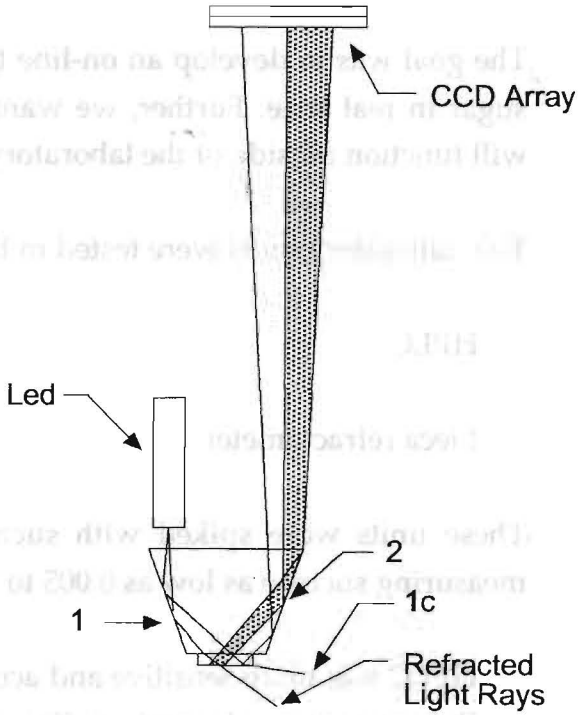
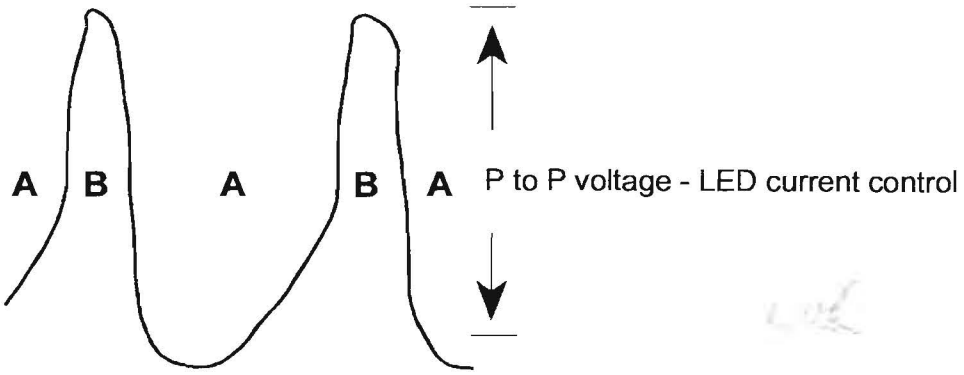
Optics

Light radiated from the LED passes through the prism surface to be reflected off mirror 1 to the prism-to-process interface. The light reaching this interface intersects the same interface over a series of angles chosen to include critical angle for the process being measured. Light intersecting the interface at an angle greater than critical angle is refracted into the solution. Light intersecting the interface at less than critical angle is reflected up to mirror 2 and out of the prism up to the CCD linear array to be scanned.





A to B = reflected to refracted light.

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Section II. Evaluation Process

The goal was to develop an on-line technique to effectively identify the presence of sugar in real time. Further, we wanted to adapt the technique into a package that will function outside of the laboratory in a factory environment.

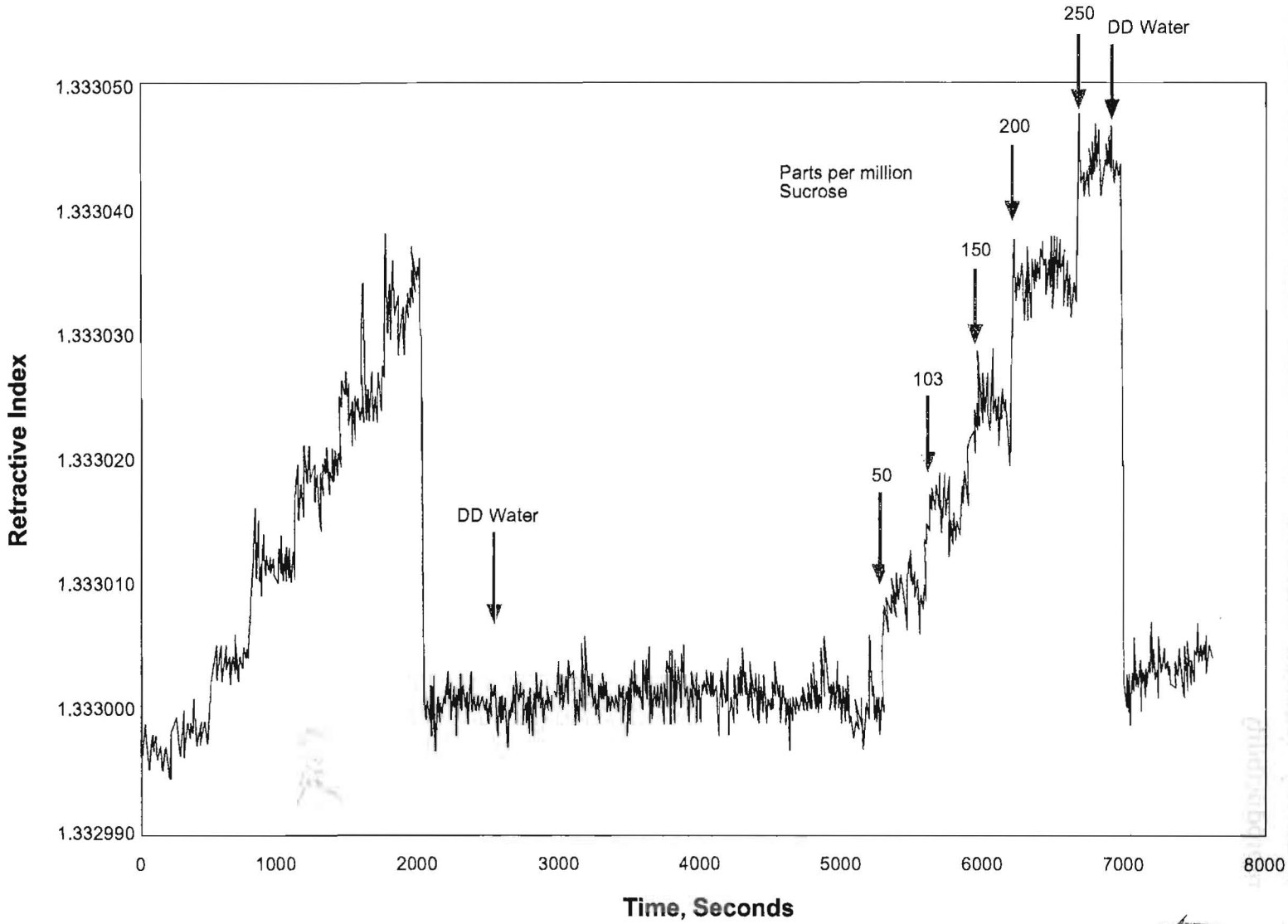
Two laboratory units were tested in the lab:

- HPLC
- Lieca refractometer

These units were spiked with sucrose solutions to assure they were capable of measuring sucrose as low as 0.005 to 0.20 Brix. The results were as follow:

- HPLC was more sensitive and accurate under ideal conditions.
- Refractometer showed sufficient sensitivity under laboratory conditions. Enclosed is a refractometer test graph.

R600 Response to ppm Sucrose



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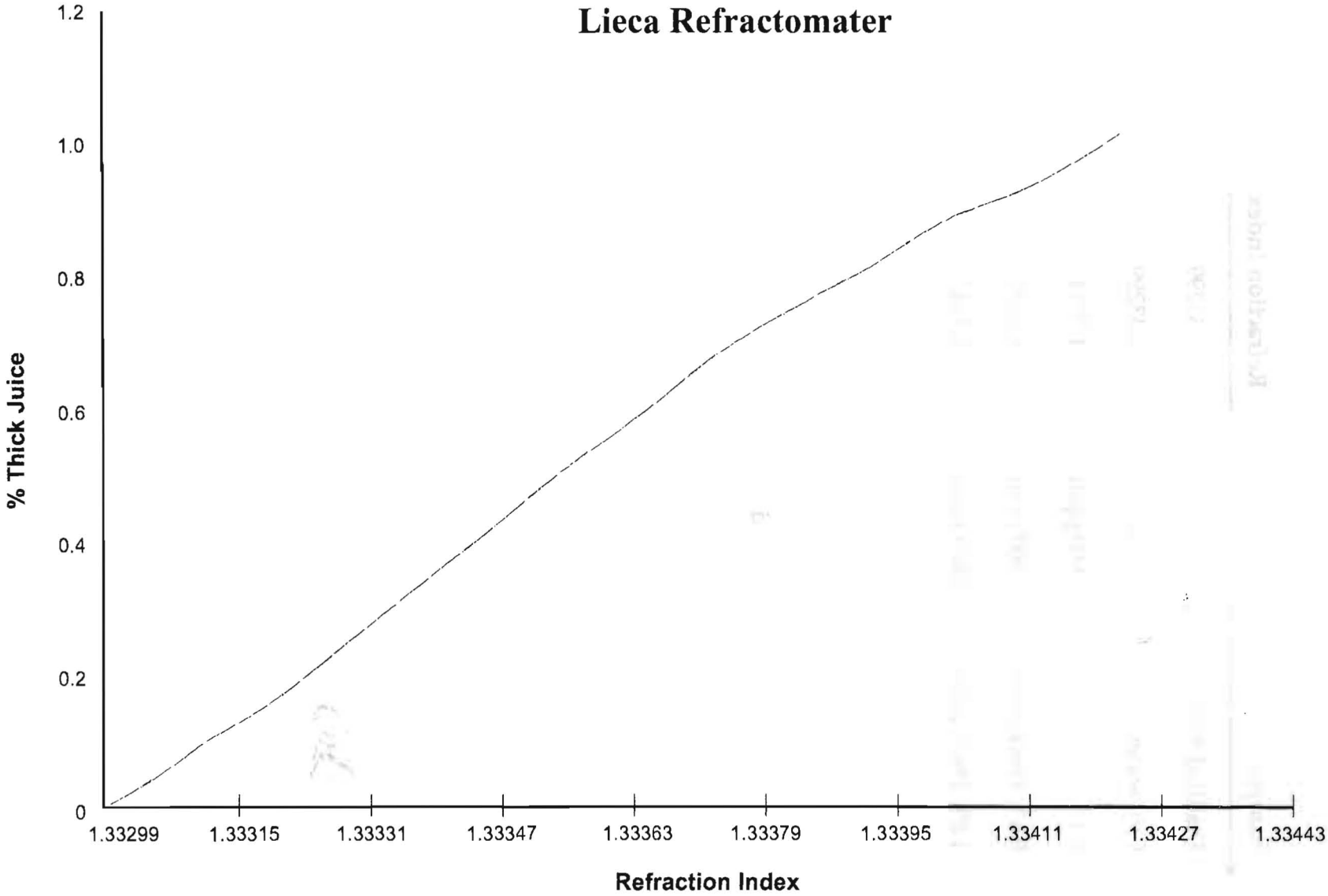
Beet Factory First Field Installation Data

Sample	Approximate Sugar	Refraction Index	Δ
Distilled #20	0%	1.33299	
City water	0%	1.33299	
0.1%	600 ppm	1.33313	
0.5% Thick juice	3,000 ppm	1.33355	
1.0% Thick juice	6,000 ppm	1.33423	

Assumption: Thick juice is 60–65 percent Brix.

It is noted that city and distilled water exhibited same 0 point.

First Field Calibration
Lieca Refractomater



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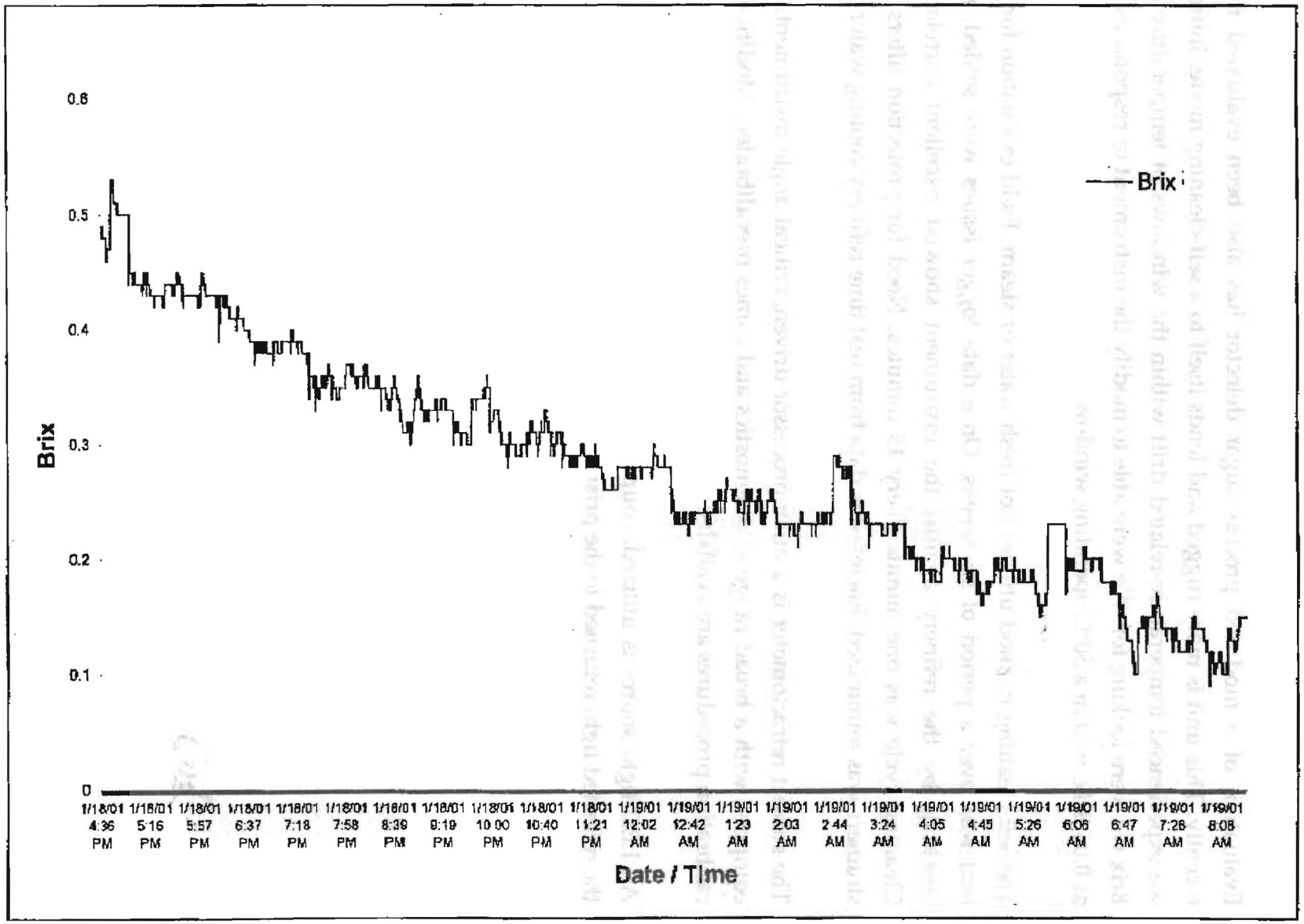
Evaluation of a modified process sugar detector has also been evaluated more recently. This unit is more rugged and lends itself to a self-cleaning mode. Initially, we experienced temperature-related drift within the windows of temperature and Brix we were looking for. We were able to modify the instrument to respond as low as 0.05 Brix, within a 50°C operating window.

The self-cleaning method utilizes hot fresh water or steam. Field evaluation for this unit was over a period of six weeks. Once data logger issues were settled, spot checking by the refinery against the instrument showed excellent correlation. Cleaning cycle was one minute every 15 minutes. Need for protection filters and strainers was minimized. Enclosed is data from real time refinery cooling water.

The subject refractometer is a microprocessor driven, critical angle instrument. It is equipped with a broad range of diagnostics and comes precalibrated. Modification calibration procedures are available.

An LED light source is utilized, coupled with charge couple device (CCD) to scan the reflected light returned to the prism.


0.6
0.5
0.4
0.3
0.2
0.1
0
Brix
Brix
1/18/01 4:36 PM
1/18/01 5:16 PM
1/18/01 5:57 PM
1/18/01 6:37 PM
1/18/01 7:18 PM
1/18/01 7:58 PM
1/18/01 8:39 PM
1/18/01 9:19 PM
1/18/01 10:00 PM
1/18/01 10:40 PM
1/18/01 11:21 PM
1/19/01 12:02 AM
1/19/01 12:42 AM
1/19/01 1:23 AM
1/19/01 2:03 AM
1/19/01 2:44 AM
1/19/01 3:24 AM
1/19/01 4:05 AM
1/19/01 4:45 AM
1/19/01 5:26 AM
1/19/01 6:06 AM
1/19/01 6:47 AM
1/19/01 7:28 AM
1/19/01 8:08 AM
Date / Time

Section III. Conclusion

Refractometer technology can be successfully utilized in measuring sugar contamination in condensates (drips), boiler feedwaters, and cooling waters in real time. The biggest restraint is time lapse of passing the sample through the instrument. In the case of the later unit discussed, installation directly into the water line is possible.

Sensitivity can be observed as low as 0.05 Brix in-field applications with qualitative number. However, quantitative data is a reliable approach as low as 0.10 Brix.