# Non-sugars Driven, Automated Milk of Lime Flow Control

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# MOL Production at Nampa, ID

- **Milk of Lime Ca(OH)$_2$ abbreviated MOL**

- **2 anthracite fired Belgian style kilns**
  - Installed 1942 and 1965
- **Nominally 350 tons/day total limestone throughput**

- **Supports beet end slicing 12,000 tons/day**

# The "Old" Way to Dose MOL

- **Flow meters on MOL lines to Pre, Cold, and Hot Limers**
  - Beet end foreman sets flow rates based on measured alkalinities
- **Simple automation would scale flow rates based on raw juice flow**
  - Most operators bypassed automation and set flow rates manually
  - Led to dramatic swings in liming

# Systemic Overliming

- **MOL was a security blanket for operators**
  - Limit the possibility of cloudy dorr clarifier
  - Excess filter aid to help 1$^{st}$ carb filtration
- **Difficulty with juice hardness**
  - Juice softeners taxed
  - High soda ash usage
- **Lime kilns maxed out**
  - Poorly burned rock – poor slaking, crusher problems
  - clinker formation
- **How much MOL does the process really need?**

# Quantifying Necessary MOL

- **Non-Sugars Based Approach**
  - Ratio flow of CaO to flow of non-sugars coming in with the juice

$$\frac{Mass\ Flow\ CaO}{Mass\ Flow\ NS} = 100\%\text{CaO/NS}$$

  - Industry targets 100% CaO/NS for an optimized purification system
  - Back calculating previous campaigns at Nampa revealed 150% CaO/NS

Van der Poel, P. W. *Sugar Technology;* Bartens, **1998**, pg 494.

# CaO/NS Calculation

$$\frac{(MOL\ gpm)(8.34\ lb/gal)(MOL\ SG)(MOL\ RDS - sweetwater\ RDS)(56.07/74.093)}{(RJgpm)(8.34\ lb/gal)(RJ\ SG)(RJ\ RDS)\left(1 - \frac{RJ\ AP}{100}\right)} = \%CaO/NS$$

- **Hardware Required**
    - Flow meters on MOL dosing points and Raw Juice
    - Density/brix meter on MOL
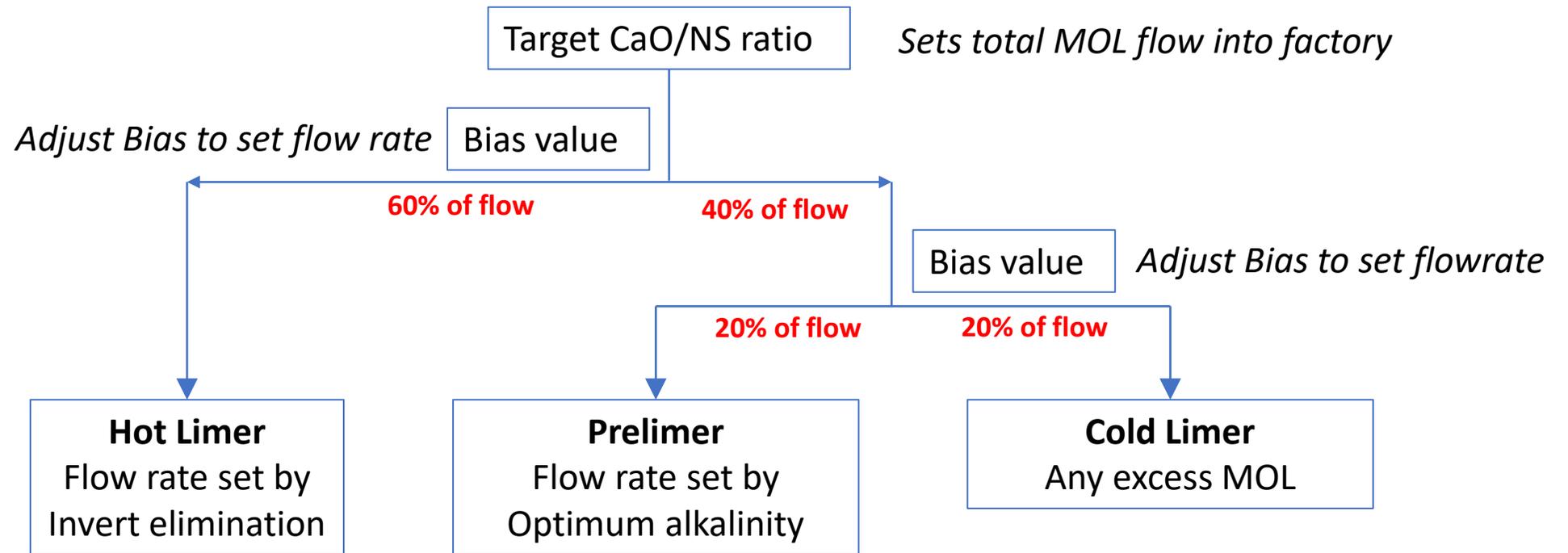    - Density/Brix meter on sweetwater
    - Density/Brix on Raw Juice

- **Raw Juice AP is a lab value**
    - Must be fed into automation every hour

# Automation Strategy

- **Divide MOL dosing to 3 users**
- **Occasionally adjust biases to respond to lab data**



| | Target CaO/NS ratio | *Sets total MOL flow into factory* |

*Adjust Bias to set flow rate* | Bias value |

**60% of flow** — **40% of flow**

Bias value | *Adjust Bias to set flowrate*

**20% of flow** — **20% of flow**

| **Hot Limer** | **Prelimer** | **Cold Limer** |
| Flow rate set by Invert elimination | Flow rate set by Optimum alkalinity | Any excess MOL |

# Robust Lab Analysis

- **Raw Juice**
  - RDS, Purity
- **Prelimer**
  - Optimum Alkalinity
    - Usually 0.085-0.120 %CaO/100RDS
    - Measured Weekly
- **Invert elimination**
  - Raw juice invert
  - Thin juice invert

- **Prelimer Optimum Alkalinity**
  - Raw juice serial titration with MOL
  - UV/Vis absorbance of supernatant
    - Unfiltered minus Filtered
  - Lowest Δabsorbance is optimum
  - Measure alkalinity

# Does this all work?

- **Yes it does**

- **MOL dynamically ramps up or down to respond to beet quality and quantity**
  - No longer Over/Under liming due to operator mismanagement
  - Fewer cloudy dorr events
- **Reduced Limestone sent to process**
  - Averaging 83.9% CaO/NS this campaign
    - 2.4 % on Beet
  - No longer bottlenecked by kiln throughput
  - Not constantly fighting clinkers
  - Improved quality of burnt lime

Nampa Factory Lime Usage
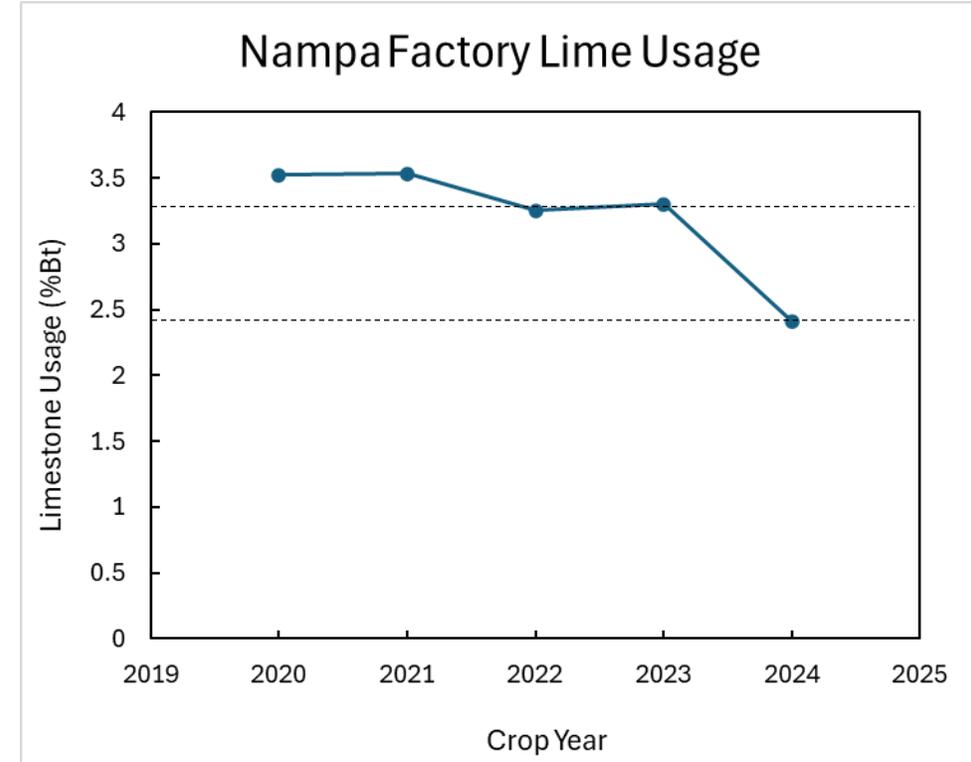
# Future Improvements

- **In line raw juice AP measurement via NIR or other**
    - Eliminates the hourly lab input
    - Constantly up to date purity
    - We are currently vulnerable to typos and bad samples
        - Guard rails in automation reject obvious errors

# Time for Questions

**Thank you!**