



Greener SC1 Process For Single Wafer Cleans

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Background

- Standard Clean-1 (SC1), also known as RCA-1 clean and APM (ammonia peroxide mixture), is extensively used as one of the major components of the semiconductor wet cleans processes.
- It is a mixture of ammonium hydroxide and hydrogen peroxide in deionized water. The ratio of the two chemicals may vary for different processes.
- Due to high volume usage of SC1, majority of the waste going down through IWD (industrial waste drain) consists of this alkaline solution.
- Requires pretreatment to an acceptable condition for discharge to the sewers.
- Requires control over the quantities and rates of discharge.



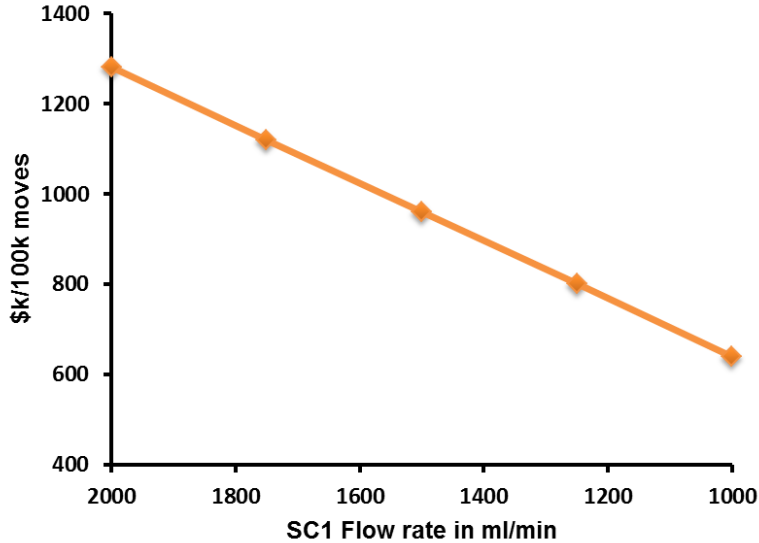
Background

- SC1 flow rate also varies by tool configuration, vendors and finally by process windows.
- Usual flow rates range from 1000 ml/min to 2500 ml/min
- Reduction in the SC1 flow rate helps in multiple ways:
 1. Reduces chemical consumption and associated chemical cost,
 2. Reduces SC1 waste volume and associated cost to neutralize the waste.
- Reduction in the SC1 flow rate risks the wafers in multiple ways as well:
 1. Possible more particles
 2. Lower etch rate
 3. Within wafer uniformity
 4. Finally, lower yield



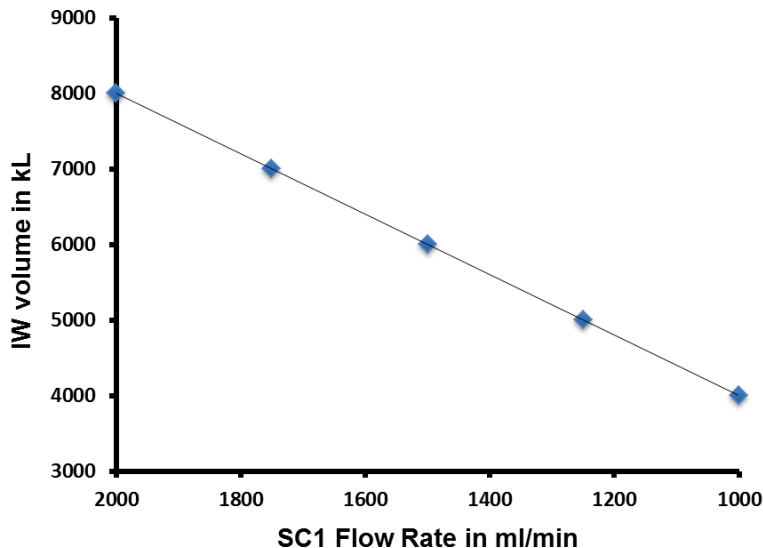
Background

- Considering following assumptions, calculations show that reduction in SC1 flow rate reduces the effective process cost significantly.



Assumptions:

- SC1 ratio 1:1:50 (NH₄OH:H₂O₂:H₂O)
- SC1 Flow time: 1 min
- Total process steps using 1 min SC1 = 40
- Moves @ each of 40 process steps = 100k

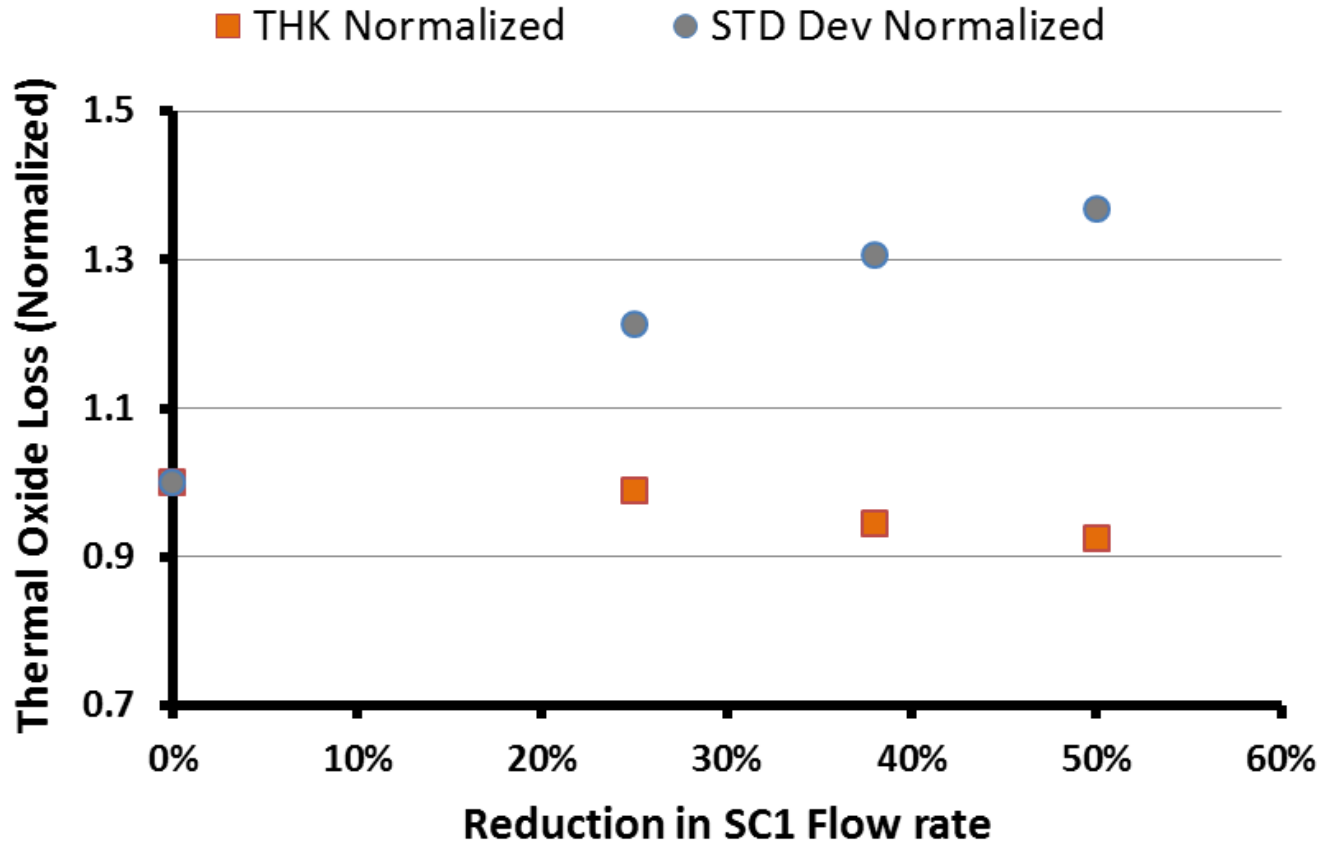


Approach

- Evaluated the effect of SC1 flow rates on etch rate on blanket wafer
- Evaluated the surface particle adders from various SC1 flow rates
- Compared the PRE (particle removal efficiency) on product wafer
- Compared the inline thickness on product
- Compared sort yield between low and high SC1 flow rates



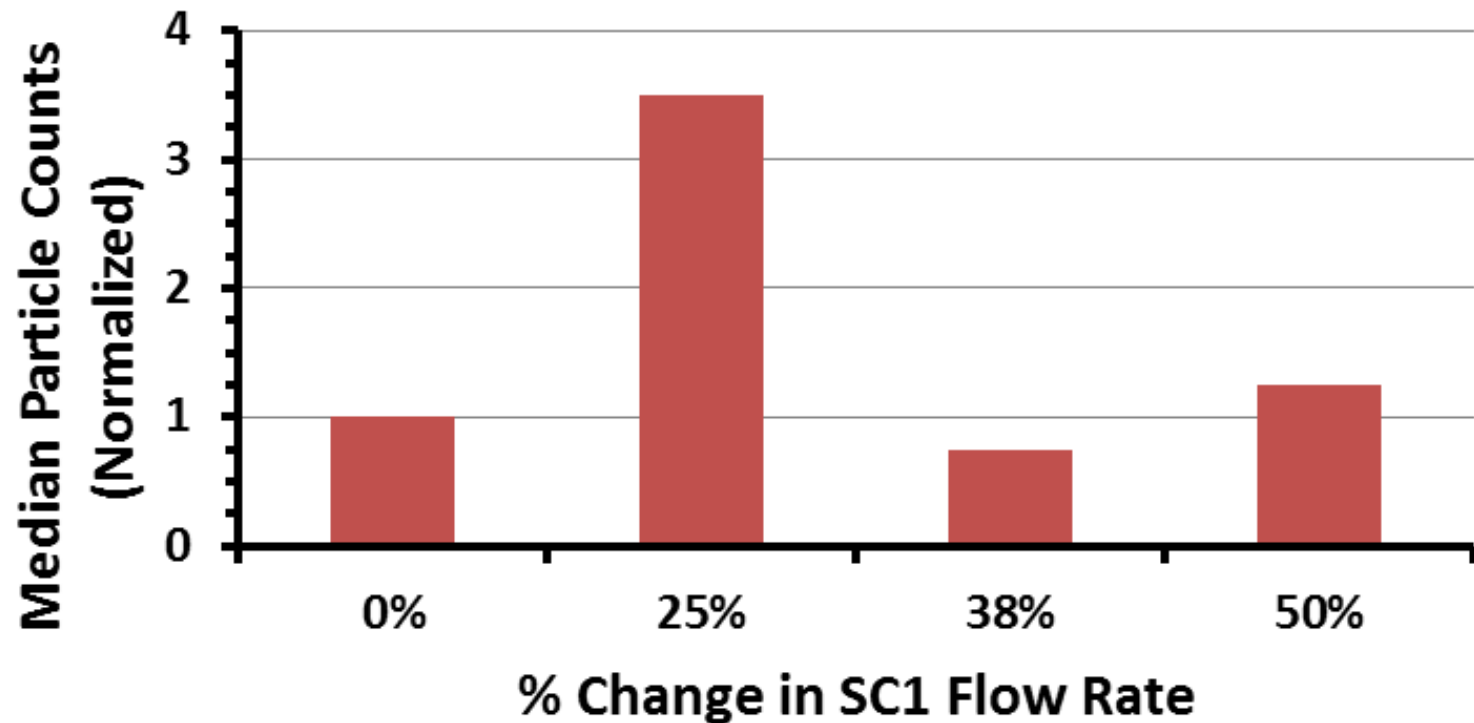
Etch rate on blanket wafer



- A minor difference in thickness etched and sigma were observed among various SC1 flow rates for SC1 only process.

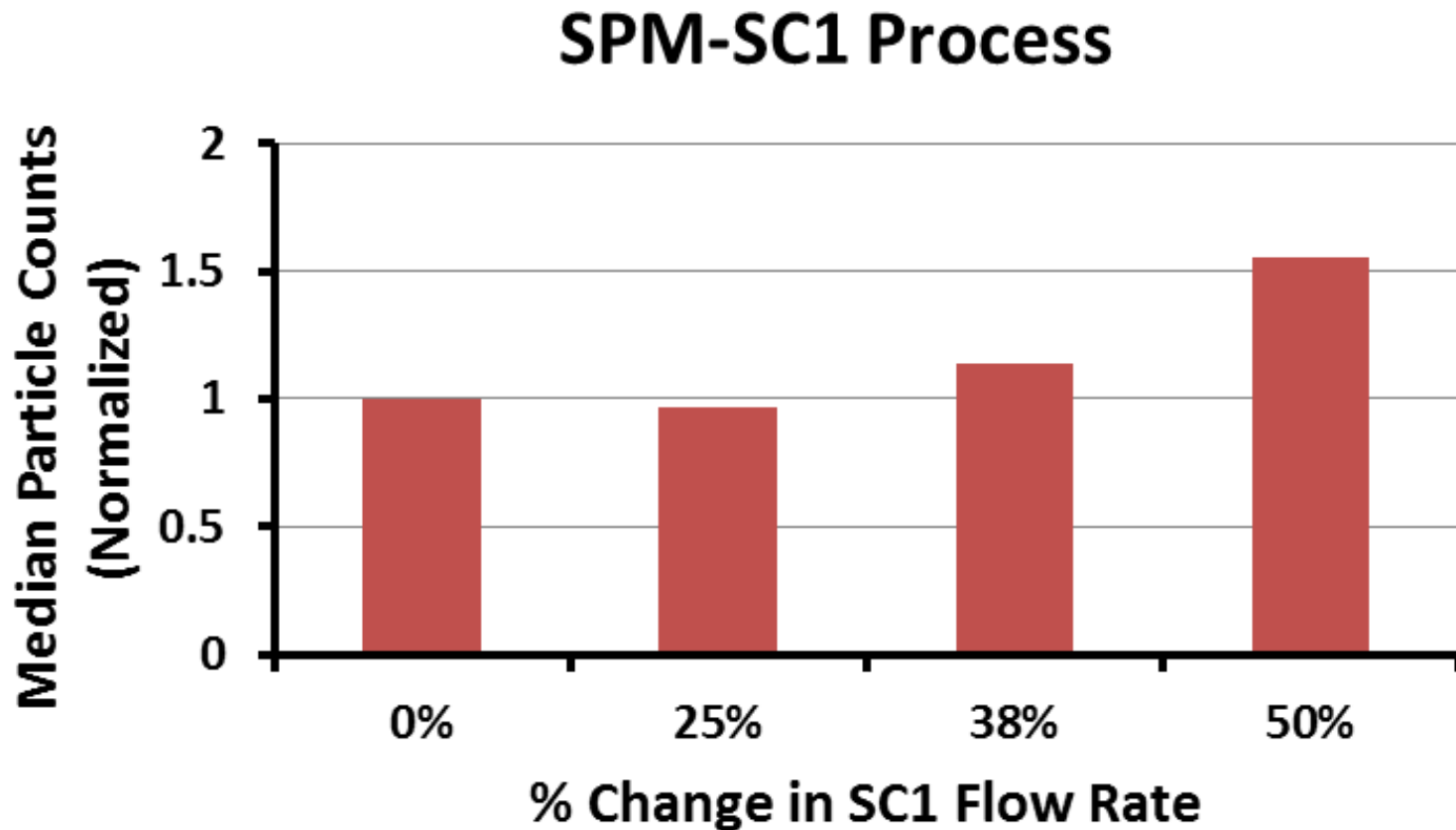
Particle Performance on blanket wafer

SC1 Only Process



- No significant difference in particle performance was observed among various SC1 flow rates for SC1 only process.

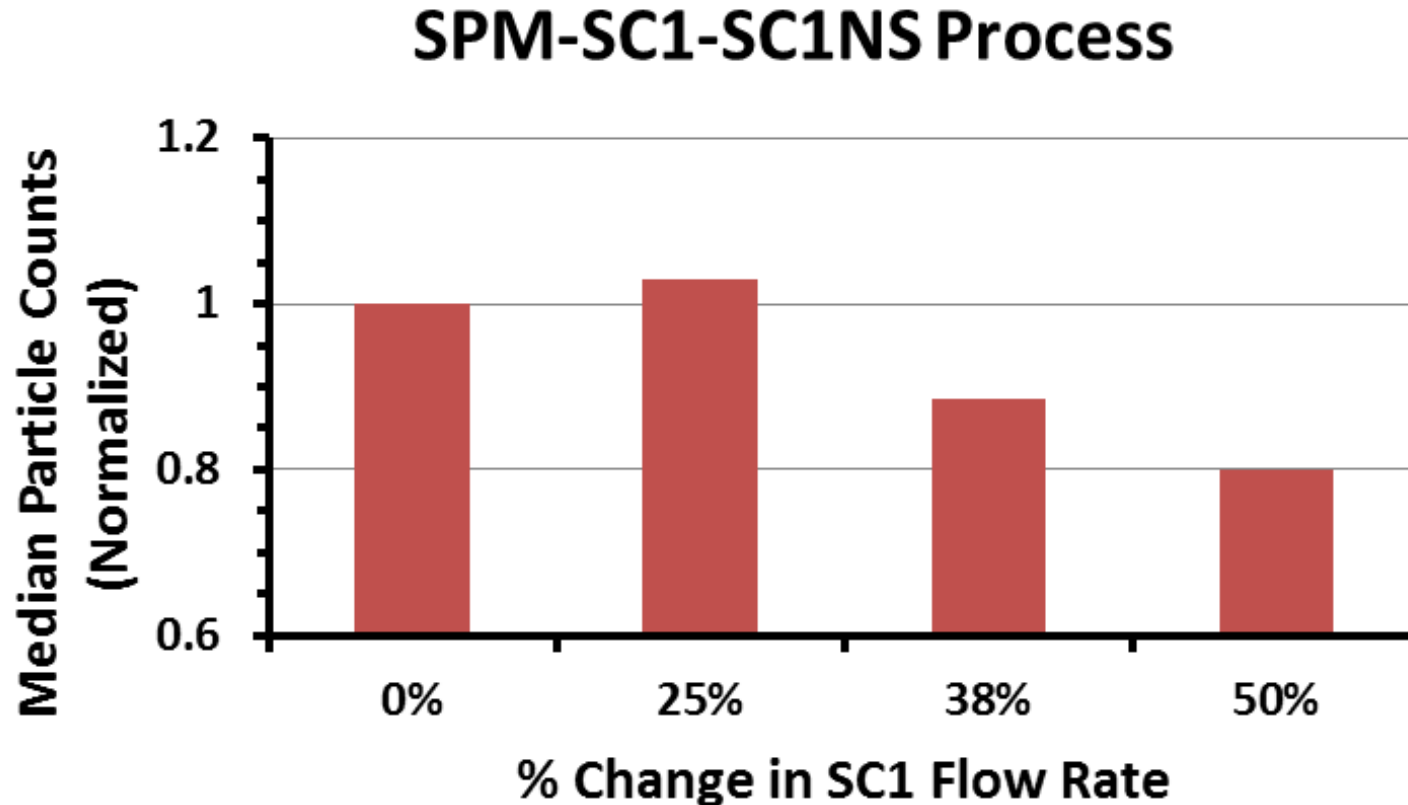
Particle Performance on blanket wafer



- No significant difference in particle performance was observed among various SC1 flow rates for SPM-SC1 only process.

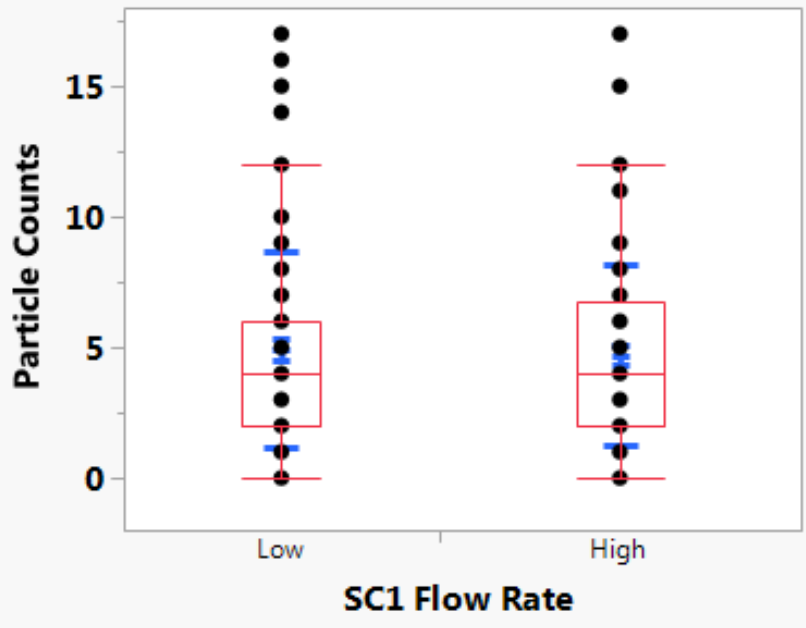
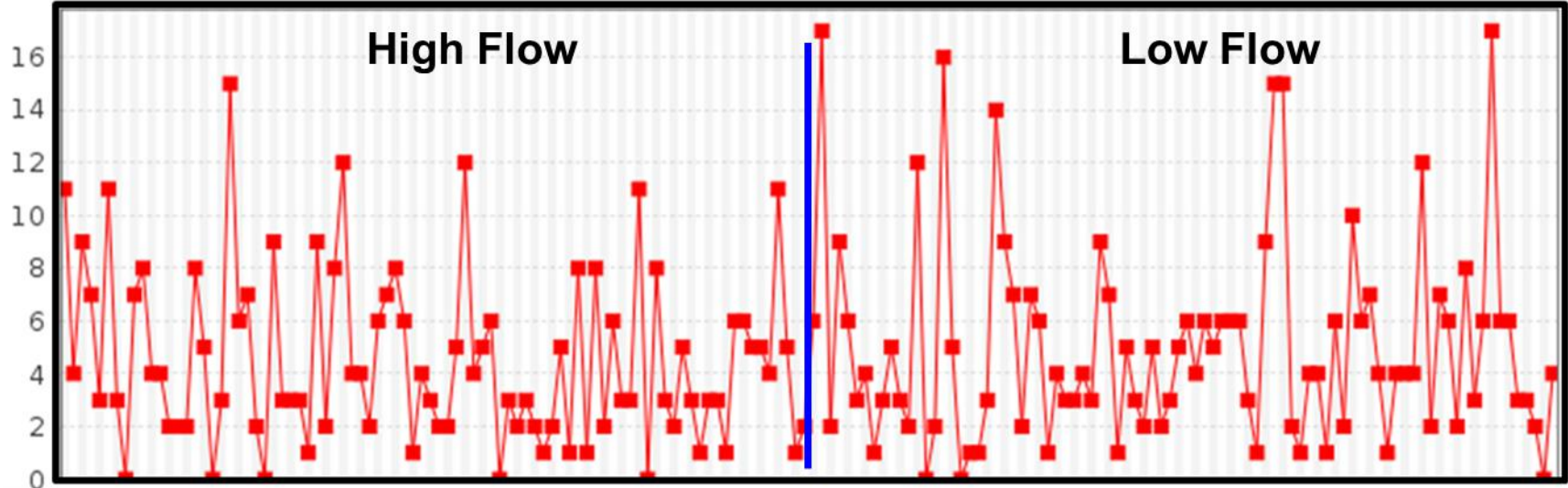


Particle Performance on blanket wafer



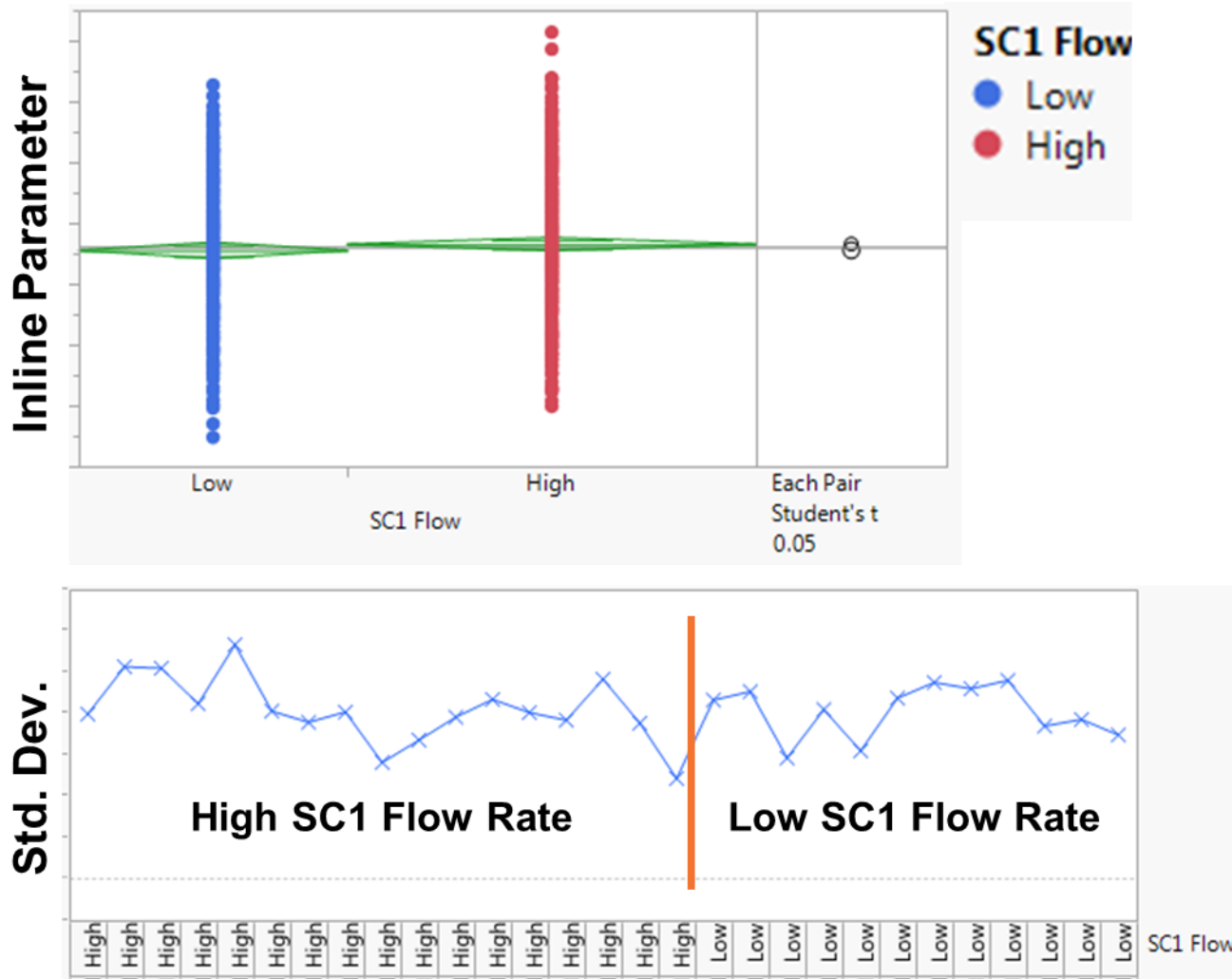
- No significant difference in particle performance was observed among various SC1 flow rates for SPM-SC1-SC1NS only process.

Particle Trend on Product



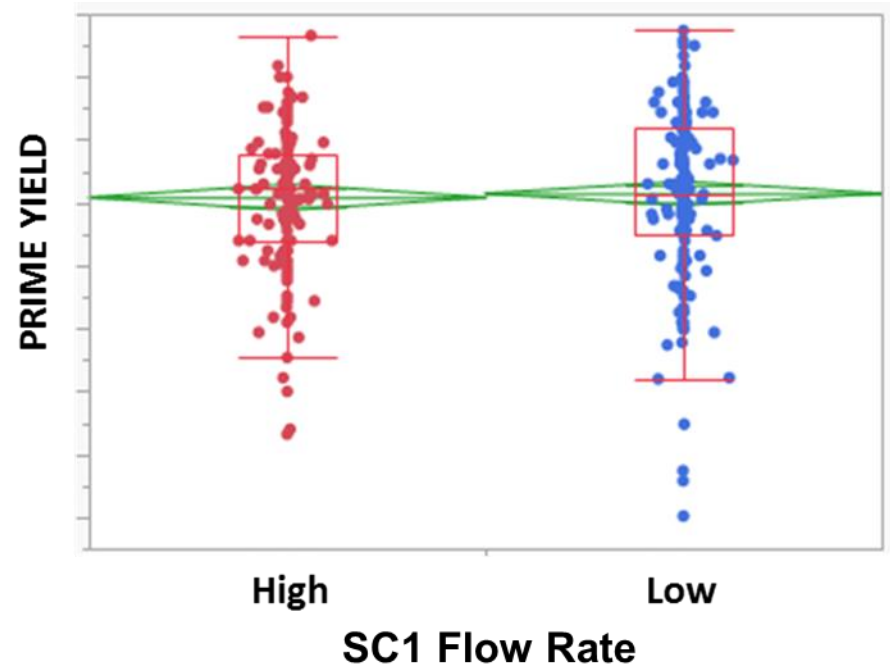
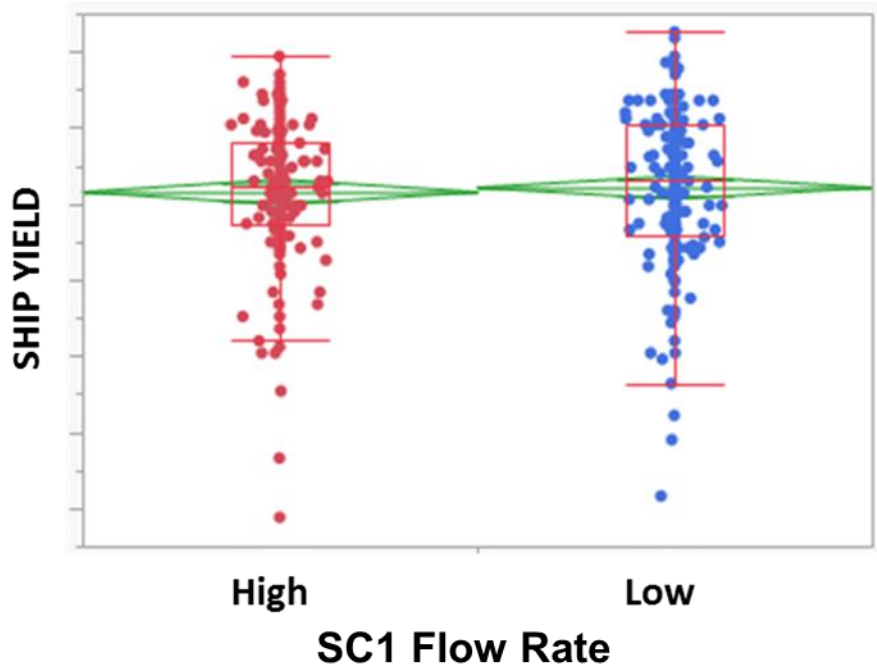
- Process with low SC1 flow rate showed comparable to or better than the process with high SC1 flow rate in particle performance.

Inline Trend on Product



- Process with low SC1 flow rate showed comparable data to the process with high SC1 flow rate.

Yield Analysis on product



- Process with low SC1 flow rate showed comparable to or better than the process with high SC1 flow rate for both Ship Yield and Prime Yield.



Summary

- Reduced SC1 usage means reduction in industrial waste volume and pre-treatment cost.
- Reduction in SC1 flow rate also reduce the process cost.
- A comprehensive study was conducted to evaluate the effect of various flow rates of SC1 on process.
- An optimized process with reduced SC1 flow rate was evaluated on product showing no degradation defects or in sort yield.
- Encourages tool vendors to work on BKMs with reduced chemical usage.



Acknowledgment:

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