Optimizing Production Performance Through Trace-level Chamber Analysis

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I. MOTIVATION

Identifying and eliminating the sources of tool and chamber variability is the primary goal of process control. When chambers are performing the same task, the chambers are expected to produce statistically similar results regardless of any maintenance events and cleaning cycles that might occur.

Fault Detection and Classification (FDC) is the primary tool used to monitor and control individual chamber performance. To monitor and control the differences between chambers, Statistical Process Control (SPC) of the post-process metrology wafer-state is generally used.

Monitoring the process output to detect differences between the various process chamber's tool-state or process inputs is not adequate for the early and accurate identification of chamber mismatch. To properly characterize the differing states of process chambers, the analysis of the full trace of all chamber parameters is required.

II. APPROACH

Trace analytics can be applied in a variety of manufacturing applications including fault detection and root cause analysis. It is also particularly effective in determining process and equipment variations in chamber analysis and chamber matching. In this presentation, two use cases are highlighted to provide examples of how this advanced technique can efficiently solve chamber performance issues.

Use Case #1

In the first use case, performance of four chambers are compared to look for variabilities. As shown in Figure #1, Chambers B, Chamber C, and Chamber D were compared against Chamber A (the reference chamber) in a solution using trace-level analysis. With trace analytics, the exact location of the signal deviation, down to the recipe step level, can be visualized through the respective trace charts. Since all chambers and related parameters are compared simultaneously, analysis time was reduced greatly. In this analysis, an overshoot was seen in the ***Gas 1 Flow*** parameter in Chamber C which could suggest possible issues with line pressure or the flow controller. This abnormality would have been difficult to detect if the analysis was done using summarized data

Use Case #2

In the second use case, a shift in FN-TOX parametric was seen in chamber 02 (see Figure #2). To determine the root cause of this shift, process trace data from the time period before the parametric shift was compared against data from after the parametric shift. Trace-level chamber analysis showed that parameter ***Chamber_Pressure*** was identified as a primary signal with the greatest deviation. As seen in the trace chart shown in Figure #3, the shift in chamber pressure in Chamber 2 correlates directly to the parametric shift in FN-TOX. Incidentally, in this case study, ***Chamber_Pressure*** was one of the critical parameters actively monitored by FDC, however, this difference was not detected in the trace summary data or seen in the traditional FDC chart.

III. RESULTS

The results in these use cases show that trace analytics achieve a high accuracy in identifying chambers that have shifted from the baseline, thus providing a highly effective means for early detection of process shift. In addition, by using the highlighted technique, root cause analysis time can be greatly reduced compared to traditional methodology of chamber matching.

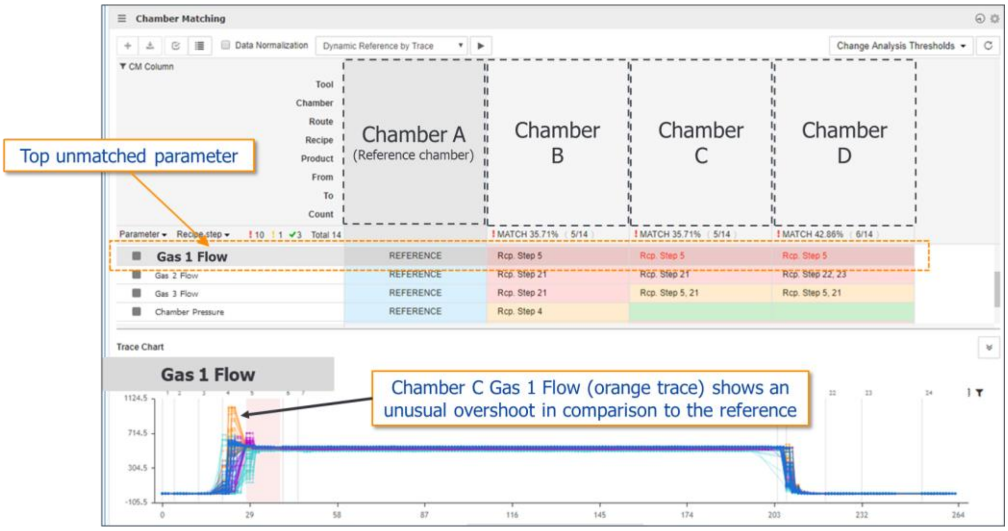

Figure #1 – Fleet Chamber Performance Analysis Use Case

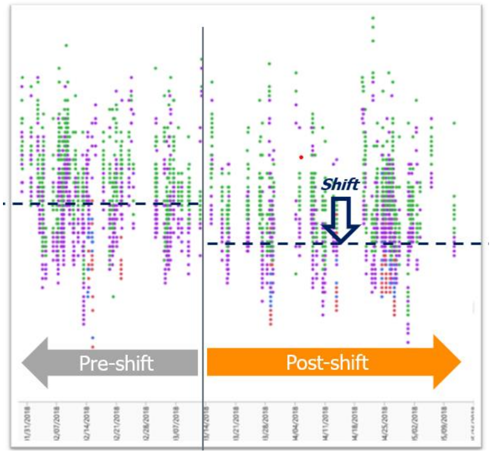

Figure #2 – A shift in FN-TOX parametric was seen

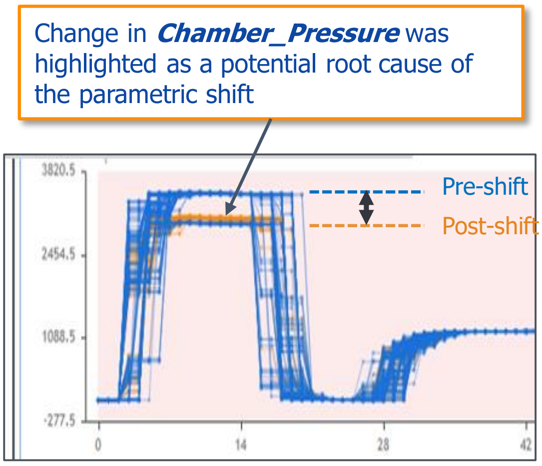

Figure #3 – Trace-level view of the ***Chamber Pressure*** change