Multivariate Statistical Analysis Finds the Bad Actors in Out-of-Spec Batches

aspentech | Case Study

Aspen ProMV™ found the three variables (of around 80) that correlated to quality.

CHALLENGE

This polymers producer had been regularly producing out-of-spec batches and could not determine the cause.

SOLUTION

Aspen ProMV desktop batch model was developed to identify the bad actors in the off-spec batches.

BENEFITS

This pilot project provided proof that Aspen ProMV can understand and resolve production problems faster to limit the losses. Aspen ProMV was able to:

- Highlight the few process variables (from a total of around 80) that correlate closely to quality
- Show how the company's batch operating procedures were affecting batch quality

Off-Spec Batches Lead to Revenue Loss

A large producer of synthetic rubber had been having quality issues with its batch products. These quality issues were resulting in significant revenue loss, as the company often needed to either reprocess the material or sell it for a lower price than expected. The producer was unable to determine what was causing the batches to be out of spec.

AspenTech has a long-standing relationship with this company, which uses a number of products from the aspenONE® Manufacturing and Supply Chain and Engineering suites. The two key goals of this pilot project were to demonstrate the Aspen ProMV methodology (i.e., show how the solution is able to highlight the key variables that correlate to quality) and highlight the ease-of-use of Aspen ProMV.

Investigating the Process

The company was investigating issues with a reactor process that brings together ingredients to manufacture synthetic rubber. There were multiple reactors that performed this process, but the Aspen ProMV project would focus on the production of one reactor.

The customer provided five months of production data, representing 55 batches produced from this one reactor. Input variables included initial temperature, amount of catalyst and amount of other raw materials for each batch. Since this was a batch process, there was batch profile data (e.g., temperature, pressure, level, reactor agitator speeds, etc.) from the batch run. Quality variables measured at the end of each batch were also provided. There were three key quality variables that customer wanted to keep in control.

The analysis was performed using Aspen ProMV desktop for batch. Aspen ProMV found several variables with very low variations and excluded them from the model.

Even though there were around 80 variables involved in this model, Aspen ProMV found three latent variables, or three independent directions that the 80 variables could move, as shown in Figure 1.

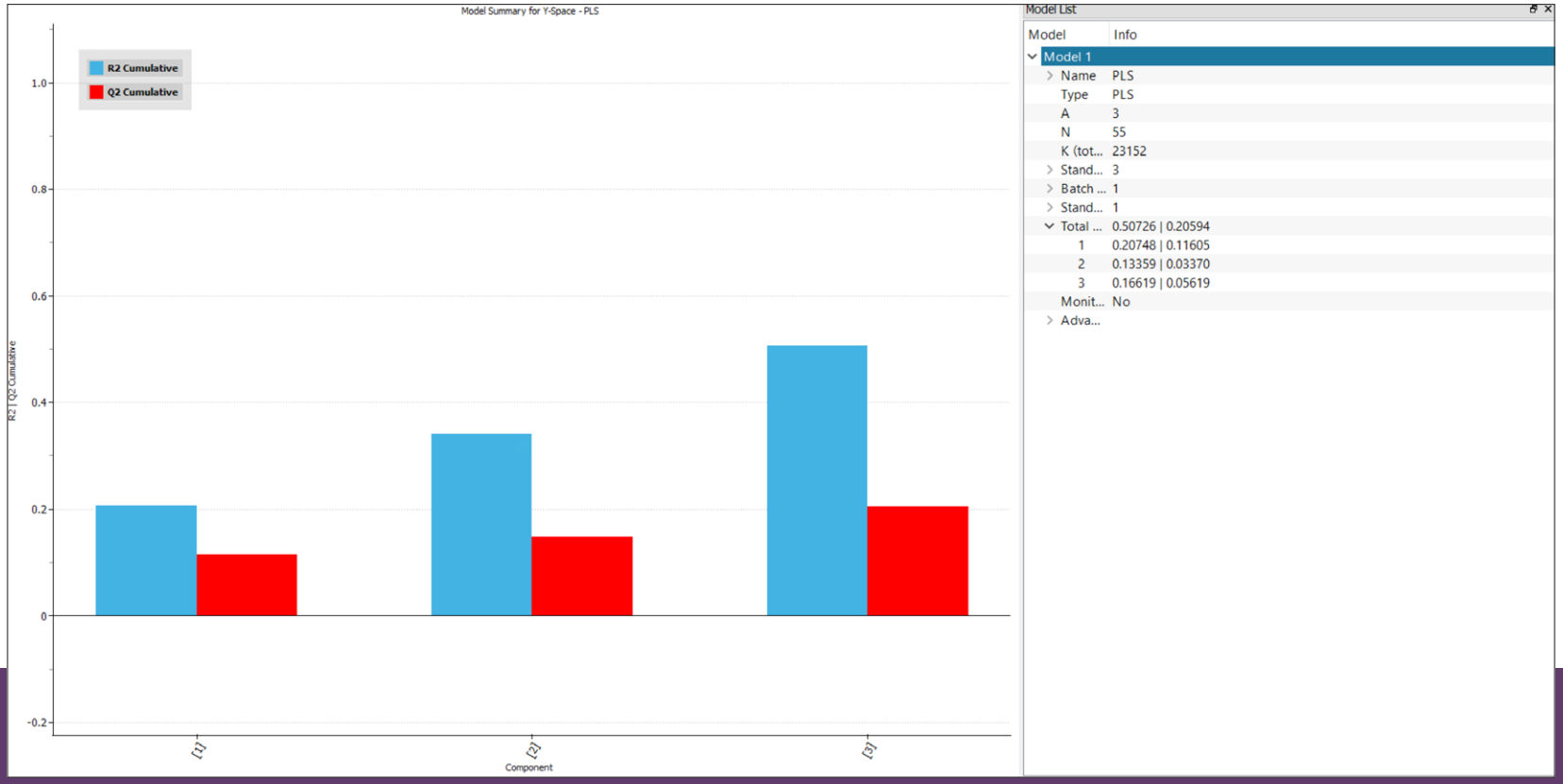

Figure 1: The three latent variables identified by Aspen ProMV

The Aspen ProMV model result separated the good batches from the bad batches using the two highest latent variables, as shown in Figure 2. The bad batches are highlighted in orange.

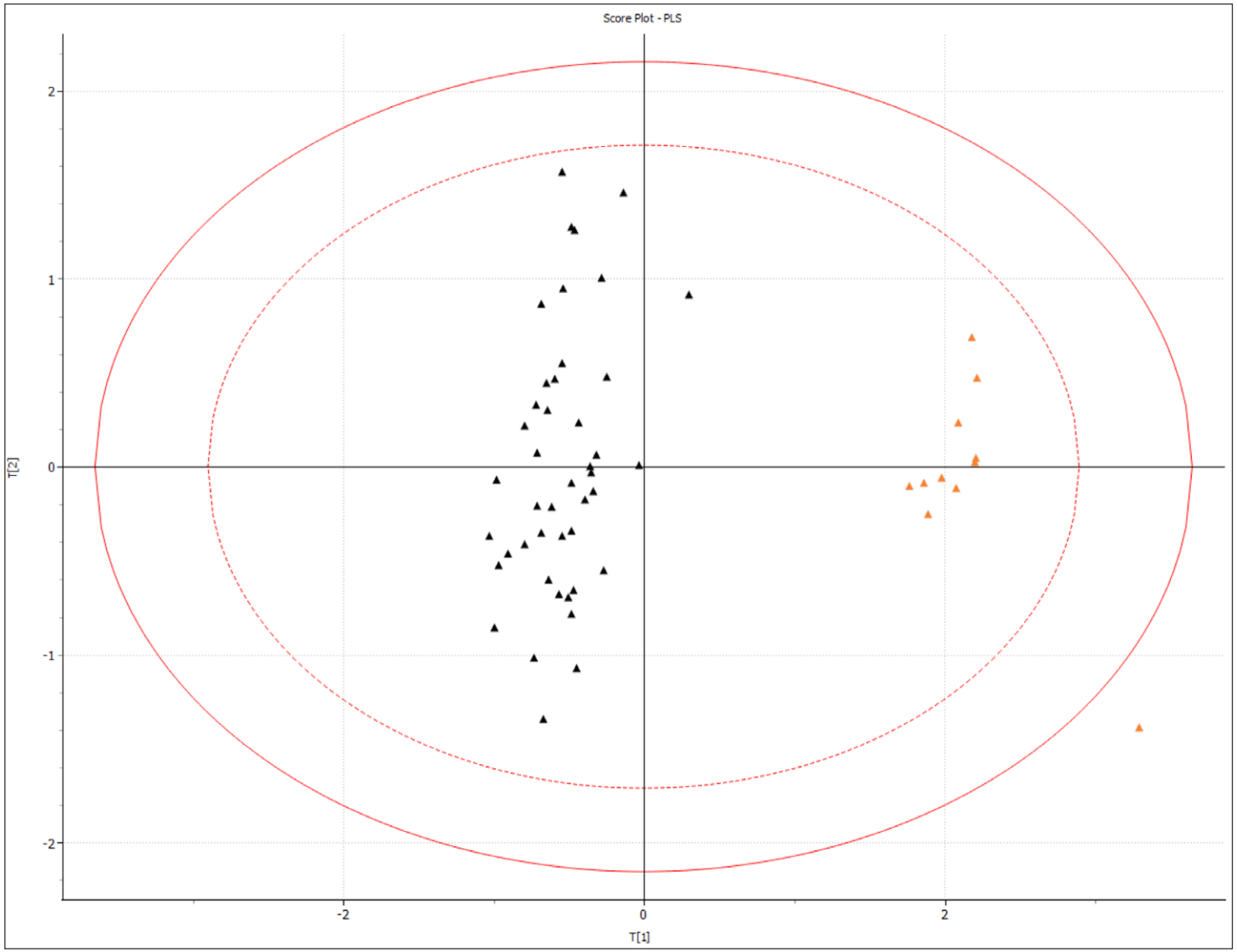

Figure 2: The good batches (black) and bad batches (orange), as identified by the Aspen ProMV model

Using Contribution Plot, Aspen ProMV was able to show the process variables that correlate most closely with the production of good batches.

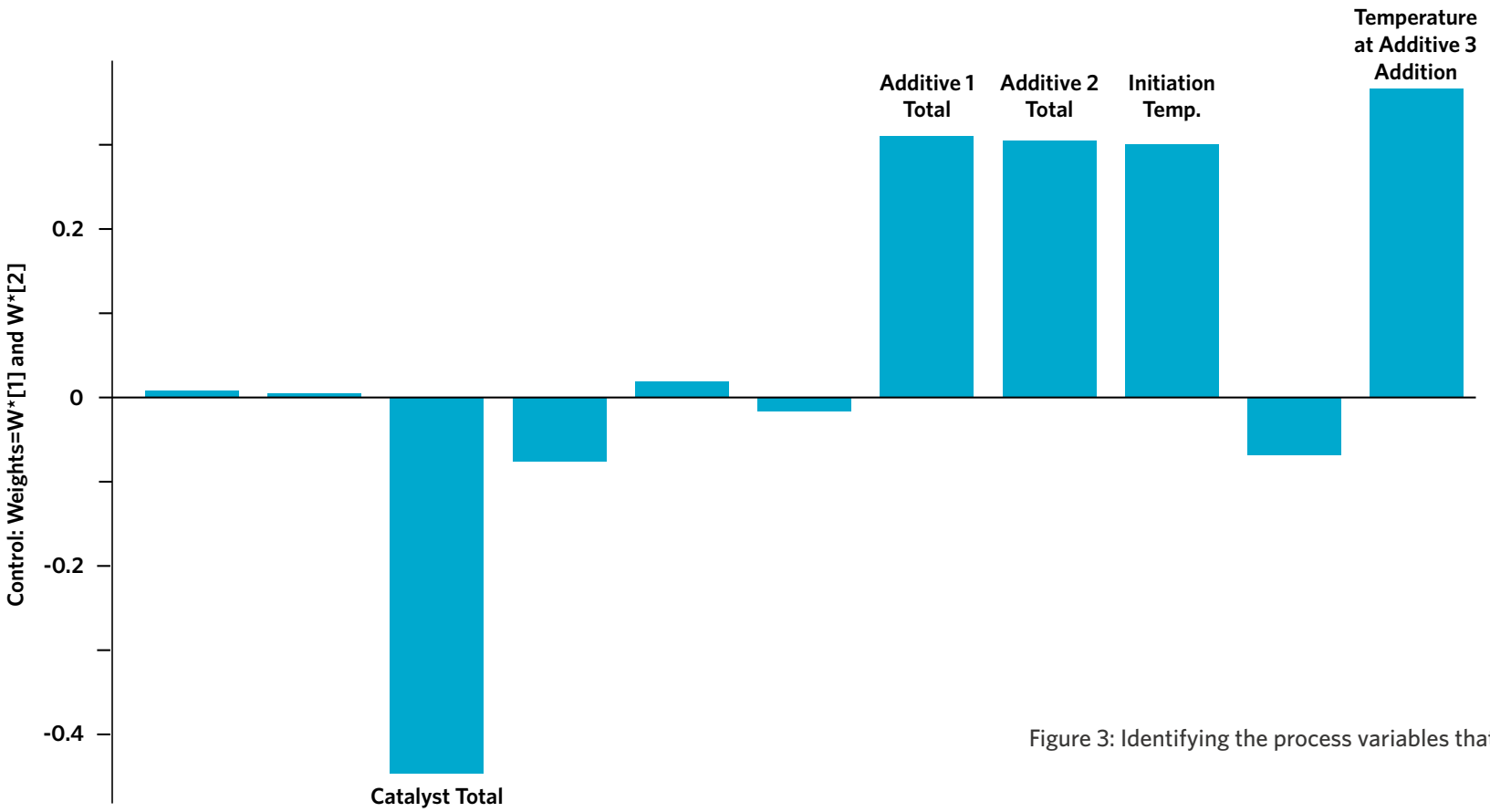

Figure 3: Identifying the process variables that correlate to good batches

Good batches were found to have high temperature during Additive 3 addition, high initiation temperature and low catalyst.

The company found it very easy to display raw data with Aspen ProMV as well. Figure 4 shows the raw data of "temperature during Additive 3 addition," which illustrates that the bad batches (in blue circles) have lower temperature. Process engineers at the plant didn't realize that the temperature was changed during the production of bad batches.

Aspen ProMV batch desktop was able to show that operating procedures during the batch process affect quality as well. For example, good batches took longer in the first reactor phase and shorter in the second reactor phase.

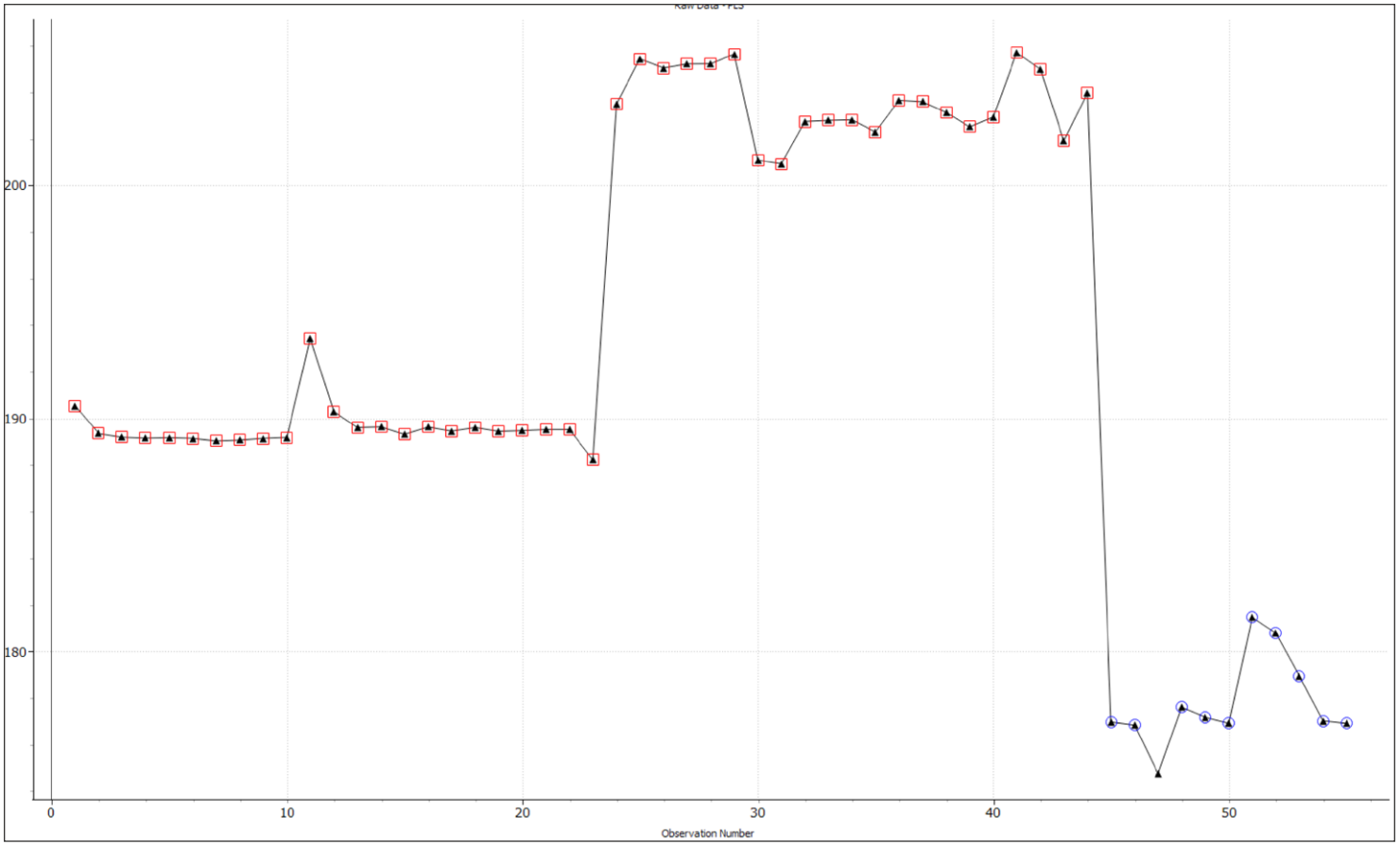

Figure 4: Data display showing the bad batches (in blue circles) having lower temperature during Additive 3 addition

Delivering Value by Driving Quality

Aspen ProMV proved its ability to show which variables correlate the most with batch quality. It identified which of these variables could be modified, and in which direction, to achieve better-quality batch products.

This application also highlighted one of the key features of Aspen ProMV — you don't have to do a lot of data massaging prior to the upload. In addition, it demonstrated the ease-of-use, as well as the solution's robustness and ability to clearly provide the right answer. Aspen ProMV can prune the variables that are "noise," those with very low variability, and from hundreds of input variables, it shows what the key drivers of quality, yield and throughput are.

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