# A Diagnostic Guide of Temperature Control for Charcoal Smokers

*-- Troubleshooting the control problems using the temperature plot from SYL-2615*

*Version 1.0 (June 2017)*

Sometimes, people may not get a good temperature control result when using Auber's SYL-2615 with their smoker. Among the many factors that can affect the temperature control result in a charcoal smoker, PID parameter setting is only one of them. In this guide, we will give a few examples of commonly seen "mistakes" or "symptoms" in using a controller with your smoker. The temperature plot acquired from our SYL-2615 in each typical situation are also shown to give a better illustration of the situation. Users can use these plots as a reference for their own trouble-shooting process.

## *Case 1: Top vent opening is too large, and/or bottom vents are not fully closed, or there is a leak of air.*

**Symptom**: If you noticed that the blower has stopped for a while but the pit temperature never drops, or, if you look at the temperature chart, the pit temperature stays above the set temperature even when the output to the blower has been reduced to 0% for more than 15 minutes, then it is an indication that vent opening is too big or there is a significant air leak.

### *Vents*

After installing the blower on the bottom vent, the rest of openings or gaps should be sealed by aluminum tape. If there are more than one bottom vents, close all other vents.

The top vent should be set smaller than what it would set to when no blower is used. This problem usually only happens to Kamado styled ceramic smokers. The thick ceramic wall is very efficient in keeping the heat inside the smoker, so only a small amount of air flow is needed to keep the same pit temperature comparing to a similar sized single-layer sheet metal smoker. For medium to low temperature cooking, we recommend set the top vent to 1/16" (2 mm) wide on Kamado styled smokers, or 1/4" wide on Weber Smokey Mountain smokers.

In this example (Figure 1), we installed a 6.5 CFM blower on the lower vent of a Large Big Green Egg. The top vent was 1/4" open during the first hour of the cooking. About 30 min into the cooking, the pit temperature has reached 225°F. In the next half an hour, there is no output to the blower yet the pit temperature stays steadily about 15°F above 225°F. At about 15:40, the top vent is reduced down to 1/16" open (see Figure 2), then pit temperature slightly dropped and the controller reacted to this change.

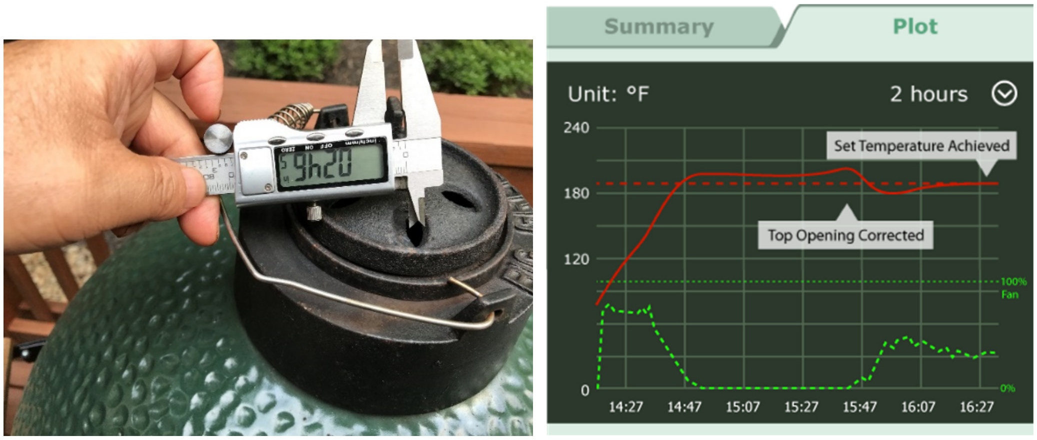


*Figure 1. In the picture on the top, the opening of the top vent is 1/4'' wide, which is too large for an 18.5'' Big Green Egg smoker cooking at 225°F with ambient at 40°F. On the temperature chart on the bottom, the pit temperature stays above the set temperature even when the fan has stopped running from 14:47 to 15:40. This problem is corrected by closing down the top vent to 1/16'' wide.*

*Figure 2. The correct opening, 1/16'' wide (top picture), just enough for inserting the tip of a toothpick (bottom picture). This configuration applies to all kamado styled smokers. Smokers with single layer sheet metal such as the Weber Smokey Mountain needs 1/4" or wider opening on the top vent.*

## *Air leak*

A good seal is critical to ensure a good air flow control in the smoker, which ultimately affects the pit temperature control.

For Kamado smokers, if you see smoke leaking out from the rim of the dome, you probably need to adjust the upper band or the hinge, or replace the gasket. The gasket material will wear and deteriorate over time. Its life depends on the amount of grill use as well as the cooking temperatures. If you see obvious signs of wear and deterioration of the gasket, please refer to the user manual for how to replace the gasket. There also are many YouTube videos on how to adjust the seal. Here is an example:

For WSMs, there is no gasket installed by the manufacture on the smoker lid or on the door of the center section. The seal on these gaps may vary from smoker to smoker. If your smoker has a large gap between the door and the center section (a common problem for the 22" WSM), you can try to bend the door to fit the shape of the center section better. You can also buy a roll of gasket for the door to make a better seal. The leakage from the smoker lid is not as critical as in Kamado smokers because WSMs normally require more air flow.

*Figure 3. Air or smoke can leak from the gap between the dome and the smoker. Poor air seal can lead to poor temperature control.*

## *Case 2: The fuel is running low, is located too far from the blower, or is scattered around the firebox.*

**Symptom a**: Power output to the blower is higher than what the smoker would normally need to maintain the same target pit temperature. On single-wall styled metal smoker such as Weber Smokey Mountain, the output may even reach 100%.

**Symptom b**: Pit temperature decreases while the blower is running.

This usually happens when you are a few hours into a long cooking process, a good percentage of the fuel has been burned off. Depending on how did you load the fuel in the beginning, the residual fuel might be scattered around the fire box or clustered in the far end of the fire box. So, the air from outside cannot reach the burning coal or charcoal effectively to make the fire stronger. The controller will have to increase its output to the blower to achieve the same pit temperature, sometimes the output percentage may even reach 100%. In some occasions, you may even see the pit temperature decreases while the blower is running. This is because of the cold air brought into the smoker doesn't pass through the burning coal or charcoal bed, it simply passes the chamber and bring down the pit temperature. The solution for this issue is to add new fuel or re-arrange the residual fuel so it is more concentrated and located closer to the blower

In this example (Figure 4), we are using an 18.5'' Weber Smokey Mountain, the set temperature is 225°F. The controller can hold the temperature by sending 40% power to the blower. However, when enough fuel is loaded to the firebox, the blower only needs about 15% power to maintain this temperature. This was because that the briquettes were mostly burned out and were scattered over the entire fire box. The controller has to increase the output power to 30% -

40% to bring more fresh air so that the temperature would stay at 225°F. At about 22:00, we open the fire door, raked all of the remaining fuel to the front, closer to the blower. Then the output to the fan dropped to 10% - 15% while the pit temperature is still well maintained at 225°F.

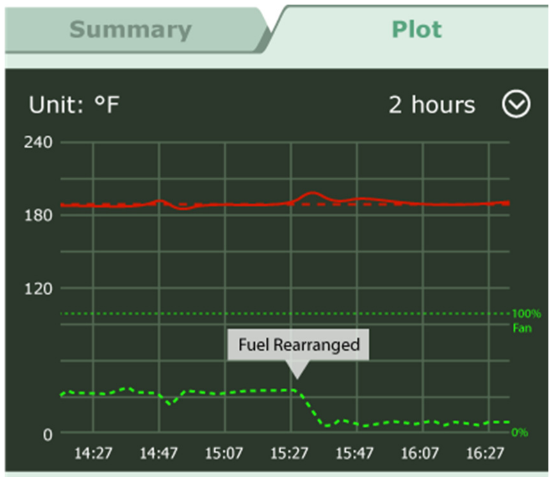


*Figure 4. The required output dropped from 40% to 15% after the briquettes were re-arranged.*

## *Case 3: PID settings are not optimized.*

**Symptom**: Temperature oscillates or takes a long time to converge.

When the PID settings are well tuned for a particular cooking condition (i.e., the type of the smoker, the cooking temperature, and ambient condition), the pit temperature can be brought to the target without any overshooting and it will be well maintained with nearly no fluctuation. The plot in Figure 5 shows a typical cooking process on an 18.5'' WSM using the re-called PID settings for "WSM 18" (P = 45, I = 1400, d = 100). The target temperature was set at 225°F. The pit temperature (red solid line) was quickly brought up to a few degrees lower than 225°F (red dashed line) and then gradually converged to 225°F. The system is responsive and stable.

In contrast, if the PID settings are not properly tuned for your system, you may see the pit temperature overshooting high above the set temperature, the system responses slowly to the temperature change, or the pit temperature constantly oscillating around the set temperature. The plot in Figure 6 is an example of P value being too large: P = 90, I = 1400, d = 100. When P was set to 90 instead of 45, the proportional band is too wide and the system gain is weak. The system response is very slow. When there was temperature overshot, it took a long time for the controller to reduce the output to the fan. The plot in Figure 7 is an example of P value being too small: P = 20, I = 1400, d = 100. When P is small, the proportional band is too narrow and the system gain is very strong. The system reacts strongly to the difference between the probe reading and the set value. The controller oscillates the output between 0% and 100%, and so the pit temperature oscillates accordingly. At 21:12 the P value was changed from 20 to 45, the oscillation gradually stopped.

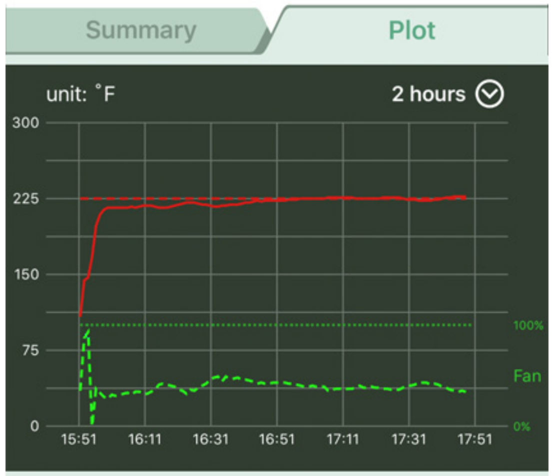


*Figure 5. The pit temperature is raised and converged to the set temperature quickly and without no overshooting. The PID setting is the default setting for 18.5'' WSM: P = 45, I = 1400, d = 100.*

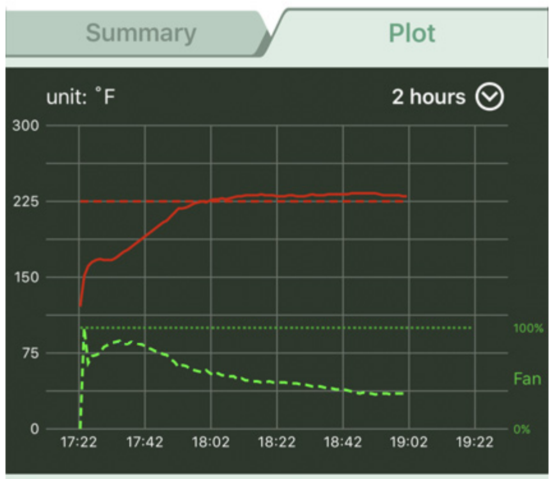


*Figure 6. Pit temperature rise and converge to the set temperature slowly when the P value (P = 90) is too large, the system gain is weak and it responds slowly to the temperature difference between probe reading and target temperature.*

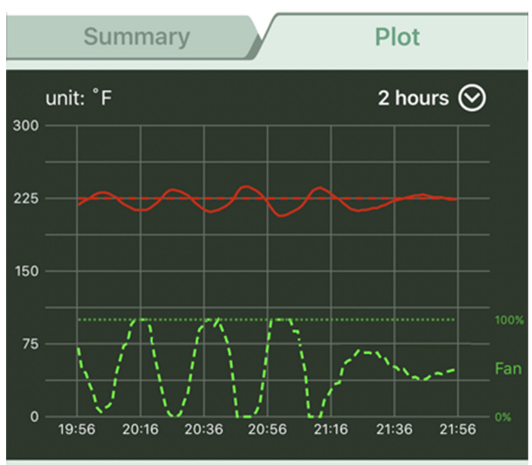


*Figure 7. Pit temperature oscillated as the P value (P = 20) is too small. When the P value was changed from 20 to 45 at 21:12, the oscillation gradually stopped.*

*Case 4: Blower shutter stuck.*

**Symptom**: Pit temperature stalls while the blower is running.

The temperature plot in Figure 8 is a good example of how the pit temperature curve looks like when the blower shutter stuck at the closed position. At 8:35 and 9:00 there are two instances of shutter being stuck, and the pit temperature stopped climbing up and even dropped a little bit in the first instance.

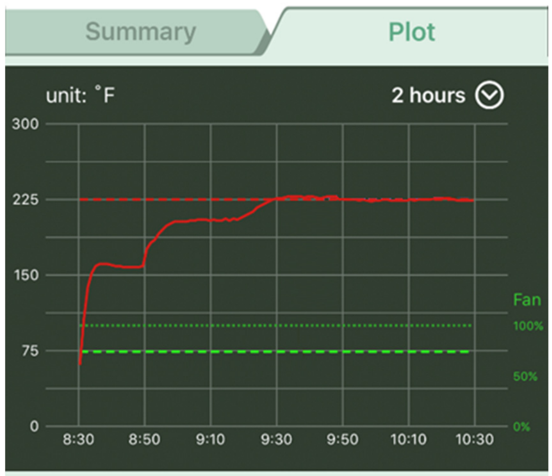


*Figure 8. Pit temperature stops climbing up when the blower shutter is stuck at the closed position.*

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