



Case Study

Staged Burner with Optional Gas Injection Configurations

BACKGROUND

A newly commissioned, highly efficient corn ethanol plant installed a state-of-the-art burner in its combustor system. The combustor was designed to operate on both natural gas and large quantities of low-heating-value gasified wood chips.

STARTUP RELIED ON NATURAL GAS UNTIL THE GASIFIER PRODUCED SUFFICIENT FUEL FOR FULL PLANT DEMAND.

A CLASS I NATURAL GAS PILOT FIRED CONTINUOUSLY TO MANAGE LOAD SWINGS.

From commissioning, however, the burner exhibited severe harmonic vibration throughout the combustor and was unable to safely operate above 25% of required heat input. After internal tuning and modification efforts failed, STEP (EES) was engaged to identify the cause and provide a sustainable solution.

SOLUTION

The original 240 MMBtu/hr burner was a premix-style ultra-low NOx (<30 ppm) gas burner, although the permit only required <75 ppm NOx. While premix burners can meet stringent NOx limits, larger units often lack operating flexibility. Their design lowers flame temperatures to reduce NOx, but this also causes instability under variable load conditions.

STEP proposed its VariSwirl non-premix staged burner, customized to meet the plant's turndown, fuel mix, and firing configuration. Key design features included:



Figure 1: CFD model of Producer Gas/Natural Gas Combo Firing

STAGED BURNER DESIGN

With optional gas injection configurations (central, secondary, and tertiary)

CENTRAL GAS NOZZLE AND SWIRLER ASSEMBLY

Producing a high-swirl, fuel-lean, stable core flame to ensure stability under varying loads

SECONDARY GAS NOZZLES

Distributing remaining fuel along the furnace length, creating a long, fuel-rich flame

LOW-EXCESS-AIR OPERATION

Reliable with decades of robust performance

RESULTS

<3% O₂ <60 ppm NOx
& 0 ppm CO

15:1 Turndown ratio



Stable operation with
no vibration issues

CONCLUSION

STEP Combustion's VariSwirl staged burner solved the plant's operational and emissions challenges. The solution provided a robust, flexible, and reliable combustion system that not only met emissions requirements but also ensured long-term stable operation across variable load conditions.

