

## Background

A recently commissioned highly efficient and technologically advanced corn ethanol plant installed a 'state of the art' burner in their combustor system. The combustor was designed to burn both natural gas and large quantities of a low heating value gasified wood chips. The system is brought online with natural gas until the gasifier produces sufficient fuel to run the boiler at plant demand. A Class I natural gas pilot fires continuously to balance load swings. Since startup and commissioning, the burner produced severe harmonic vibration throughout the combustor and was unable to safely operate above 25% of the required heat input. After exhausting tuning and modification efforts, STEP (EES) was contacted to assist in identifying and providing a solution.

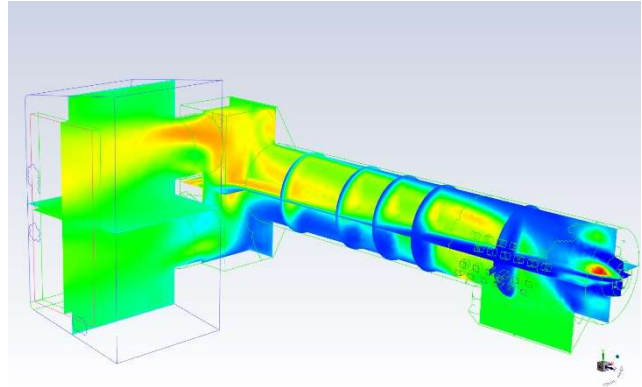


Figure 1: CFD model of Producer Gas/Natural Gas Combo Firing

## Solution

The original 240 MMBtu/hr burner was a 'pre-mix style' Ultra-Low NOx (<30ppm) gas burner. However, the plant permit only required <75ppm NOx. Generally, pre-mix type, ultra-low NOx burners can be operated successfully, but these larger premix burners are typically limited in operating flexibility. By nature of their design, these units rely on reduced bulk flame temperature to achieve their emissions limits. With reduced flame temperatures, the burner becomes unstable at variable firing conditions. STEP proposed their VariSwirl non-premix burner, customized for the turndown, fuels and firing configuration in this combustor.

The STEP VariSwirl burner is a staged burner with optional gas injection configurations (central gas, secondary and tertiary poker arrangements). The design selected for this application included a central gas nozzle and swirler assembly combine to create a high swirl, fuel lean, stable core flame. This core flame provides the necessary stability to support staged gas and low excess air operation. The secondary gas nozzles stage the remaining fuel throughout the length of the furnace to create a long fuel rich flame. Our VariSwirl burner provides consistent, proven, robust, and reliable performance for decades of operation.



Figure 2: VariSwirl Burner

## Conclusion

The STEP Combustion VariSwirl burner was commissioned and is successfully operating at <3% O<sub>2</sub>, <60ppm NO<sub>x</sub>, and 0ppm CO. Stability was proven with a remarkable 15:1 turndown with no vibrations.