(559) - (*) - A CAMERA-BASED FLAME STABILITY CONTROLLER FOR NON-OSCILLATING AND OSCILLATING COMBUSTION

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With an increasing share of fluctuating wind and solar power in the future energy system, conventional combustion power plants have to enable a high load-flexibility. In addition, a high fuel-flexibility aiming at the partial substitution of coal with biogenic fuels is desired. Especially in low load conditions, a total shutdown of combustion plants has to be prevented. Instead, in such situations, a stable low load operation should be realized, e.g. by increasing the share of biogenic fuels with a lower calorific value, and thus decreasing the total power.

Unfortunately, this low load operation with a high share of biogenic fuels usually leads to a destabilization of the flame, which can (up to a certain degree) be circumvented by online adapting fuel-, air- and swirl settings of the burner system or by using plasma supported burners. Furthermore, low rank biogenic fuels may contain more nitrogen than fossil fuels which leads under unfavorable operational conditions to an increase of NOx. With a new patented method with an oscillating burner the NOxes could be clearly decreased up to 50 % (for detailed information about the impact of oscillating combustion, see submitted abstract "Oscillating Combustion for NO_x- Reduction in Pulverized Fuel Boilers").

A necessary precondition for the online burner adaptations is the availability of a quantitative real-time measurement of the flame stability, e.g. using camera systems. Some approaches for the flame stability measurement already exist for continuous, non-oscillating combustion systems based on flame flicker analysis. So far, existing approaches for the flame stability measurement are rather empirical and give no defined value range and interpretation for a stable flame. Thus, they have to be adapted to the specific burner and fuel system. For forced oscillating combustion systems with a pulsed fuel flow rate, aiming at reducing the NO_X-formation, no flame stability measurement systems exist at all.

In this paper, we first present a new image processing based measurement system for the quantitative online flame stability monitoring for non-oscillating as well as for oscillating (pulsed) low NO_X combustion systems. The new flame stability measure has a clear geometric interpretation and can thus be directly applied to different burner-, fuel- and camera configurations.

Using the online camera-based flame stability measurement we then present a burner control algorithm, which automatically finds the optimal burner setting for a stable flame. The algorithm searches for the swirl and air setting that maximizes the flame stability. The burner control algorithm together with the camera based flame stability measurement can be used online for non-oscillating as well as for oscillating combustion.

We demonstrate the new flame stability measure and the burner control algorithm at a 1 MW pilot-scale power plant for different fuels (biochar, hard coal) using cameras in the visible and near-infrared spectral range with standard framerates of 25 fps.

Palavras-chave : Flame stability, Oscillating combustion