Elements of ND-TLUD Design: ‘Counter-Current’ Burners

(Preliminary Observations)

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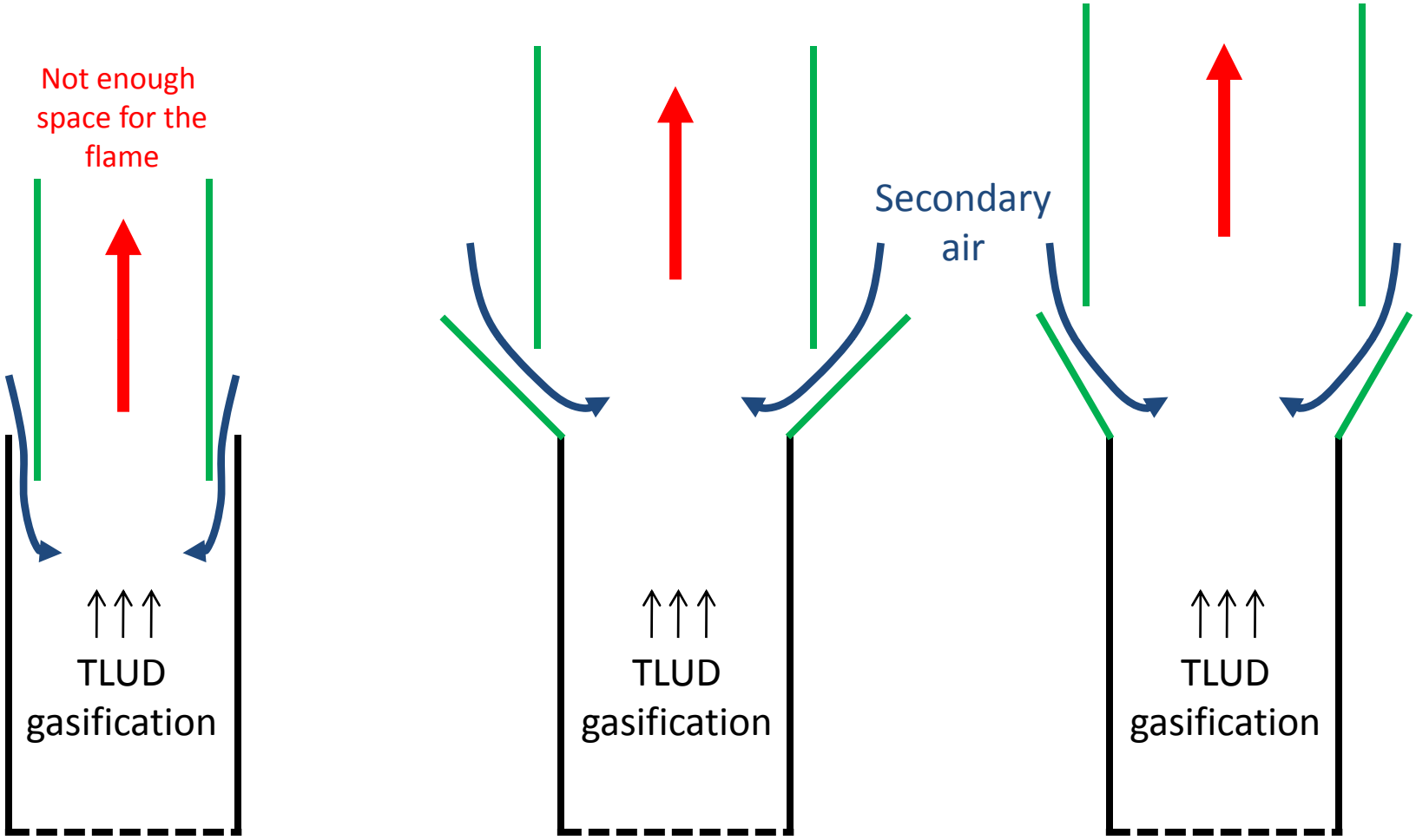
Counter-Current Burners

Introduction

- Counter-current gas burners collide air and fuel from opposing directions to increase their degree of mixing and the efficiency of combustion.
- In the pyrogas burner of a natural draft, top-lit updraft gasifier (ND-TLUD), we can't get true counter-current flow as in a pressurized burner.
- However, we can approximate counter-current flow if we direct secondary air downward towards the fuel bed. It was expected that this would:
  - maximize turbulent mixing of secondary air and pyrogas at the base of the gas flame.
  - initiate the gas flame low over the fuel bed to help keep temperatures high in the TLUD reactor.
  - assist keeping the gas flame alight at low rates of pyrogas production by combusting some charcoal on the top of the fuel bed (after Kirk Harris)
- Preliminary observations on visible smoke emissions and flame structure were made on three prototype burners. Since one of burners looks very promising, these early observations are being presented here.

Three Models of Pyrogas Burner



Burner 1: inserted chimney

Burner 2: 45° collar

Burner 3: 60° collar

Burners were tested on wood chip fuel on a TLUD with 20% grate area for primary air.

Preliminary Observations

These burners rely on downward laminar flow to propel secondary air downward toward (but not necessarily reaching) the fuel bed.

Burner 1: was very effective at propelling secondary air downward, but there was not enough space in the burner chimney for the flame to expand, so the burner produced smoke. This burner was rejected.

Burner 2: was less effective than Burner 1 at propelling secondary air downward, but was less smoky, because the chimney size was increased to 1.2 x TLUD diameter.

Burner 3: showed a lot of promise. The gas flame was low, and occupied the diameter of the TLUD reactor. The flame appeared turbulent, and there was no central peak.

More Research Needed

- Basic observations on how Burners 2 & 3 affect TLUD function are needed. The burners need to be tested:
  - over a power turndown curve, especially to see if they work at low rates of primary air.
  - with wood chip fuel above 12% water content.
- It is expected that the burners will be very sensitive to the height of the gap through which secondary air passes, and that gap may have to be reduced as primary air is cut back.
- Some modifications to the lower edge of the burner chimney would improve laminar flow.
- If the route for secondary air was made so that it narrows, it could be used to increase the velocity of secondary air as it enters the reaction chamber.

Conclusion

- Burners 3 looks very promising, because it created a low, turbulent flame, indicative of good mixing of pyrogas with secondary air.
- Burners 2 and 3 are also very simple build.
- However, we can’t be certain that they are reliable until they have been tested at low primary air, and with moist fuel.

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