
Flame Cap/TLUD ???– Ethos 2019

Flame Cap/TLUD?

Don't Flame Caps and TLUDs Function Differently?

Ethos/2019

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Combustion of Burning Wood

Pyrolysis that makes Biochar - Volatile gases start evaporating at 260 C.
Pyrolysis occurs before combustion at approximately 450 C. Mostly CH_4 and CO and H_2
Incomplete combustion **does not burn all the gases and creates smoke**.
Complete combustion we are completely **burns all the gases** coming off the wood.

Basic Composition of Wood

60% is Synthetic oil or **Syn-Oil** → **Need complete Combustion of Syn –Oil**
Chemically this is an Oxidizing Flame

10% is Synthetic gas or **Syn-gas** → **Need Pyrolysis (or incomplete) combustion here**

30% can be made into **Biochar** → **Save and use the biochar**
Chemically is a Reduction Flame

This is the problem and the question.
How do we save the biochar and have complete combustion?

HISTORY

Started tinkering with Jolly Roger TLUDs in 2007 with classes taught by Art Donnelly.

Side by Side Comparisons for Improvements

Jolly Roger TLUDs

Versions 6,

Version 7

Version 8.

Notice Incremental Improvements for each version

All are 20% Primary Air TLUDs

Notice also the Height and Intensity of the Flames

Slowly made improvements in performance and function resulting in version 8.
and I made a lot of smoke!

This is the Ring of Fire or Version 16!

Run Video

As the flames reach over the top of the combustor, reduce the primary air – add rubber stoppers.

As pyrolysis nears the end, restrict the primary air even more and more.

Notice there is some smoke and no sparks exiting the TLUD.
TLUD is running a little hot.

This *Ring Of Fire TLUD* accomplishes several things.

First, it creates a quality high temperature (450 C.) biochar for the soil.

Second, it has a good yield of close to 30% - - more than a Jolly Roger TLUD. There is less also ash with a lower pH.

Third, the feedstock barrel is used to both dry and pyrolyze the woodchips making the TLUD more ergonomic and much more labor efficient.

Fourth, there is little smoke and no sparks (fireflies) leaving the TLUD.

Fifth, At 16 cents/Kw, it costs less than a dollar or two to dry the feedstock.

10% MC is acceptable but even drier means a quicker burn and with less pollutants.

We can go from 45% Moisture Content to 10% in 5 hours and to 1-2% in 10 hours (at approx. 15 C.).

Design Improvements on Ring of Fire TLUD

First, this is not a 20% primary air Jolly Roger TLUD. Actual measurements and calculations of the amount of primary air show it accomplishes a good clean efficient burn with 6 - 11% primary air which must be regulated. This is stochiometric combustion.

Second, the combustor operates as a stratified secondary air injection for more complete combustion (hopefully?).

5% of secondary air
(quaternary air?)

10% of secondary air
(tertiary air?)

85% of secondary air

Third, the ratios of stratified air are shown.

Problem is, version 16 requires a interior false bottom, carefully but intensively constructed primary air feed and control, considerable metal working skills, the ability to weld (and a $1500 welder), and takes about 2 1/2 days to construct.

Goals for a Biochar Kiln

First, my goal is to build a democratized biochar kiln;

a. easy, with the skills of a typical Do-It-Yourselfer.

b. easily available and/or recyclable materials – 55 gallon barrels, metal paint cans, waste wood, etc.

c. no welding should be required.

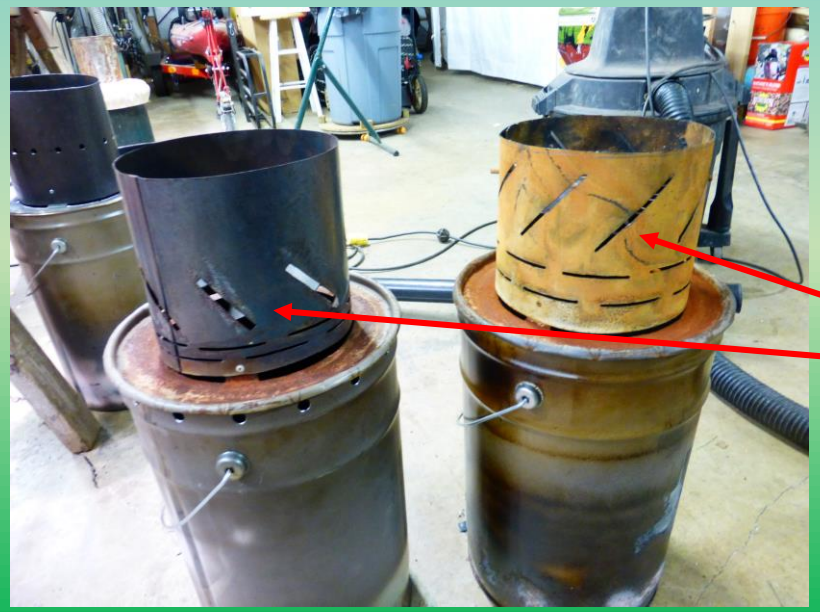
d. develop a prescriptive formula for construction and operation – no caveats or exceptions.

e. cleanest possible emissions – Carbon Monoxide and Ultrafine Particulates as low as possible.

f. inexpensive so people would actually make and use them with environmental sensitivity.

Problem is the Ring of Fire, version 16 is a bitch to build!

Typically, I use readily available popcorn cans to experiment with and when I think we have something of real benefit, we test the ideas on a 55 gallon TLUD.

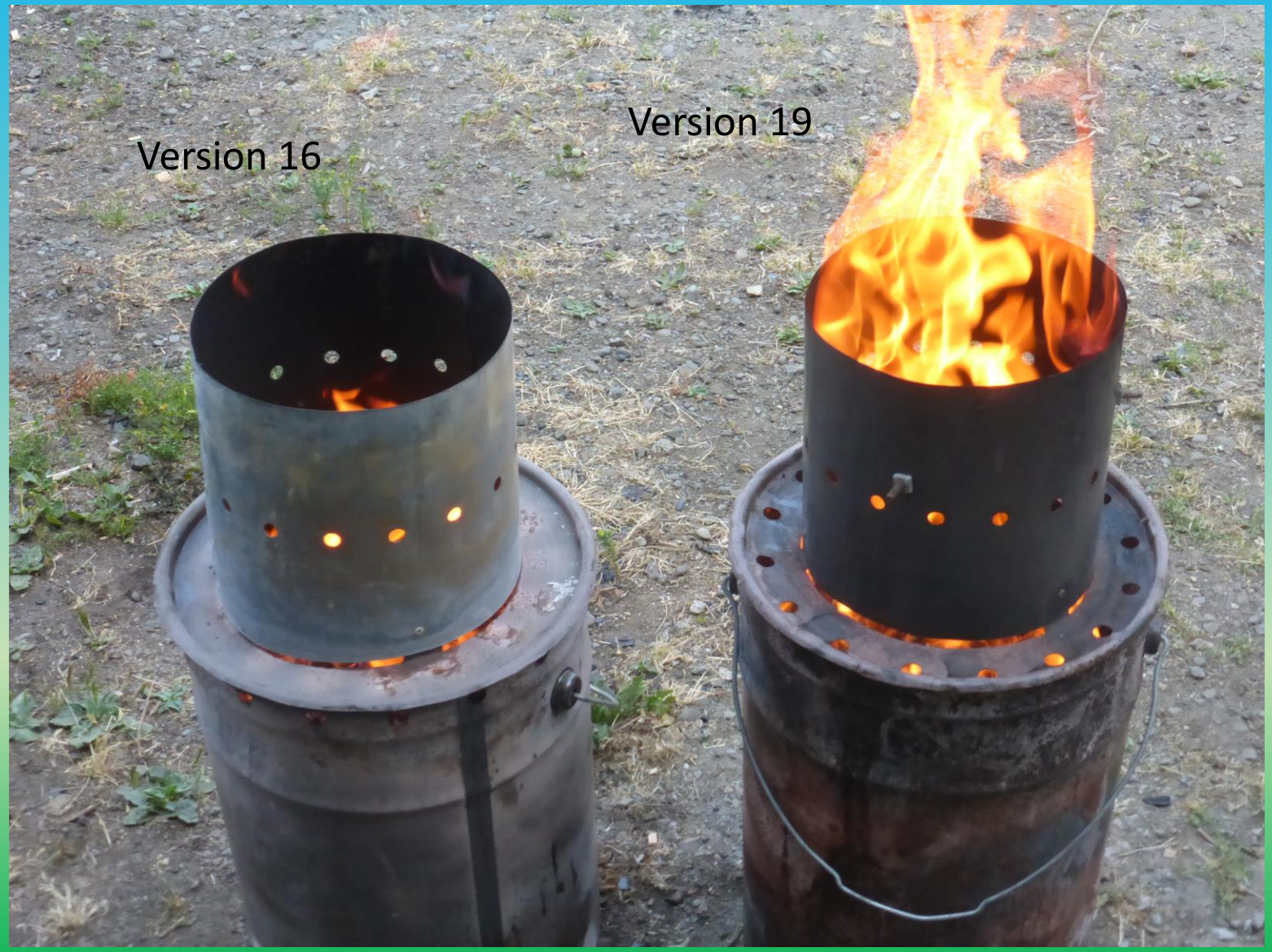


Side by side comparison of experiments on the stratified secondary air system.

Notice the differences in slot sizes and design.

What do you see that is different between these two TLUDs?

Version 16 and version 19 with some adaptations to make it easier to construct.



Version 19 compared to Version 16;

a. was quicker to start and get going
b. reached pyrolysis temps and secondary temps much sooner
c. had less smoke at start-up
d. finished the burn sooner
e. flames more turbulent and more vigorous
f. ran at hotter temperatures
g. resistant to the blowing wind
h. and, most importantly, when pyrolysis was finished, it simply stopped secondary combustion.
i. and, there was very little to no pyrogas smoke at the end of the burn.

Version 16 on the Left and Version 19 on the Right

Run Videos - 2

Click for first Video and then the Second

Run Video Version 16 - Flames following the air injections

Run Video - 4

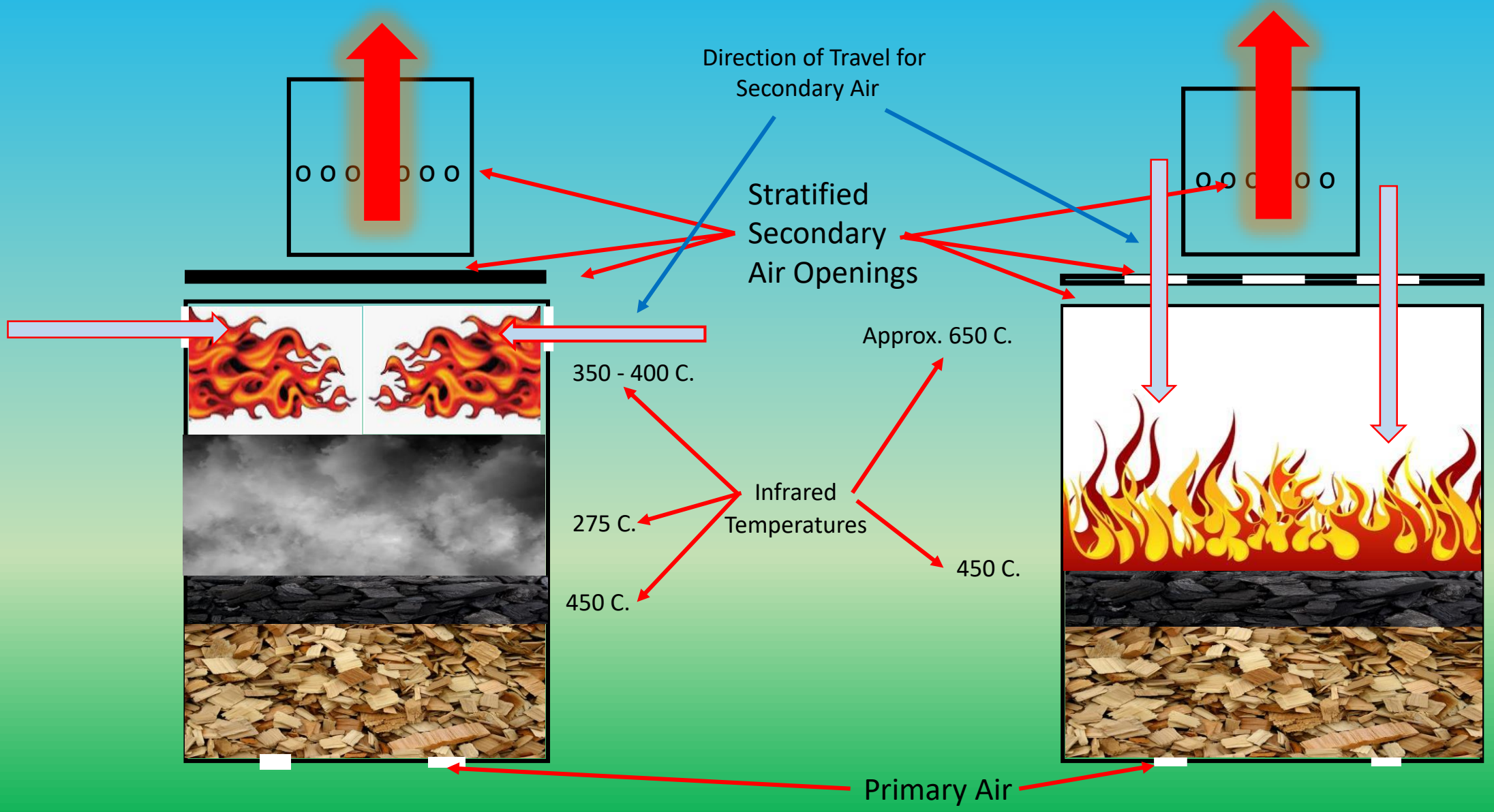
Version 16

Version 19

Version 16

Version 19

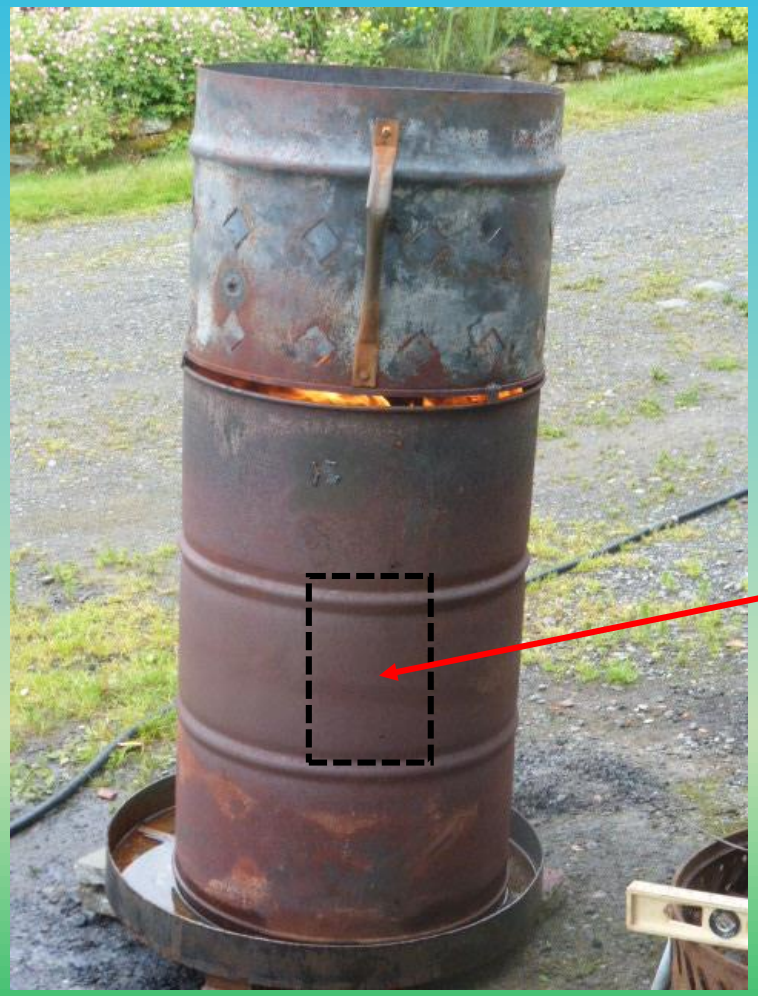
Version 16 and version 19 – Flame Cap/TLUD (Seven Gallon)



Wood Chip Sifter – 55 gallon barrel, ½” hardware screen rotates on a water pipe
Produces wood chips of two different sizes for pyrolysis.

The Inconsistency of Pyrolysis

Inconsistent temperatures over the Surface of a TLUD are **consistently inconsistent** when measured by an Infrared Thermometer or Thermocouple



Installed an 8” X 11” Pyrex Baking Dish into the side of a TLUD to watch what was happening.

Expected a pyrolytic front – never got one. Got a pyrolytic zone.

Not a pyrolysis front but a pyrolysis zone with wood chips
Repeated with wood pellets showed a pyrolysis front.

Run 2 videos

Pyrolytic Layers and Channels in a TLUD

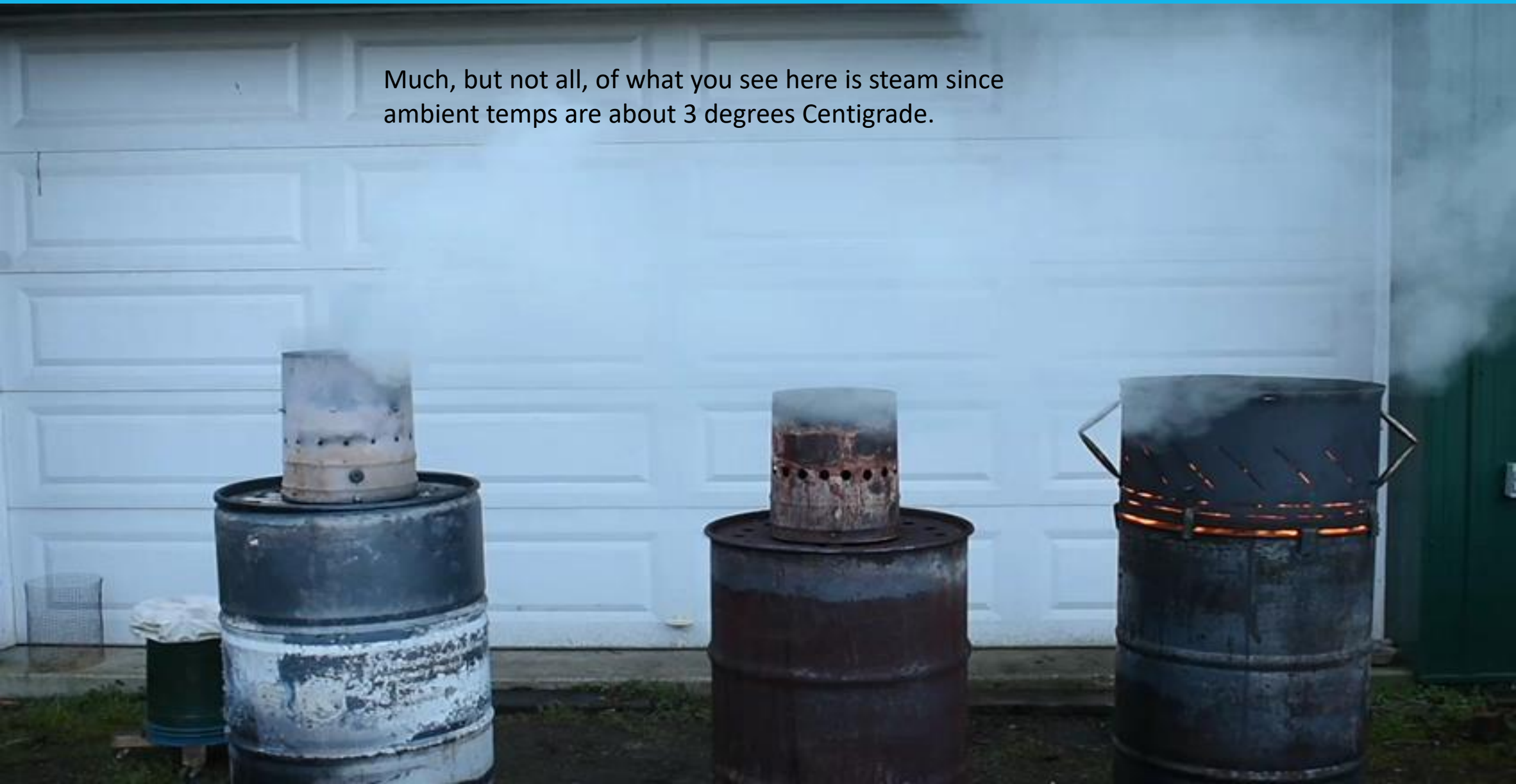
Wood pellets have a pyrolytic front, wood chips have a pyrolytic zone.


Version 16 – Ring of Fire
Version 22
Version 19
FAT (%) :
DRUM NO :
PRODUCTION DATE :
EXP. DATE :
NET WEIGHT :
GROSS WEIGHT :
01 . 13 . 2019 04 : 20

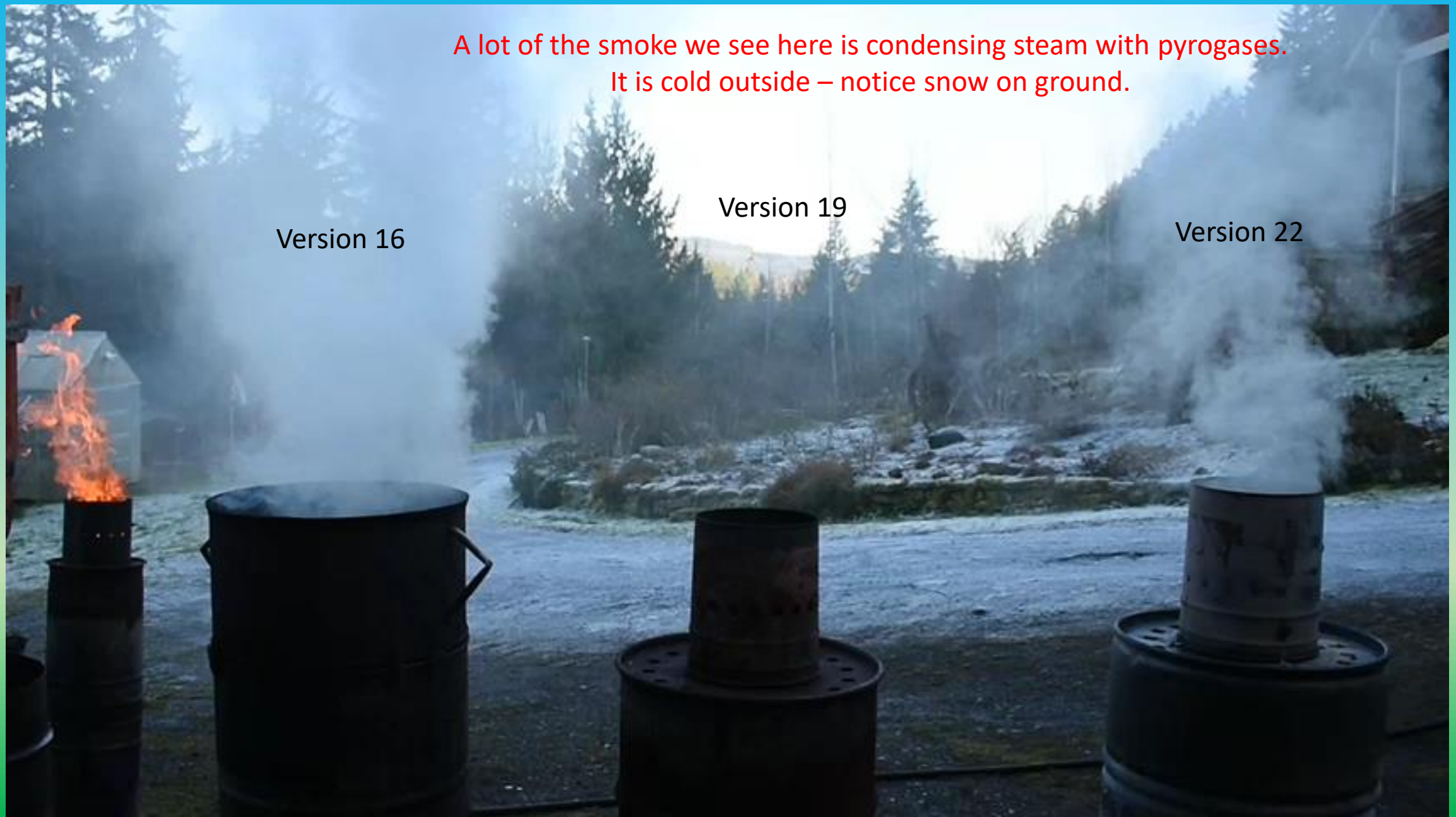

Version 22
Version 19
Version 16
01.14.2019 03:50

Run Video

Run Video


Much, but not all, of what you see here is steam since ambient temps are about 3 degrees Centigrade.

Run Video


A lot of the smoke we see here is condensing steam with pyrogases.
It is cold outside – notice snow on ground.
Version 16
Version 19
Version 22


What's going on???
Version 22
Version 19
Version 16 – Ring of Fire
PRODUCT OF INDONESIA
01 . 13 . 2019 04 : 20


Start ‘flame cap’ protocol when the TLUD gets up to temperature and the flames are going full on.
01 . 16 . 2019 05 : 49

Run Video

Version 19 – Set up for a Burn

Secondary Air Heat Shield

Secondary heat shields increase temperature of secondary air inside about 250 C.

Will this improve emissions???

We will find out at the TLUD Summit.

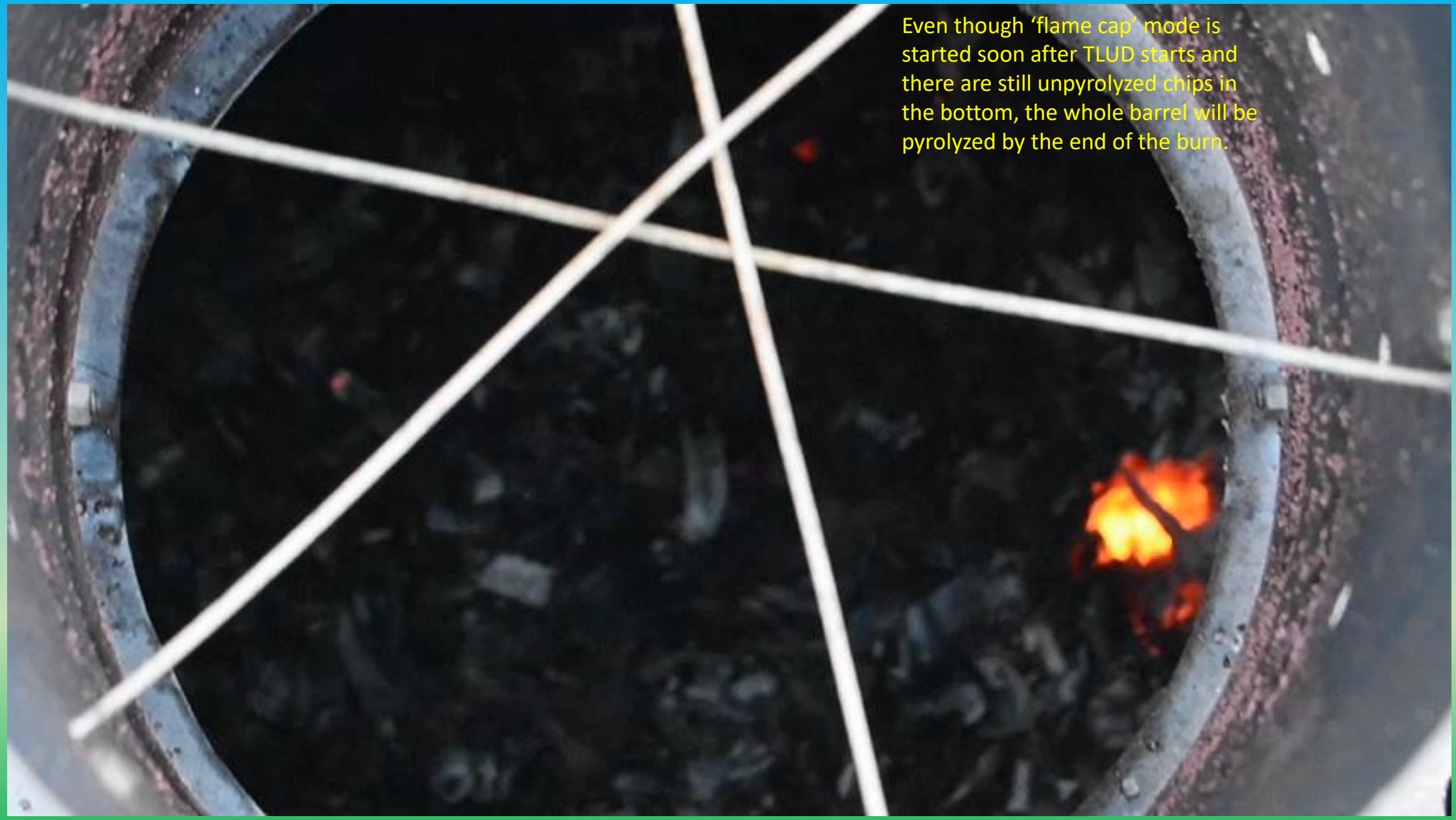

01 . 17 . 2019 05 : 26


01 . 17 . 2019 05 : 26


01 . 17 . 2019 05 : 27


01 . 17 . 2019 05 : 27

Run Video


Even though ‘flame cap’ mode is started soon after TLUD starts and there are still unpyrolyzed chips in the bottom, the whole barrel will be pyrolyzed by the end of the burn.


01 . 17 . 2019 05 : 30


01 . 17 . 2019 05 : 30


01.17.2019 05:37


RSUP - INDUSTRY
01.17.2019 05:32

Run Video

Walk away and let it cool. Open later and note the lack of tar smell.

Current Conclusions

Can I answer some questions?

“The only difference between science and just fooling around is writing it down”.
Peggy Baker