Bio-Mass Reactor

Gas Cylinder with Can Test 2

Engineer88

1/29/2015

[Type the abstract of the document here. The abstract is typically a short summary of the contents of the document. Type the abstract of the document here. The abstract is typically a short summary of the contents of the document.]

Second Test of Welded Can Inside Gas Bottle

Experiment 25/01/2015

Introduction

Experiment was conducted with largely the same equipment as found in Experiment #1 with some additions and modifications based on what was observed. With the help of these changes a successful biomass to biochar reaction was completed.

Notable differences in how the experiment was carried out:-

- A wooden board (damp veneered chipboard) had a circle cut from the center to fit around the orange gas cylinder, with a 5mm gap all round. The board also had a 73 mm hole cut at the back to allow for combustion gases to escape (this hole was in line with the burner flame and was "in front" of the flame front, not behind. See Fig 1)

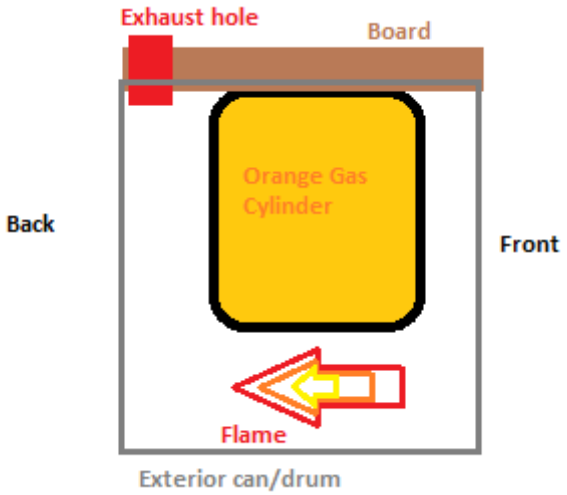

Fig 1

- Al Foil was wrapped around the underside of the top board to help reflect heat back into the external can and to protect the board from the heat (Fig 2)
- Three 32 mm holes were drilled into the lower back of the exterior cans to allow air in for combustion. A separation of 5-10º (Wild guess, not measured)
- One 32 mm hole was drilled into the lower front, directly under the hole for the burner. With several 6 mm holes around the can, on the same level. (Fig 2)
- A M14 nut was welded to the top of the internal can's exhaust pipe, this allowed for standard pressurised air fittings to be used. (Fig 2)
- A "cyclone filter" was fabricated with whatever material was readily available. This material dictated the size of the final dimensions. How well it works is not the product of smart engineering design.
- The cyclone filter was connected to the internal can with a piece of rubber airline hose, approximately 600mm long. (Fig 2)
- Some crushed beer cans were placed under the internal can, inside the gas cylinder, to fill the cavity in the base. The intention of this was to distribute heat more evenly across the internal can.

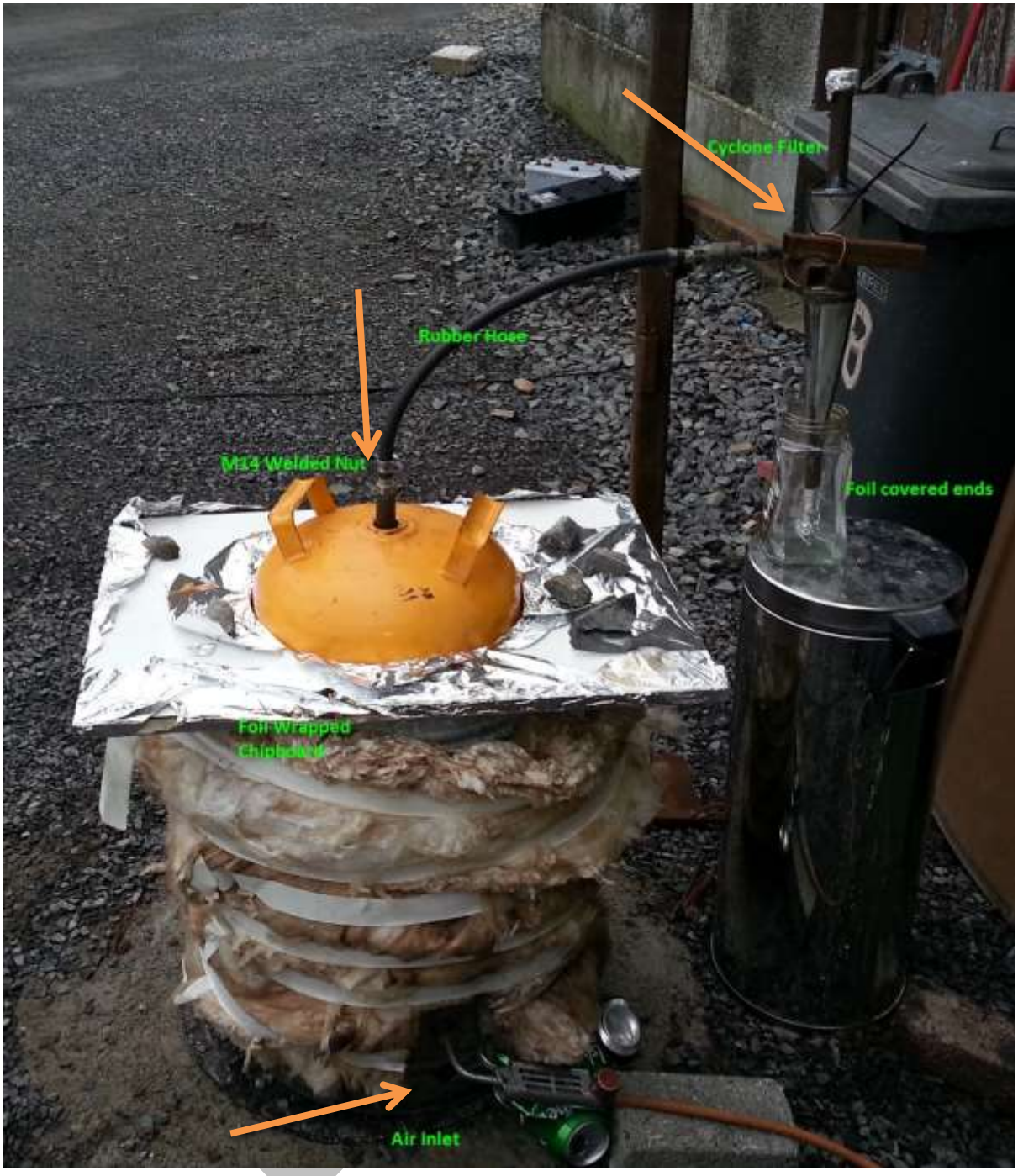
Cyclone Filter
Rubber Hose
M14 Welded Nut
Foil covered ends
Foil Wrapped
Air Inlet

Fig 2

Logged timeline of experiment #2

0h 2 min	• Flame started – Can already see "heat" in the air • Wind is stronger than before, worried about rain
0h 10 min	• Flame is steady – Mid heat – Exterior drum wall is hot at top
13 min	• Internal can exhaust neck is getting warm to touch
18 min 30sec	• First sign of stuff escaping at gas cylinder neck – Not exhaust pipe. o Water from beer cans in cavity? Paint?
21 min	• Another burst of fumes escaping
22 min	• Smell wood charring – Is it top board? o There is a faint scent from the cyclone filter top
27 min	• Can's exhaust neck is getting hot to touch + more fume bursts escaping.
36 min	• Flame was seen to be out of position – Corrected
39 min	• Exhaust fumes hot enough to light a match in less than 30 seconds
45 min	• Feeling spits of rain
60 min	• Increase flame
1h 13 min	• Smell of hot paint • Flame increased further. Maximum equipment will allow.
1h 15 min	• Listening to changes in sound • Smoke appearing around the wooden cover board
1h 17 min	• Hose is heated throughout its length. Heat is transferring to the metal fittings.
1h 18 min	• Change in smell. Woody. Suspected problem is cover board.
1h 25 min	• Using water splashes to remove some heat from the cover board.
1h 35 min	• More smoke & fumes are escaping at the gas cylinder neck. (Fig 5) o Bursts of wind make the flame flutter
1h 45 min	• Smoke escaping from neck is becoming constant – Is this the beer cans? (Fig 5)
2h 0 min	• Hose is no longer warm. Why? o Disconnected the hose from the cyclone filter. Some (not hot) fluid dripped out from the female connection.
2h 8 min	• Moved the cyclone filter so that the hose no longer sits up hill (Fig 3)
2h 15 min	• Fumes have started leaving the bottom outlet of the filter. (Fig 4) o Fumes are thick and contain an oily substance
2h 40 min	• Considerable smoke is escaping from the gas cylinder neck. – Unpleasant and irritating, requires a respirator. (Fig 5) • Rain is starting • Gas cylinder paint is peeling – Signs of glowing red hot
3h 0 min	• Escaping smoke is acrid. Burns eyes and absolutely cannot breath without a respirator. (Fig 5) • Retreating inside for a break and to avoid the smoke
3h 50 min	• Fumes from internal can – that leave the cyclone filter – have reduced significantly • Fumes escaping from gas cylinder have reduced significantly • Burner gas (propane) is turned off • Cyclone filter disconnected - thus sealing the internal can • Experiment ended

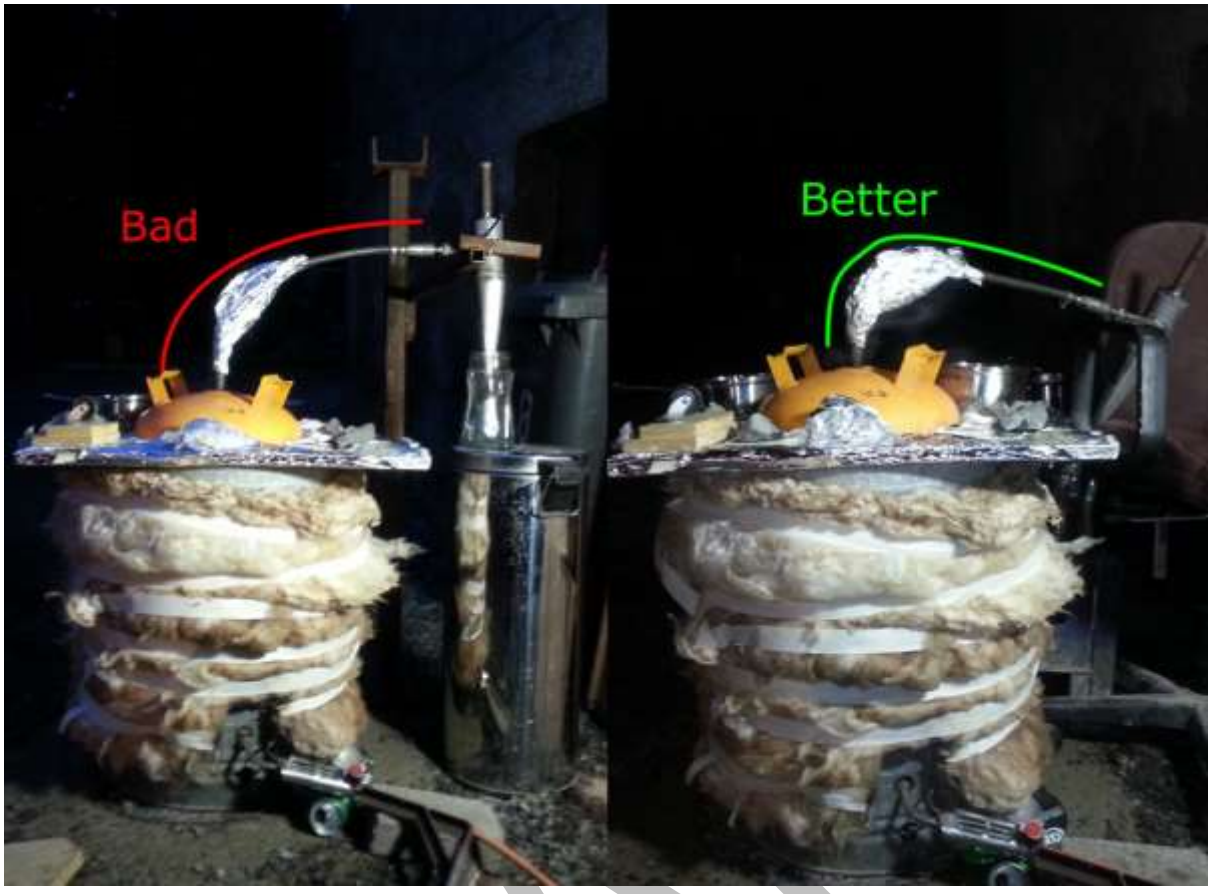

Fig 3 – Changing the position of the cyclone filter

Fig 4 – Image showing the fumes exhausted from the internal can and the oily substance that has condensed from them

Fig 5 – Image showing the acrid smoke that was released from inside the gas cylinder. Note the discolouration of the internal can's exhaust pipe. It is a heavy black residue.

Fig 6 – A comparison of the materials before and after the reaction.

Fig 7 – Image comparing the internal can's surfaces. (Left is Experiment #1 – Right is Experiment #2).

After experiment #1, surface rust remains on the can with a very localised discolouration on the can's base.

In contrast, after experiment #2, the surface rust has been removed entirely from the can. There is discolouration around a portion at the top of the can; there is no immediate explanation for this discontinuity in uniformity.

Fig 8 – A low density charred product was found in the cavity between the gas cylinder and the internal can. It feels like very low density expanding foam and is very brittle – it will grind into small particles if not handled very gently.

Comments and Discussion

- The foiled wooden board is an insufficient cover. The heat damages the material, it poses a fire risk and it is not an efficient insulator (there is still heat loss).
- Flow at the cyclone filter was not visibly significant. There is no evidence of a cyclone effect, fumes only visibly exhausted from the bottom.
- Fluid heat was lost at the hose. There was a significant temperature difference at either end of the hose, radiant heat was felt.
    - The fluid that dripped from the female connection when the hose was disconnected is a sign that the setup was acting more like a condenser. In the demonstration from ASU, they collected a less viscous substance from the cyclone filter. They collected a visually similar product to what is shown in Fig 4 from a separate condensing unit, a stage beyond this reactor.

Conclusions