Appendix-III

Gas analysis procedure

The gas samples were taken after steady state gasifier operation. The clean and cool gas was collected in gas balloon from the one of the sampling port installed at the exit of the filter in the prior stage of burner at specified time intervals. The producer gas was analyzed by a gas chromatographer GC 2010 (Shimadzu) to detect CO, CO$_2$, H$_2$, CH$_4$ and N$_2$. The gas chromatograph was equipped with a Shin Carbon ST 100/120 micro packed column and operating on $\mu$TCD (micro-thermal conductivity detector). Tubular led bed reactor of GC made of stainless steel column of 1 mm inner, 1/16 inch. outer diameter and column length 2 m. CO, CO$_2$, H$_2$, CH$_4$ and N$_2$ were identified from their retention time as obtained by chromatograph of a calibration mixture. The injector, column and detector temperatures were maintained at 150 °C, 60 °C and 130 °C respectively. Helium at a flow rate of 30 ml/min was used as the carrier gas. The current for TCD (thermal conductivity detector) was maintained at 90 mA.

Figure III.1. Gas chromatograph.
The sample solution was injected into a separation tube (column) of GC with helium as the carrier gas. A carrier gas propelled the sample down the column. The various components were separated inside the column. The detector was inserted into the gas stream at the end of the column and the detector measured the quantity of the components that exit the column. Each component ideally produced a specific spectral peak. The chromatograph produced a spectrum of peaks for a sample demonstrating the components present in a sample. The time elapsed between injection and elution is called the retention time. The retention time could help to identify compounds if the method conditions were constant. Under constant conditions, the pattern of the peaks would be constant. The size of the peaks is proportional to the amount of compounds present in the chromatograph. The concentration of compounds in the original sample could be determined by calculating the area of peak. This area was then taken as reference. By comparing the areas of peaks for original sample and gas sample, the composition of gas sample was calculated/predicted by the computer software. The chromatographs were recorded and peak areas were calculated. The gas calorific value was calculated based on concentration of gaseous products. Few screenshot of GC analysis is presented below.
(a) GC analysis of producer gas from 13-16 mm lignite particle size.

(b) GC analysis of producer gas from 16-19 mm lignite particle size.

(c) GC analysis of producer gas from 19-22 mm lignite particle size.
(d) GC analysis of producer gas from 22-25 mm lignite particle size.

(e) GC analysis of producer gas from 25-28 mm lignite particle size.

(f) GC analysis of producer gas from 28-31 mm lignite particle size.
(g) GC analysis of producer gas from 10% W/L ratio.

(h) GC analysis of producer gas from 20% W/L ratio.

(i) GC analysis of producer gas from 30% W/L ratio.

Figure III.2 (a-i). Screen shot of GC analysis.