Improvements in Reliability to the GPCS System

Gas Producer Combustion System, developed by Livio Dante Porta on the

Rio Turbio Railway

Used by David Wardale on the Class 26 “Red Devil”

Also used on some subsequent locomotives (mainly narrow gauge or miniature).

Advantages

Reduces clinkering due to lower fire temperature – less molten ash.

Longer firebar life

Can increase the grate limit, potentially producing more power for a given size of grate

Disadvantages

Sometimes not successful.

Chemical Reactions

Orange box = flames

$CO + (1/2)O_2 \rightarrow CO_2$ $H_2 + (1/2)O_2 \rightarrow H_2O$

-184.8 KJ/mol -285.8kJ/mol

Oxygen provided by secondary air

Black box- coal

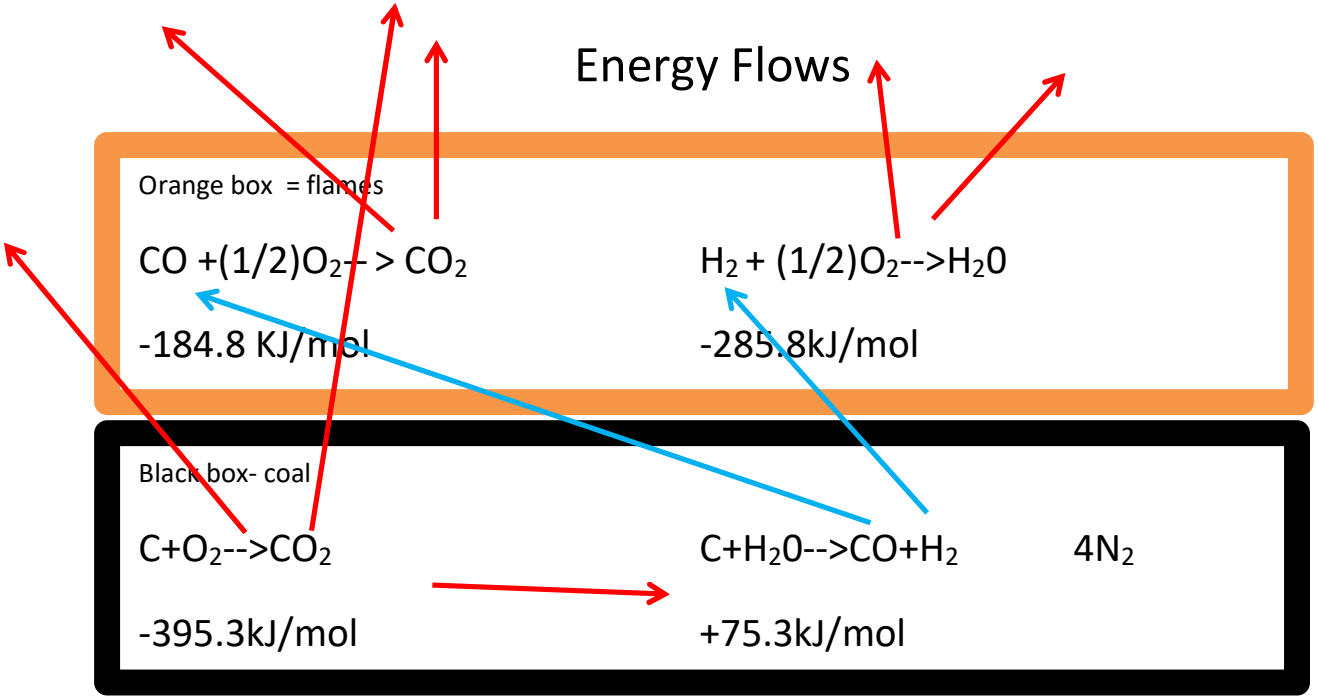
$C + O_2 \rightarrow CO_2$ $C + H_2O \rightarrow CO + H_2$ $4N_2$

-395.3kJ/mol +75.3kJ/mol

(exothermic reaction) (endothermic reaction)

1 mole corresponds to the number of atoms in 12g of carbon

$=6.022140857 \times 10^{23}$ =602,214,085,700,000,000,000,000 atoms



Energy in the form of heat

Energy in the form of carbon monoxide or hydrogen

The temperature of the firebed depends on difference between the heat produced by combustion, and the heat absorbed by gas production.

If there is too much gas production, the temperature will drop too low to the detriment of combustion.

Heat transfer to the boiler will reduce.

Proposed Improvements

1) **Detect when fire is overcooled**

Reduce the steam flow

Manual Valve?

The crew already have enough to do

Automatic System

Measuring the temperature of fire is difficult, the transducer is liable to have short life and fail.

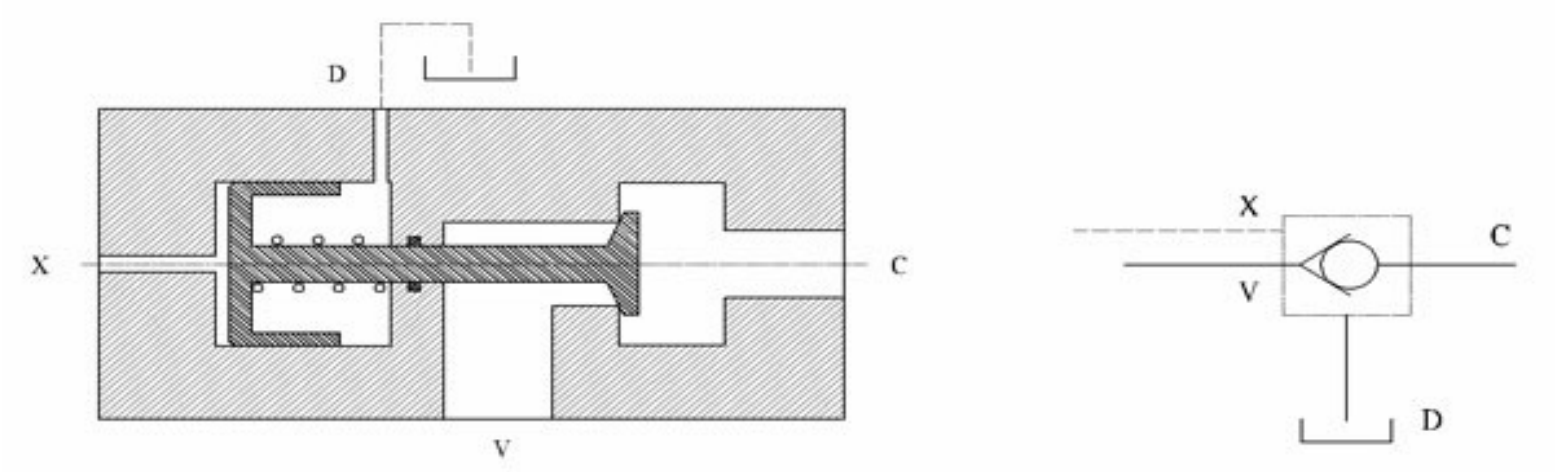
Measure steam pressure?

More reliable, reduce or shutoff the undergrate steam flow if boiler pressure drops below about 85% of nominal value (adjustable)

For 250psi boiler 85% will be 212.5psi

Example of possible valve arrangement

(diagram copied from Valve Products website)



Further developments in the control system are possible (electronic?)

2) Insufficient secondary air

GPCS equipped locomotive requires greater secondary air than for conventional combustion.

Comment on the Nat Pres website about the "Bunsen burner effect" on Sentinel locomotives observed at night.

Water was sprayed into the ashpan, evaporated and caused GPCS type chemical reactions.

Insufficient secondary air to burn the gases.

Not really a reliability issue, but caused a reduction in efficiency.

The rule of "light grey smoke" would need to be re-examined for a GPCS equipped locomotive.