CASE STUDY

H-VARB PF Diffuser at Ratcliffe Power Station, UK

Background.

December 2004, Ratcliffe engineers asked if Greenbank could develop a new Variable Area Rope Breaker (VARB) for use in splitting Pulverised Fuel (PF) in the horizontal configuration.

Each 500MW boiler at Ratcliffe has 4 rows of front wall firing burners. The upper two rows have sufficient height to install both the current VARB and trifurcator arrangement but the lower two rows have insufficient height to install this arrangement.

Greenbank's sister company GAIM undertook this task. Using their experience with particulate control and CFD techniques, various prototypes were put to test on the test rig, which is located at the University of Nottingham. This rig can easily be modified to replicate positions of splitters in either the horizontal or vertical configuration.

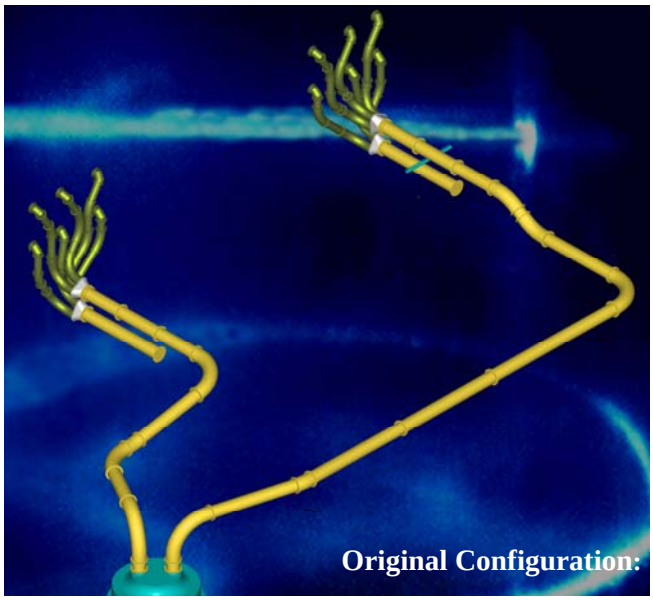
In comparison to the vertical VARB, gravity has a detrimental effect on particles passing within a horizontal pipeline and as such it was not anticipated that a homogeneous distribution could be produced in the same way.

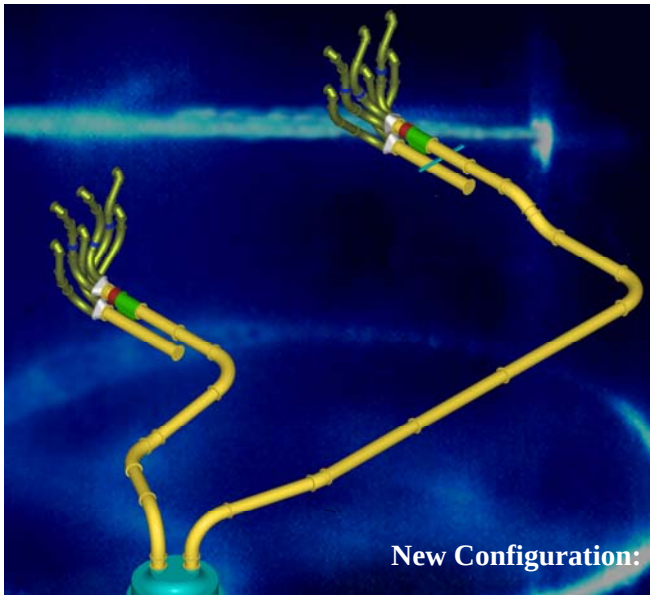
Upon testing one device, using entirely different flow principles than the vertical VARB, it stood out above the rest. Christened the H-VARB, under test conditions the flow through a three outlet trifurcator consistently produced distribution within +/- 6% across the outlet legs. These tests were replicated under different velocities and air to particle ratio.

To enhance this test, a control gate with three blades was installed downstream of the H-VARB. The idea was to add a facility for fine tuning so that the distribution can be improved or controlled.

In November 2004, Greenbank supplied 2 x VARBs, 2 x Control Gates and the associated pipe work to Ratcliffe Power Station.

The PfMaster system was installed in advance of the H-VARB being fitted so the distribution data could be analyzed and the improvement in distribution easily noted.





Outline Performance Data.

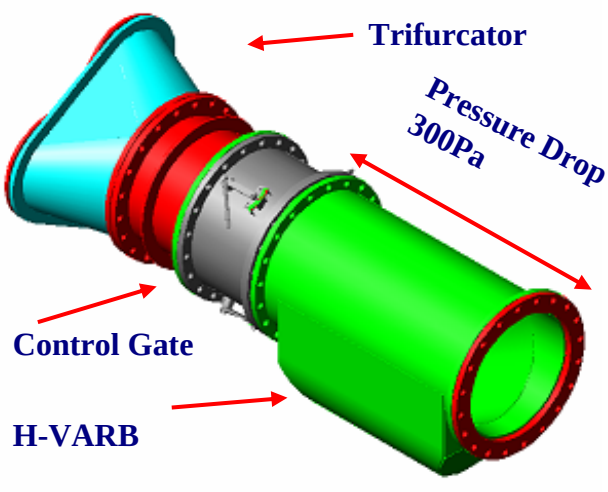
- Air to Fuel Ratio: 2.6 to 3.4:1 Velocity: 21-25.4m/s, Coal Type: Black (Varies)
- Pipe Inlet Diameter: 660NB (26"), Pipe Outlet Diameter: 380NB (15")
- Pipe Linings: Eucor & Basalt

VARB Arrangement:

Installation and Operation:

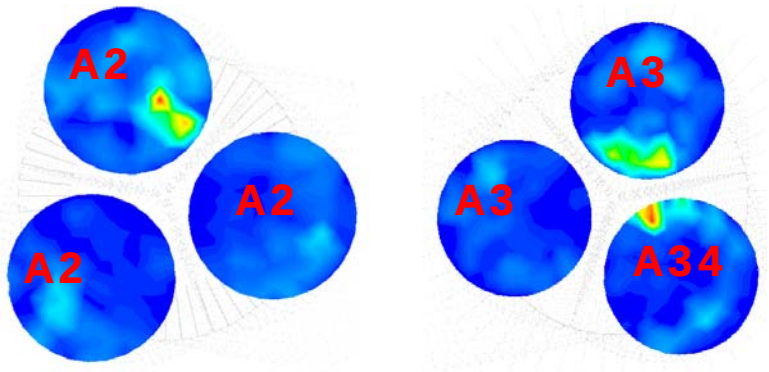
The Control Gate and H-VARB were installed directly in front of the existing 3-way Trifurcator.

The position and orientation of the H-VARB is critical for its performance. The principle of the H-VARB is to lift the rope away from the pipe wall and in turn, fan it out into a turbulent void. In order to do this, prior distribution results need to be analysed and a CFD study completed to replicate the existing conditions. When this is achieved, only then can the position of the rope be identified.



Should the H-VARB be right after a bend or elbow, the position of the rope would be obvious. However, if the position of the H-VARB is somewhere along a straight pipe section the position and the profile of the H-VARB may need further design input.

The control gate is positioned strategically at the correct distance from the H-VARB so that the flow into each splitter leg can be finely trimmed. It is also designed such that the air pressure is rebalanced after the diverter blades so only particulates are diverted and not air. The degree of movement of the blades is limited to +/-15° from zero.



Results: Control Gates Set at Zero Degrees

The results are outlined below showing the installation before and after the H-VARB was fitted. In this instance 2 H-VARB's were fitted to one mill, so that the distribution is over 6 outlets. The results are shown stating:

% Distribution: Which is a percentage of the total mass flow and,

% Deviation: Which is the percentage deviation from the required mean.

Results 1	Outlet:	A25	A26	A27	A34	A35	A36
% Distribution	Pre H-VARB	11%	27%	12%	11%	22%	17%
	Post H-VARB	19%	22%	12%	17%	14%	16%
Deviation From ideal	Pre H-VARB	-5.67%	10.33%	-4.67%	-5.67%	5.33%	0.33%
	Post H-VARB	2.33%	5.33%	-4.67%	0.33%	-2.67%	-0.67%

The following results were after adjusting the Control Gates blades:-

Results 2	Outlet:	A25	A26	A27	A34	A35	A36
% Distribution	Post VARB	18%	20%	15%	17%	14%	16%
% Deviation	Post VARB	1.33%	3.33%	-1.67%	0.33%	-2.67%	-0.67%