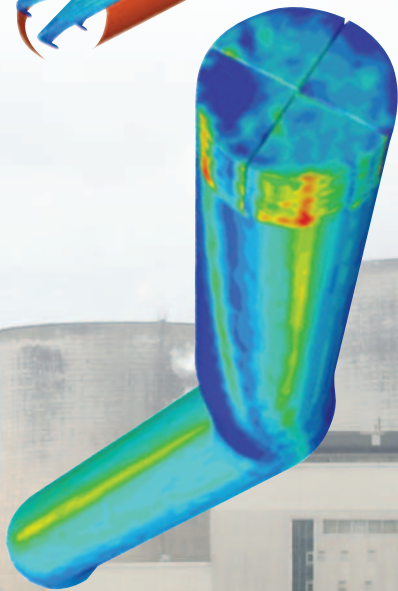
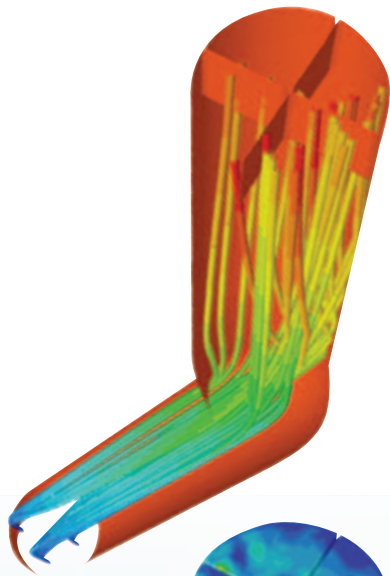


VARB®

PF Diffusion, Flow Balancing
and Control



"Enhancing the performance of our
customers plant & equipment"

VARB® & Control Gate®

PF Distribution System

Accurate, reliable PF Diffuser with low pressure drop

Power plant operators are faced with increasing pressure to improve the efficiency and reduce emissions from their boilers. Recently, this has become further complicated due to the burning of biomass fuels as well as coal in the same boilers. Greenbank Terotech Ltd, in partnership with GAIM (Greenbank Advanced Instrumentation and Measurement Ltd), offer a revolutionary non-intrusive rope breaker for pulverised fuel (PF) with the unique family of VARB® PF diffusing systems.

As pulverised fuel is conveyed from the mill classifier to the boiler burners through the supply pipework by the primary air, a roping effect can occur within the flow of material being transferred. This disrupts the balance and efficiency of distribution of the fuel as it reaches the burners. The purpose of the VARB® (Variable Area Rope Breaker) is to break the PF rope and allow the fuel to flow evenly to each burner.

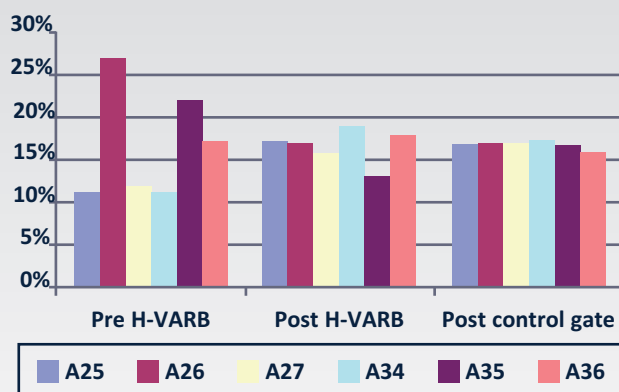
In particular, where the pipes split into one or more branches, uneven distribution often leads to a poor fuel-to-air ratio, combustion inefficiencies and accelerated erosion. The Greenbank patented VARB® PF diffusing system together with Greenbank Control-Gate® technology will destroy the rope then control, balance and trim the air/fuel ratio to the desired distribution down each pipe leg.

The H-VARB® is second generation in the VARB® family. It was developed to balance the air/fuel ratio equally at bifurcations, trifurcations and multi-outlet splitters. In conjunction with the Control-Gate® the performance of the HVARB® is repeatable to within +/-5% of the mean distribution under different fuel /air loadings. Since its development it has been proven to work equally well in the vertical mode.

H-VARB® & Control Gate® Assembly



H-Varb & Control Gate Distribution Data



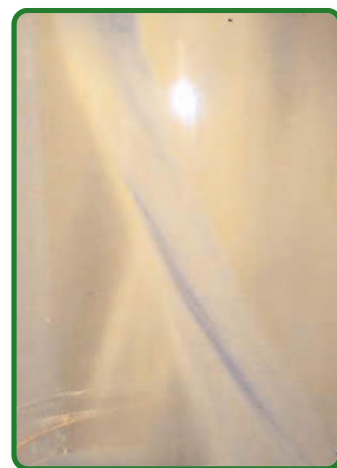
Better by Design

Lower Maintenance Costs

- Reduced pipe erosion
- Elimination of riffle box internals/dampers

Control of NOx

- A better distribution allows the lowering of secondary air levels under stable operating conditions without increasing NOx



PF Rope Forming

Significant Benefits Using VARB®

Higher Combustion Efficiency/Burnout

- 10x less pressure drop than a riffle
- Stable combustion
- Reduction in pressure drop across the PF piping system
- Reduction in flame length
- Elimination of flame detachment

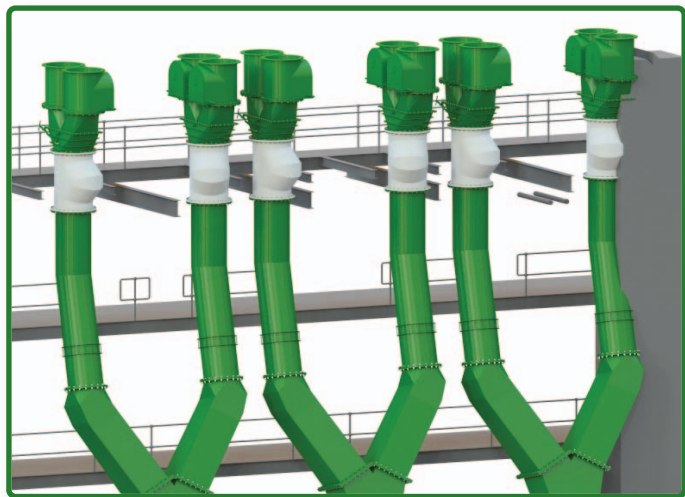
Reduced Carbon-in-Ash

- Saleable ash
- Avoidance of disposal and land fill taxes



“It is our vision to excel and lead the world in our area of expertise”

Operating Philosophy



Engineered Using CFD

In order to find the best solution, we will apply the following methodology rigorously for each application and every VARB® design will consist of the following steps:

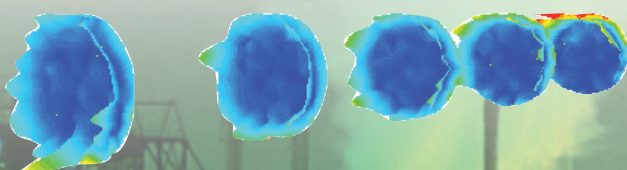
- Acquisition of customer's existing PF distribution data
- Creation of a computational fluid dynamics model and the numerical simulation of the existing distribution
- Prediction of the PF rope position
- Introduction of the VARB® design within the computational model
- Optimisation of the VARB® design and location within the numerical model
- Verification of Rope position by survey
- Production of Engineering Layout drawings for customer
- Manufacture of VARB® and Control-Gates®
- Installation and optimisation of VARB® and Control-Gate®

The VARB® can be designed for use with pulverised coal and biomass fuel. This has become more common in the UK as more plants convert to the use of biomass, particularly in the form of wood pellets.

Benefits to Combustion

The benefits of improving poor PF distribution can be seen with a direct reduction of carbon-in-ash. Poor distribution will have a detrimental effect on the combustion performance at individual burners. Equalising the distribution of fuel to the burners lowers the carbon levels from the boiler without having to make further changes to boiler controls. This can also allow the boiler operators to optimise for NOx having had their carbon levels minimised. Having Control-Gates® fitted enables the optimisation of our VARB® technology and, in turn, the PF distribution to the boiler. The optimised position of each Control-Gate® can quickly and easily be found using a rapid on-line measurement technique such as the Greenbank Coal Flow Monitoring System.

The Control- Gates® are positioned directly after the VARB® and are designed to fine tune the distribution down each leg. The Control- Gate® is a damper which is mounted to the VARB outlet. It can be utilised to trim the diffused PF into or out of the downstream pipework legs. It is cleverly designed to increase or decrease the flow of PF into any of the outlet legs without affecting the airflow or air pressure down each pipe leg. The VARB® and Control-Gates® can be installed during outage periods or mill shutdowns where inspections of PF pipework systems are already planned. This reduces the additional costs of labour and access to the pipework.



S-VARB® and A-VARB®

The S-VARB® was the original VARB® designed and developed to break the PF rope and produce a homogenised mixture of PF and air at the outlet in the vertical mode. Utilising gravity, it works by reducing the velocity and inducing spin so that the PF particles become thoroughly mixed in the transport air before the pipe exit. Again, the S-VARB® operates under differing air/ fuel ratios and is unaffected by moisture or coal type changes.

The A-VARB® is designed to combat particularly aggressive rope situations. Working in the same manner as the S-VARB® it incorporates a throttle to agitate the rope before it is destroyed. The A-VARB® has operated successfully in front of 4-way splitters and has improved PF distribution compared with multi-outlet dynamic classifiers which were replaced with a HP static classifiers to gain increased throughput.

L-VARB® and T-VARB®

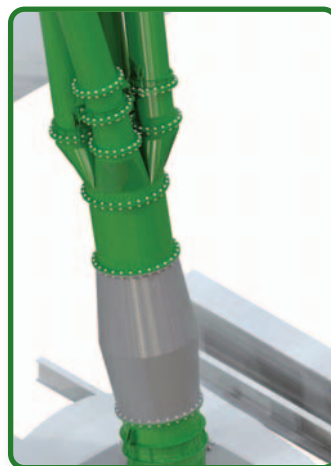
The VARB® technology has been applied to brown lignite coal. Many plants in Europe crush this fuel using large BETA mills with square outlets supplying the burners. These outlets have been shown by measurement to produce unequal distribution of the fuel. Several attempts by operators to balance the fuel have failed.

L-VARB®



T-VARB®

The L-VARB® can be designed using CFD to correct this and ensure a near perfect balance is achieved. The T-VARB® has been specifically designed to address inverted splits found immediately after sharp elbows commonly found on T-fired boilers.

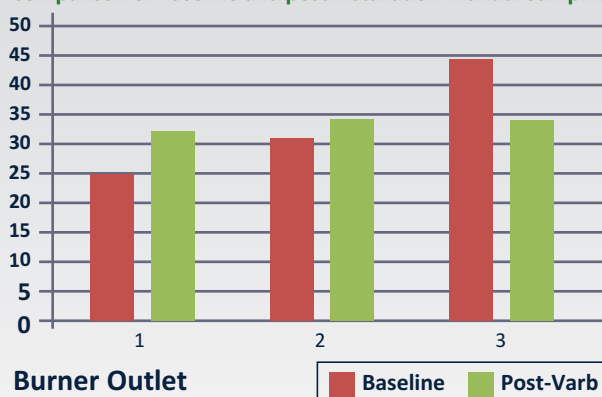


A-VARB®



S-VARB®

Comparison of Baseline and post installation Manual Sampling



BIOMASS

Greenbank have demonstrated that the VARB® technology is successful when balancing the distribution of biomass fuel using the same methodology as pulverised coal. Following installation, the system is fully tested and commissioned. The control gate is used for fine tuning until the desired results are achieved.