Ketton filters out emissions

by Donaldson Membranes, UK

Donaldson Membranes has recently provided a technologically advanced filtration solution for a new bag filter at Castle Cement's Ketton plant in Rutland, UK.

With the cement industry committed to reducing environmental emissions, the use of alternative kiln fuels has become increasingly attractive. As a consequence, such materials as waste tyres, recycled liquid fuels and Meat and Bone Meal (MBM) are now widely used as supplementary fuels, as their combustion in the kiln can significantly reduce the output into the atmosphere of many exhaust contaminants compared to that achieved when burning traditional fossil fuels.

Castle Cement is a great champion in this field and leads the way with its continual efforts to embrace operational methods which are not only economical, but that also minimise the impact of the Company's operations on the environment.

Recent work on Kiln 8 at Castle Cement's UK Ketton plant illustrates perfectly the Company's strong commitment in this respect.

Kiln 8 is a four-stage precalciner kiln. The fuels used for firing the kiln include coal, Cemfuel and Profuel.

Ketton is currently authorised to use these two alternative fuels – Cemfuel, a solvent derived fuel, and Profuel, a fuel based upon waste paper and plastics. Both of these are proprietary fuels developed by Castle Cement.

The use of these fuels does however result in high chlorine recirculation in the kiln system which could potentially lead to dangerous preheater blockages and/or restricted output. Hence, the amount of chlorine in the kiln system is the limiting factor on the use of alternative fuels.

To enable the continued and increasing use of these alternative fuels at Ketton, it was clear that a Chloride Bypass system was needed. The aim of the project was to engineer and install a system to allow a high proportion of the chlorides to be removed from the kiln gas stream, thereby enabling increased levels of alternative fuels to be burnt, the ultimate goal being to avoid blockages in the kiln and control the chlorine level in the hot raw meal.

Bypass filter under construction at Castle Cement's Ketton plant
Picture reproduced courtesy of Intensiv-Filter UK Ltd

Process requirements

Calculations showed that up to seven per cent of the kiln gas flow needed to be diverted through a Bypass system with the gases collected being filtered by a high temperature bag filter. Hot meal chlorine levels leaving the lowest stage cyclones also needed to be controlled to facilitate trouble-free kiln operation.

Objectives included:

- meeting WID (Waste Incineration Directive) emission limits at the stack with a suitable margin
- minimising production of high chloride dust as a waste material
- minimising reductions in kiln output as a result of bypass operation

Table 1: expected gas content

Gas	*Unit*	*Normal operation*	*Peak (30 mins)*
O_2	Vol %	0-20	20
H_2O	Vol %	0-20	30
SO_2	mg/Nm³	0-1700	6000
SO_3	mg/Nm³	0-100	150
HCL	mg/Nm³	0-50	1400
NO_x	mg/Nm³	0-1000	2000
HF	mg/Nm³	0-20	20
Br	mg/Nm³	Trace	Trace

Process specification

The dust produced during the production process is high Alkali Chloride and Sulphate bypass dust. The design gas volume for the bag filter was 106,800Am^3/h with an inlet temperature of between 130°C to 220°C. The expected filter dust loading was typically 35g/Nm^3.

Dust and chemistry conditions

Generally, dry kiln systems report dust loadings of around 0.15 to 0.80 kg/Nm^3 at the kiln inlet. It was anticipated that kiln 8 would be at the higher end of this range, typically 0.4 to 0.8kg/Nm^3.

The system needed to be designed for 0.8kg/Nm^3 at a 100 per cent bypass rate.

This project necessitated space in the plant layout for the retrofit of a conditioning tower after the injection point and before the bag filter. This was for the activation of Calcium Hydroxide and Sodium Bicarbonate, with the conditioning tower size to be around 5m diameter by 26m high, with capability to achieve an outlet temperature of 130-150°C. The equipment insulation was to be based on 130°C.

Bag Filter and Media

After much consideration, the project contractor placed the order for a new bag filter system with Intensiv Filter UK Ltd.

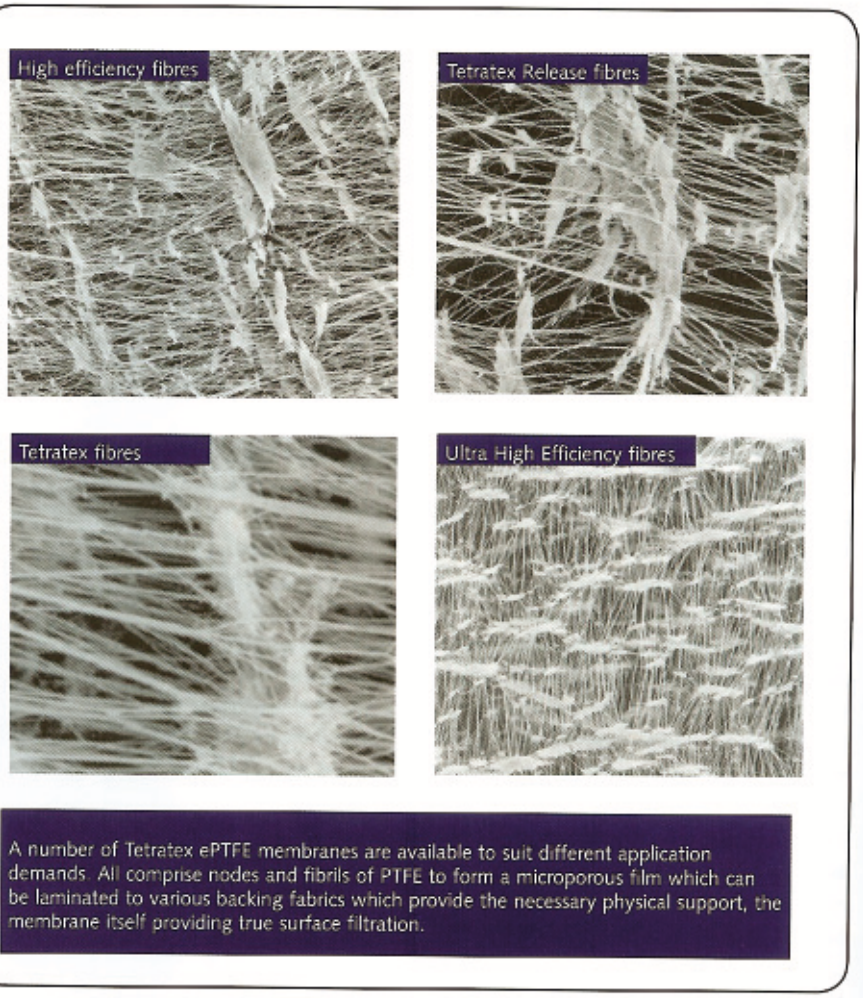
Intensiv Filter UK are able to provide a wide variety of filtration solutions to the cement industry and have a great deal of expertise in the field of dedusting for both kiln and bypass applications such as was needed at Ketton.

Following a full technical evaluation, Intensiv designed, manufactured and supplied a bespoke bag filter system incorporating the very latest filter media and pulse-jet cleaning technology.

The filter was to be fitted with 840 off tubular filter bags mounted on stainless steel support cages. All such dry dedusting applications require the filter bags to be cleaned to ensure operating pressure drop and gas flow are maintained at satisfactory levels. In the case of the filter installed at Ketton, dust building up on the surface of the bags is removed by means of a controlled jet of compressed air which is periodically blown down the centre of each bag. Engineered components ensure this jet provides an accurately formed "pulse" or "wave" of air which not only momentarily reverses the flow of air through the filter media, but also dislodges the cake build-up as it moves vertically down each bag. The frequency of cleaning is determined by a PLC which monitors the operating pressure drop, constantly maintaining the system at an acceptable level.

Some factors influencing pressure drop and frequency/pressure of cleaning

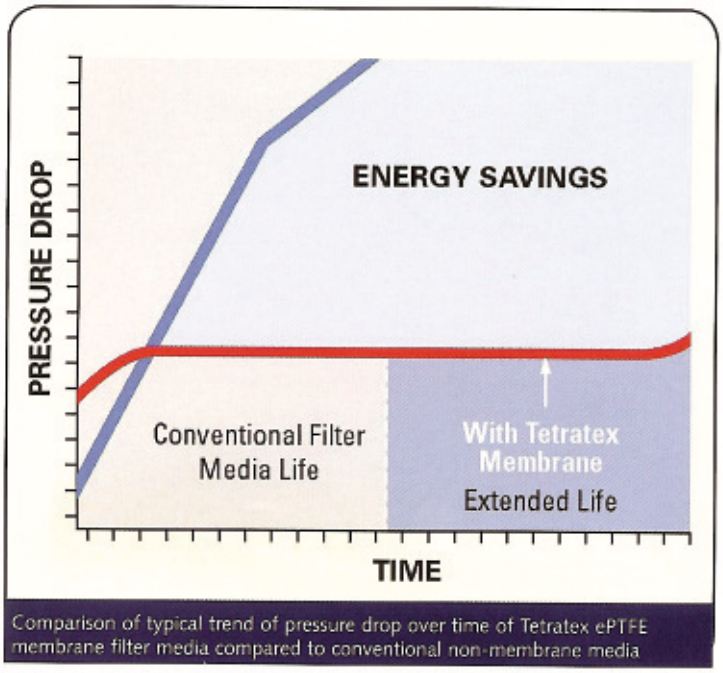
- dust loading
- humidity
- efficiency and condition of the cleaning system
- design of bag and cage
- inlet configuration
- can velocity (spacing between filter bags)
- filter velocity (air-to-cloth ratio)
- condition of filter media
- particle size and shape
- agglomerative nature of dust



A number of Tetratex ePTFE membranes are available to suit different application demands. All comprise nodes and fibrils of PTFE to form a microporous film which can be laminated to various backing fabrics which provide the necessary physical support, the membrane itself providing true surface filtration.

Table 2: specification for bypass bag filter

Manufacturer	Intensiv Filter UK Ltd
Gas volume	106,800Am^3/Hr
Dust loading	Typically 35g/Nm^3
Gas temperature	Operating 220°C – Maximum 260°C
Filtration air-to-cloth ratio	0.75m^3/m^2/min
Bag size	160mm nom dia x 5625mm long
No of bags	840 off
Filter cloth area (total)	2375m^2
Cleaning (offline or on-line)	Pulse-Jet, On-line
Bag support cages	20 Wire, Stainless Steel
Warranted particulate emissions	<5mg/Nm^3
Filter media employed	Tetratex #6255 Ultra High Efficiency Woven Glass



Comparison of typical trend of pressure drop over time of Tetratex ePTFE membrane filter media compared to conventional non-membrane media

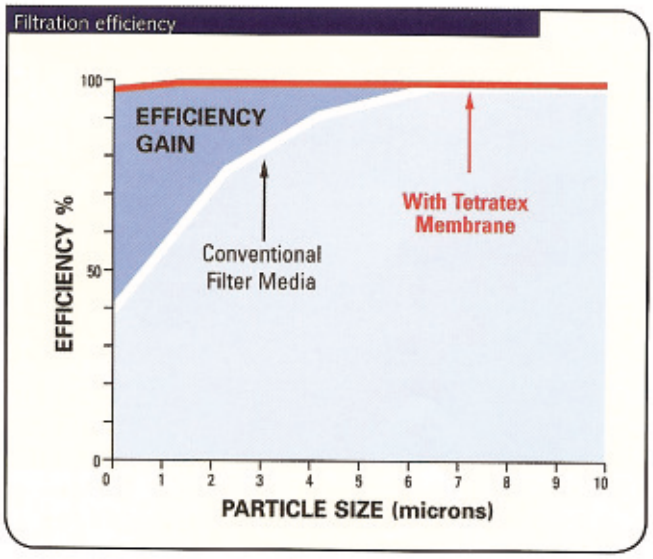
• type of filter media employed.

The latter is discussed in more detail below.

To ensure the required high level performance was successfully achieved on the Castle Cement Bypass project at Ketton, Donaldson Membranes Tetratex Ultra High Efficiency #6255 Woven Glass fabric was selected by engineers at Intensiv Filter, with the filter bags themselves being manufactured to the required design and specification to provide optimum performance and lifetime.

Tetratex Ultra High Efficiency #6255 Woven Glass filter media has been widely used throughout the world on cement kiln dedusting applications. The fabric comprises a woven glass fibre backing laminated with a Tetratex Expanded PTFE membrane. Emissions to atmosphere can be warranted to near-zero levels with expected bag lives for kiln dedusting reaching upwards of six years.

The key differentiation that Tetratex ePTFE membrane filter media provides over conventional non-membrane media is its non-reliance on a filter cake. Non-membrane media will often allow the passing of quantities of fine particles not only into but also beyond the media. This is especially so on start-up when the media is new. Conventional media only truly start to filter efficiently when a suitably dense filter cake has formed on the filter surface. Whilst this can sometimes provide the necessary performance, the reliance on a filter cake and the readiness of fine particles to penetrate into the open surface structure of the media often limits the ability of non-membrane media to perform consistently over extended periods of operation. Additionally, capability to recover from process upsets can be limited.



Tetratex ePTFE membrane media has no such reliance on cake formation and the membrane (being laminated to the filter surface as it is) prevents the penetration of particles into and beyond the backing fabric. Additionally, the smooth PTFE surface provides exceptional dust release on cleaning and as such operating differential pressures can be expected to be much lower and altogether more consistent over time. It should be noted that Tetratex #6255 Ultra High Efficiency Woven Glass filter media in use at Ketton is capable of collecting particles in the sub-micron range, even with non-agglomerative, free-flowing dusts.

Filter bags constructed from Tetratex ePTFE membrane media are used in many parts of the cement manufacturing process including kilns, clinker coolers, raw and finish mills and fuel mills. Additionally, as with Ketton, an increasing number of cement manufacturers are looking at running similar alkali bypass systems.

Of course, no two applications are ever the same. If optimum performance is to be achieved, it is vital that all factors related to the process are considered. Donaldson Membranes' engineers have the necessary product and technical application experience to offer sound advice on the required selection from the full range of membranes and their respective backing fabrics, the combination of which is designed to provide specific physical and filtration characteristics.

The four membrane families; Tetratex Release, Tetratex, Tetratex High Efficiency and Tetratex Ultra High Efficiency are all available with an extensive range of backing fabrics to meet a wide variety of thermal and chemical demands, whether that be for operation in pulse-jet, reverse-air or shaker filters.

These high performance Tetratex laminates can all supply superior dust cake release, low pressure drop, high air flow, and high particle collection efficiency.

Donaldson Membranes Industrial Filtration Product Manager Callum Baxendale, said: "Performance figures achieved from the filter to date are well within regulatory limits as well as those laid down in the comprehensive warranty that was provided at the time of supply.

"As a leading global player in the cement market, Castle Cement are constantly seeking new innovative and environmentally sound ways of operating. The installation of the new alkali bypass system at Ketton clearly demonstrates this and we are pleased to report that Donaldson Membranes #6255 Ultra High Efficiency Woven Glass Media is contributing positively to this strategy."