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Forterra creates flexible PFA production facilities in the UK

Aircrete Europe has been selected by Forterra Building Products, one of UK's leading building materials groups, as its technology partner to convert its existing AAC facilities at Hams Hall and Newbury. Both plants are able to handle PFA (Pulverized Fuel Ash) (Figure 1) as conditioned field ash or stockpiled ash as opposed to the current dry ash system. The first project, Hams Hall, was successfully implemented in June 2018 and the second project, Newbury, is currently being installed.

The use of fly ash in AAC production in the UK

The UK market for precast concrete masonry units is approximately 8.6 million m³ (DETR). Of this total market approximately 24 % are lightweight aggregate blocks in the density range 1000 – 1500 kg/m³ and 31 % are AAC block in the range 400 – 800 kg/m³. Most AAC products made in the UK uses fly ash as a siliceous raw material (Figure 2). There are several advantages associated with the use of fly ash for producing AAC. Environmental benefits are achieved by using a by-product material, as an alternative to a primary aggregate such as sand. The autoclaved matrix that results from the use of fly ash, because of the influence of aluminium ions, has a high resistance to sulphate attack. A low thermal conductivity can be achieved for AAC products made with fly ash, due to the low conductivity of the fly ash itself. [1]

Pulverized Fly Ash

Pulverized Fly Ash is a collective name for a range of Pulverized Fuel Ashes. It is predominantly used in the UK, India, China and Eastern Europe for AAC production. As a replacement of cement and quartz sand, PFA (which is often significantly cheaper) can be used in the production of AAC blocks. As a by-product from electricity generation by coal-fired power stations, unconditioned PFA (also known as "dry PFA" or "fresh PFA") has always been widely available to the market at attractive price levels. Nevertheless, climate change (i.e. an increasing occurence of milder winters) and increasing use of greener energy resources have put pressure on the availability of dry PFA. A major driver here is the Climate Change Act, which will result in a shutdown of many coal-fired power stations by 2022. As a result, the price of dry

Fig. 1: Used in cement, AAC blocks, and a variety of other applications, fly ash, or Pulverised Fuel Ash (PFA), is an important material for the construction industry

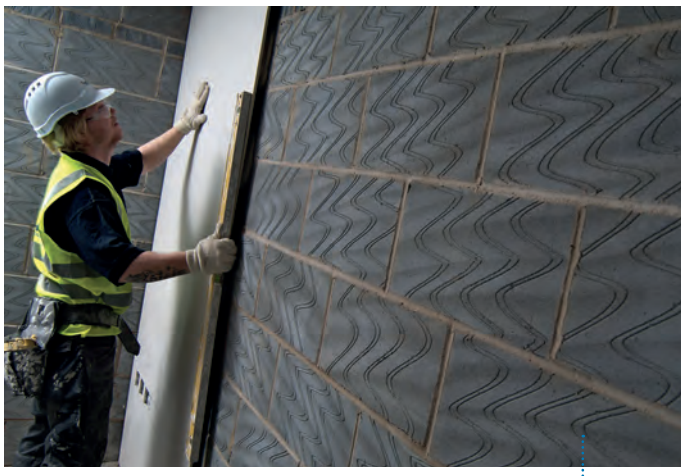

Fig. 2: Most AAC products in the UK are made using fly ash, giving the product its grey colour

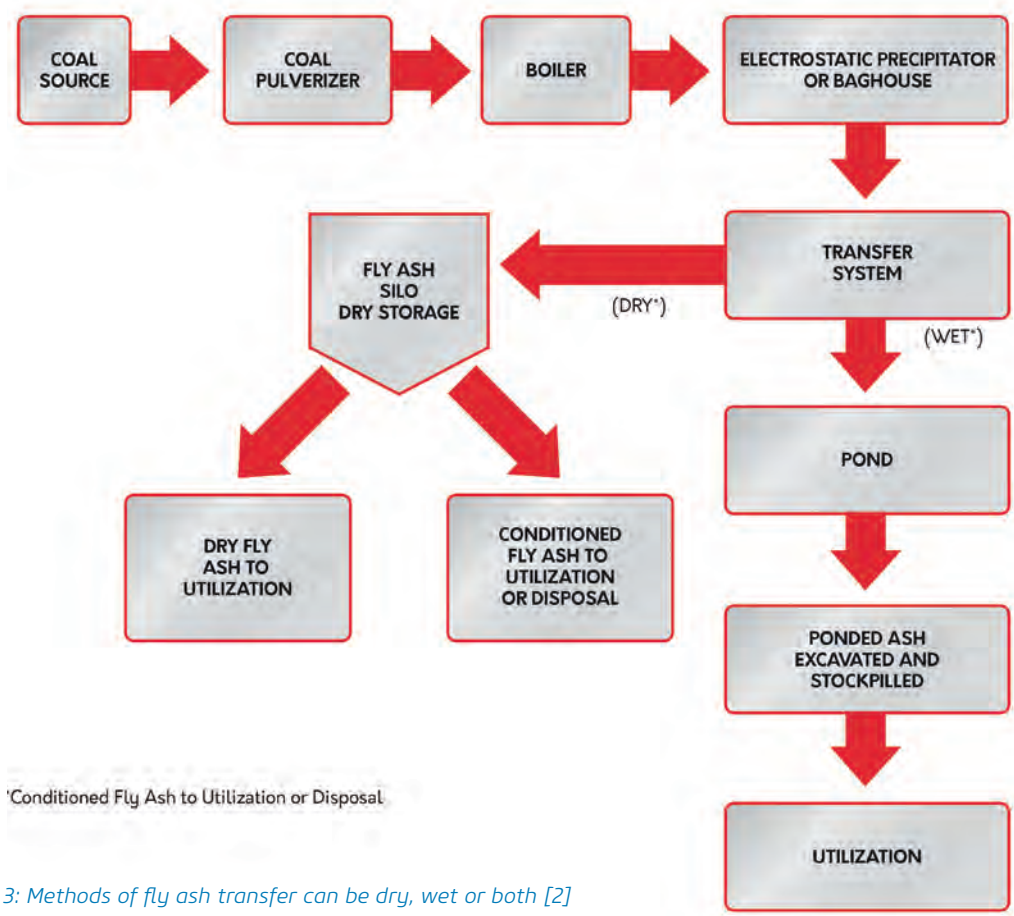

Fig. 3: Methods of fly ash transfer can be dry, wet or both [2]

PFA has doubled in the last 3 years and import of dry PFA is also already the case.

One solution to overcome this shortage of dry PFA would be to switch to use the fine conditioned stockpiled PFA and often mixed with courser Furnace Bottom Ash (FBA). Stockpiled PFA is old PFA stored in fields or coming from lagoons and ponds (Figure 3). It is estimated that there are well over 50 million tons of landfilled fly ash located at currently operating or recently closed power stations in the UK.

Conditioned Fly Ash taken directly from silos at the power station where the fly ash is fed into mixers and "conditioned" with 15 % to 25 % water prior to delivery (Figure 4). Lagoon Fly Ash is slurried at the power station and pumped to lagoons. This material is excavated from the lagoons and allowed to stabilise to reduce its water content. If desired, it can also be screened prior to dispatch. Conditioned Fly Ash is more easily handled in trucks and the addition of water makes it easier to compact.

Although widely available, stockpiled PFA is not directly suitable for AAC production, because of the chemical and physical changes that occur over time. Particles are exposed to water for long periods -months to several years- as well as the contamination to the material during this period.

Stockpiled PFA, as a result, is neither pure nor consistent and often contains high concentrations of incomplete burnt material. The quality and contaminations of conditioned PFA often differ greatly even between the truckloads. The variability, incon-

Fig. 4: Up to 50 million tons of potentially usable fly ash is available in stockpiles across the UK

Fig. 5: Removing contamination and agglomerations is only one of many challenges that needs to be overcome

sistency and contamination of the ash typically result in an inconsistent production process, high quality variations, increased waste and higher costs.

The goal is to design a system that can handle and pre-treat the variances and contamination of stockpiled PFA to make is suitable for high quality, continuous and reliable AAC production. By enabling stockpiled PFA as a source for AAC production, a new source of 50 million-ton available wet PFA would become available to the market. As an indication; currently around 2 million-ton of PFA is used annually by building material producers in the UK and much more worldwide.

In 2018, Forterra already secured a large supply of conditioned (wet) PFA and capital expenditure requests were approved to convert the Hams Hall and Newbury facility to enable the plants to use 100 % conditioned (wet) or dry PFA, or a mixture of the two.

Wet Front End solution

Aircrete Europe is designing and implementing a fully customized system solution that will allow the operating facility at Hams Hall to handle the stockpiled PFA and decrease reliance on the dry PFA as the infeed. The main principle is that the wet PFA is treated and made into a slurry and ultimately fed into the mix for AAC production. Nevertheless, the reality is more complicated as the system needs to handle and treat contamination and agglomerations while running continuously and keeping high quality slurry parameters in terms of density and temperature (Figure 5). Besides this, the material seriously behaves as a shear thickening dilatant fluid.

Stuart McQuillan, Head of Engineering at Forterra, commented: “We were looking for a true technology partner who would also take on the project on a turn-key technology supply basis and not just an engineering firm or machine supplier, as we needed a system from the stockpiled ash all the way to towards good quality product. Aircrete Europe has proven to be a reliable partner to take on this role.”

The details in the system and process design are the key part for a successful project (Figure 6). Even though the project is relatively small in terms of size, it is highly complex as multiple technical and operational disciplines need to collaborate effectively to

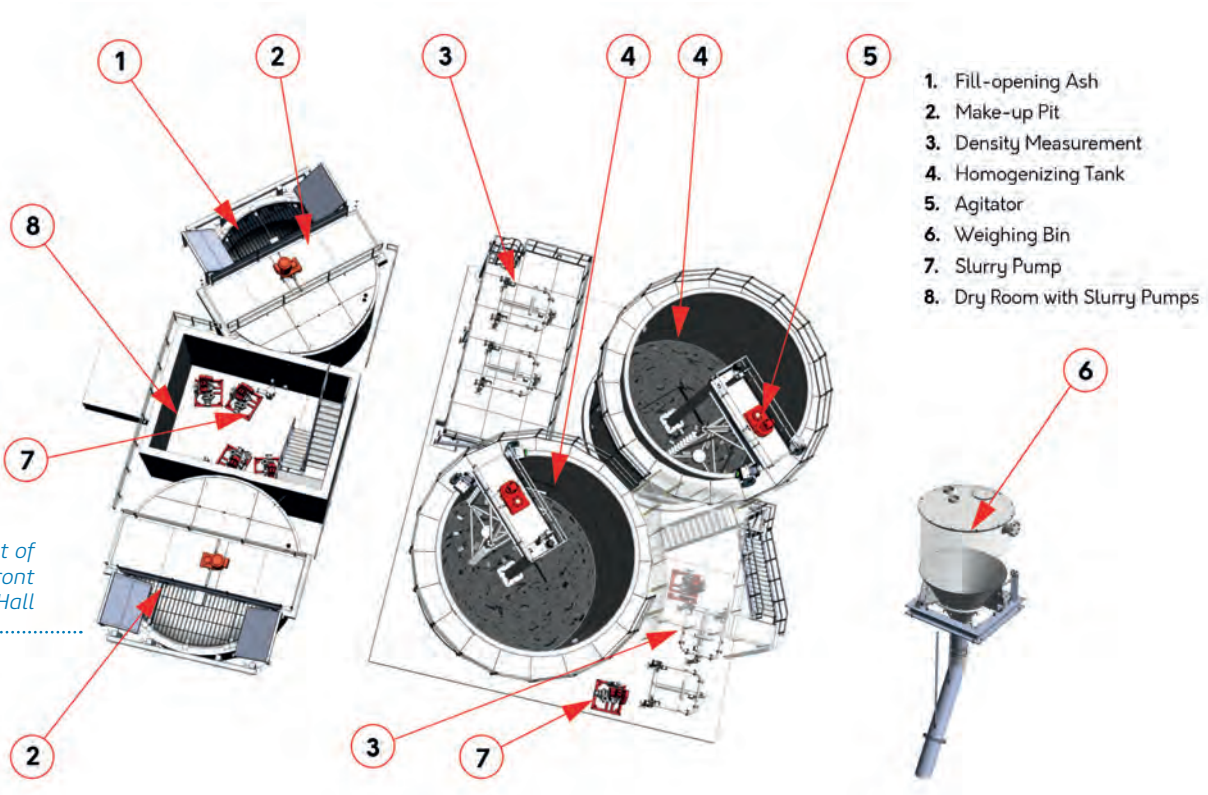

Fig. 6: Layout of the Wet Front End at Hams Hall

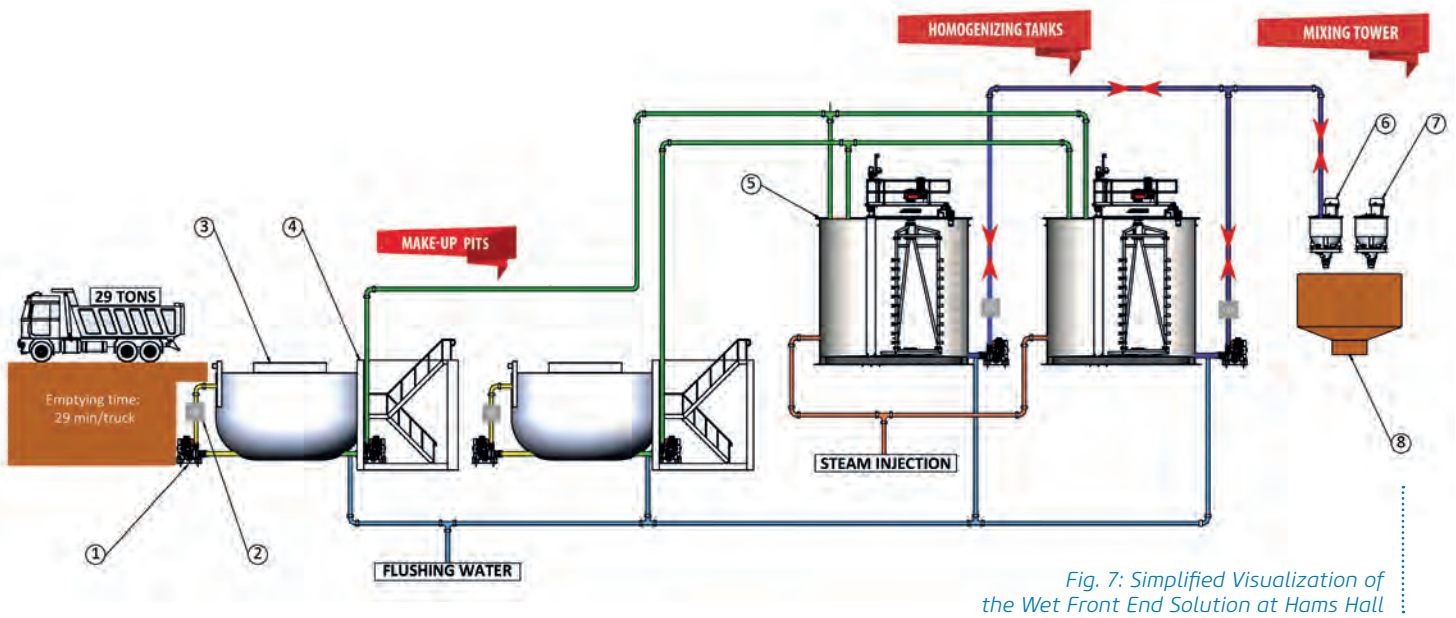

Fig. 7: Simplified Visualization of the Wet Front End Solution at Hams Hall

take care of the details in the system. However, in short and simplified, the process can be described as follows (Figure 7):

The conditioned stockpiled ash is supplied to the AAC plant by truck and is offloaded directly from the trucks to one of the make-up pits (Figure 8). Alternatively, the make-up pits can be loaded with front-loaders. The damp conditioned stockpile ash is mixed with water using a special designed high-speed agitation system to create PFA-Slurry. This slurry is then pumped to one of the homogenizing tanks, which not only acts as a storage tank, but as the name states, has the main function of making the slurry homogenic by mixing up several batches of conditions ash in the large tank (Figure 9). From these tanks the ash slurry becomes ready to be used in the AAC mix.

Fig. 8: The make-up pit for receiving the conditioned ash

Fig. 9: Homogenising tanks make the slurry more homogenic by mixing up several batches of conditions ash in the large tank

As mentioned before, the real know-how lies in the details, as the raw material coming is contaminated and also far more sticky than sand slurry (which is more common in the AAC production) and this requires the selection of the right components and design in order to ensure that the system works reliably. Especially, the slurry pumps are operating at much harsher conditions than pumping ordinary sand slurry, which required a new design of the slurry pumps.

An open and transparent project approach resulted in effective collaboration between the chemical, process, mechanical and control systems engineers as well as operational disciplines such as plant and logistics staff. In turn, this resulted in an overall system design that is well aligned from beginning to the end.

Following a successful project design and implementation at Hams Hall, Aircrete also was engaged to implement a similar solution at Forterra's Newbury location.

George Steward, Operations Director at Forterra, commented: "Given a remarkable performance of Aircrete Europe to complete this project successfully within the budgets and implement within the very short timeframe, it was logic that we engaged Aircrete also to design and implement this solution for our project at our Newbury location."

Sources

[1] Technical Data Sheet 7.1 Pulverised Fuel Ash in Aircrete blocks, UK Quality Ash Association, Updated 06.08.2018) http://www.ukqaa.org.uk/wp-content/uploads/information/data-sheets/Datasheet_7-1-PFA-in-Aerated-Blocks-08.18.docx.pdf

[2] US Department of Transportation, Federal Highway Administration https://www.fhwa.dot.gov/pavement/recycling/fach01.cfm

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