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The Practicalities of Handling Alternative Fuels

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Frank Thomasberger and Harald Faber, Schenck Process Group, Germany, discuss the engineering and operational experience of using alternative fuels in the cement industry.

Introduction

The manufacture of cement is an energy intensive process and the cost of energy represents a significant part of the total production costs. The cement industry has made significant inroads into improving energy efficiency, for example through the use of alternative fuels (AF), also known as secondary fuels.

Alternative fuels are recycled or "unused" materials from industrial production processes or municipal waste. They often have a high calorific value that may even exceed that of hard coal. The range of solid alternative fuels available is increasing all the time and the list of combustible "wastes" is now virtually endless. Particular and growing importance is attached to what is known as "biomass", i.e. organic materials with interesting heat values. Typical examples of alternative fuels include shredded plastics, foil chips, treated sewage sludge, wood chips, municipal waste, refuse-derived fuel (RDF), saw meal, shredded tyres, animal meal or combinations of these.

In addition to the aforementioned cost savings, which can be gained through substitution of fossil fuels, alternative fuels deliver a number of benefits to the cement industry and society in general:

- Recovery of energy for further "secondary" processing.
- Reduction in harmful emissions, for example, CO_2 from burning biomass.
- Reduction in landfill waste for a cleaner environment.
- Controlled use of waste products with regard to emission rates.
- Conservation of primary fuel resources (oil, gas).

The average substitution rate of alternative fuels in Germany has reached 60%.[1] There are cement producers who are trying to reach 100% substitution at the main burner. Here the consistency and quality of the alternative fuel have to be extremely high. RDF is mainly used for such purposes. The market in central Europe is highly developed, which is not currently the case for all of Eastern Europe, the Middle East and Far East. However, substitution rates are rising from below 20%.

There is a trend towards increasing the substitution rate of primary fuels as coal dust at the preheater tower/calciner. Feeding alternative fuels into the calciner enables use of "lower" quality fuel for the cement producer, which results in lower coprocessing or preprocessing costs for AF. In response to the steadily growing demand for alternative fuels, manufacturers have begun to increase the proportion of municipal waste used in the composition of AF. As a result, cement plants need to be able to handle materials with a higher moisture content, larger particle size and unstable composition. Users are therefore tending to increase the quantities of alternative

Figure 1: Various alternative fuels

Figure 2: Alternative fuels installation at Ożarów

fuels fed to calciners, which can handle coarser materials than the main burner.

A reference plant using AF in the calciner: CRH Ożarów, Poland

The Ożarów cement plant is located in Poland, some 180 km south of Warsaw, and belongs to Ireland-based global building materials group CRH. The plant had already been using alternative fuels for many years when, in 2010, CRH decided to build an expanded AF storage and feed system to further reduce production costs. The CRH cement plant in Ożarów operates the largest kiln in Europe, and the alternative fuel system had to provide sufficient AF capacity of approximately 160 – 180 m³/h to two calciner inlets. Interested in the idea of an innovative solution, CRH decided to install an online chlorine detector to first store the materials separately and blend them later on with materials containing less chlorine contamination. Another innovation of the installation is that the system prevents inleaked air from entering the calciner. CRH was looking for a supplier with proven solutions in the field of unloading, storage, transport and gravimetric feeding of alternative fuels. One key factor in the decision to place the order with Schenck Process Poland was the company's ability to build the system on a turnkey basis together with Polish subcontractors for CRH. The installation was the largest investment project for alternative fuels in CRH's history.[2]

Details of the installation and innovative ideas at Ożarów

Up to 5000 t of alternative fuels can be stored in the five silos, providing 4 – 5 days of storage security in the event of disruptions to AF supplies. The system is capable of feeding 1000 tpd of material using two inlets, one leading to the calciner and one to the tertiary air duct. The majority of the equipment was manufactured by the Schenck Process Group. As well as supplying the necessary technology, the company was also responsible for overall project management and monitoring at each stage of the project. Notably, the project included an online scanner. Engineers developed a system that instantly and continuously recognises the fed material, enabling the fuel parameters to be monitored and helping the operator decide whether or not to store lower-quality alternative fuels in a previously selected silo. In future, it is intended that these fuels will be selectively added to the main portion of the fuel and then burned in the calciner.

The supplied analysis system can also identify the moisture content and calorific value of alternative fuels, thus fulfilling

Figure 3: Belt conveyor, scanner and MULTIDOS® weighfeeder.

Figure 4: MultiFlex screw weighfeeder. Innovative solution for feeding alternative fuels: dust tight, double screw for pulsation free discharge, feeding and calibration hopper for on-stream calibration.

the specific requirements of the cement industry. The online analysis process works as follows: samples are taken using a screw conveyor; material is transported on a fast-running flat belt conveyor with optimised material distribution in the loading area and a MULTIDOS® weighfeeder.

Analysis and data processing are performed by a scanner and special software. These components are fully integrated in the system, but can be flexibly adapted to the customer's individual requirements. The results of the analysis are available to both the process control system and the local host system in the form of tables and charts. "The alternative fuel system, including the scanner, is currently going through the test and optimisation phase. So far the results are very promising, and we plan to use them to improve the combustion process and kiln operation," said Jerzy Walaszek, Deputy Director for Investments and the CRH project manager at Ożarów. As another innovative feature, the fuel is fed into the calciner by a MultiFlex screw weighfeeder followed by a second screw feeder, the Schenck Process MultiAirLock.

This device forms a material plug as a seal between the calciner and infeed system. These two units ensure a constant and reliable feed and also prevent cold false air from leaking into the calciner. The double flaps that were previously used achieved a much lower feed consistency than the new system. The new continuous feeding process eliminates undesired side effects caused by the flaps opening and closing and offers better leakproofing. The MultiAirLock also allows for higher pulsation-free throughput without taking up any additional space.

The closed MultiFlex feed system has a highly flexible usage capability in terms of control range and material acceptance. In more than 50 installations worldwide, the state-of-the-art equipment delivers high accuracy and reliability even with low-quality alternative fuel. The system consists of a feed and calibration hopper with internal agitator and double shaftless screws to extract the fuel from the hopper and feed it into the process. The mass flow is determined by weighing the mass inside the entire screw and multiplying it by the mass flow speed in the screw

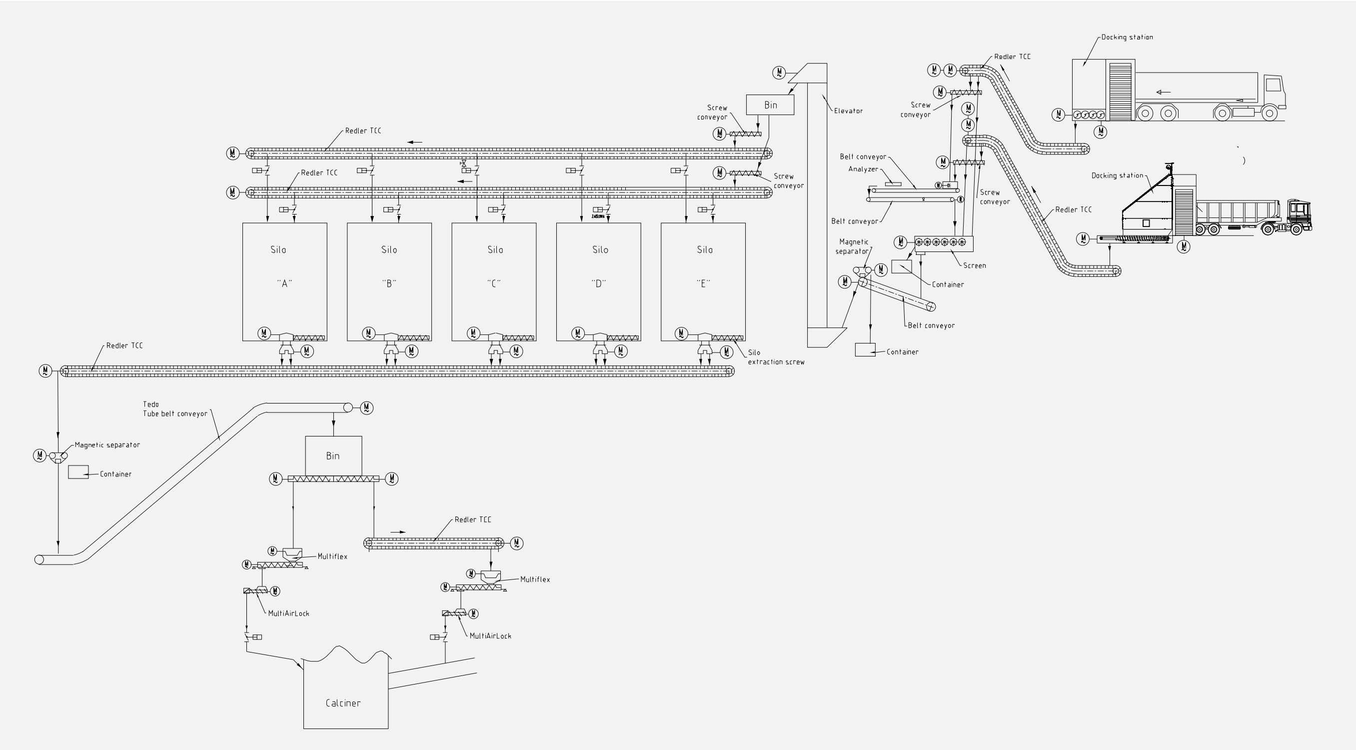

Figure 5: Flow diagram of alternative fuels installation at Ożarów.

weighfeeder. The mass flow can be continuously checked through the use of on-stream calibration. Accuracy of more than 1% is achievable.

The scope of supply for machinery for the complete AF section at Ożarów consists of the following products:

- Two IntraBulk® bulk reception units for unloading from walking floor trailers and tipping trucks.
- Several MoveMaster® chain conveyors for transport to and from silos.
- One TEDO tube belt conveyor to convey the AF from ground level to the two feeding systems at the calciner tower platform.
- One MULTIDOS® belt weighfeeder for material analyser systems.
- Two MultiFlex screw weighfeeders, as described above.
- Two MultiAirLock units, as described above.

In addition, the following systems were delivered and commissioned:

- One bucket elevator for raising the fuel to the top of the silos, lifting height 27 m.
- Star screen.
- Two overhead magnets.
- Five storage silos and silo extraction screws with a length of 8 m.
- Fire fighting and detection system.
- Automation system and control cabinets.

Operational experience in AF storage and transport

Various aspects of experience in operating AF systems have to be considered for further concept engineering, system design and operational sequences:

- Variations in basic characteristics of the delivered AF materials.
- Various bulk densities of AF caused by preprocessing, transportation, unloading and conveyance, screening, storage, secondary conveyance and feeding.
- Moisture content of the AF.
- Storage time in the silos.

Requirements of users

The cement plants define the AF qualities they need based on limits for grain distribution and permitted oversize, chemical composition, moisture and heat value. In reality, the ability of such external deliveries/sources to remain within such limits is often not completely given and not easy to test at the unloading point.
Nowadays, all users of alternative fuels and biomass can refer to common standards and prestandards to determine the typical characteristics. The definitions are indicated in various CEN norms.[3]

A separate cement industry-wide preprocessing technique requires additional CAPEX decisions and only applies if the AF sources are totally unstable or not sufficiently developed.

Figure 6: MultiFlex screw weighfeeder when lifting into plant.

Figure 7: MultiAirLock installation.

As a result, a "proactive usage strategy" for AF before usage and storage on site is recommended for the cement plants. The strategy should result in:

- Analysis at the unloading point (by samples, offline or online analysers).
- Protection for AF storage and feed system from noncompliant material by rejecting or isolating this material.
- Separation of oversize and metallic parts.
- In some cases, the use of a chipper, debaler or secondary shredder on site is also economical or necessary if the AF sources could not supply a reliable quality.
- For wood chips, dryers are also available for incorporation into a preprocessing step.

An alternative approach is to gasify AF before use in the cement production pyroprocess. However, the majority of plants will use solid AF as the main fuel substitute in the medium term.

Bulk density: a real flexible parameter of alternative fuel

The bulk density changes throughout the whole storage and feed process. When delivered in walking floor trucks, the density of common RDF is around 0.2 kg/m^3. Depending on moisture, biomass and oversize, the density could be even higher. When unloaded and conveyed, the density decreases. If storage silos are installed, the density rises again and could reach 0.3 t/m^3. Star screens may be the right technology for separating oversize material. After this step of the process, the bulk density is even lower than the densities stated above.

All these facts have to be considered when designing an alternative fuels handling system to deliver maximum availability and reliability. For example, mechanical conveyance equipment should be at least 20% over-designed for the expected volumetric feed rate at the defined handover point for the process. AF in its various forms is not normal "bulk solid" as we would associate with homogeneous bulk materials. AFs are often compressible and, therefore, a fixed "bulk density" is unrealistic for system concept designs. Also the techniques applied for silo dimensioning, i.e. with gravity mass flow as target or chute inclination, cannot be used without additional tests and design adaptations.
These tests are essential for designs of system elements, such as conveyors or bucket elevators, for a more reliable future system operation.

Moisture

The moisture content within the (inhomogeneous) AF materials changes the adhesive behaviour and bulk density.
However, it also changes the chemical reactions, as it acts as an amplifying agent for chemical corrosiveness, as well as changing temperature effects through composting during storage.

Extremely low moisture content of less than 2% creates dust emission problems and needs large filter areas and may result in increased spillage.

High moisture of over 20% can create extraction and conveyance torque, which increase energy costs and chemical corrosion. This may result in the need for more expensive mechanical equipment parts (stainless steel) and a high-efficiency scraper technique.

Storage time

When using compressible AF with organic contents, you need to keep an eye on the maximum possible storage time. Long storage times (over one week) often result

in high extracting torque or even overloading the silo's extraction technique. A high organic content starts composting processes at increased temperatures and may present an ignition risk. Furthermore, chemical reactions of corrosive effects with longer storage times can be assumed.

A storage concept with a larger number of smaller silos or boxes within a hall reduces the aforementioned reliability reductions and cost, increasing risks.

Conclusion

The demand for alternative fuels within the world's cement industry, as well as electrical power and heat-generating plants, will continue to increase within Europe and the emerging markets.
The key reasons are a reduction in energy cost, a reduced need for CO_2 certificates, as well as environmental benefits for society by recycling materials followed by controlled combustion of waste.

At high substitution rates with AF, the volumes for storage and handling at the plant site become huge (up to 20,000 m^3 storage capacity and up to 750 m^3/h handling and conveyance system capacity).

The AF quality has to be controlled as much as possible through processing at RDF plants, pellet plants, etc. and, in some cases, preprocessing at the cement plant site.

The way AF material behaves is only partly comparable with a homogenous bulk solid. There are several reasons why handling AF is very often a challenge: bulk density changes through handling and storage, contamination with grained and also metallic lumps; moisture generates increased corrosive effects and also high extraction torques, which also results in build-up on chutes and belts.

The risks of self ignition and AF dust explosions have to be considered for particular AF types of mixtures.

All these aspects have to be considered when designing an AF handling and feed system. Experience is essential for successful installations. New system integrators without several years of experience in this field face a high risk of failure under these conditions.

Given the discrepancies experienced by AF systems worldwide, a compromise has to be reached between CAPEX decisions for such AF handling systems and the following factors:

- Limitation of possible range of AF infeed materials.
- Further preprocessing on site or removal of lumps/foils.
- Adaption and modification of existing burner, calciner and filter techniques.
- Maintenance costs during system life time.
- Environmental protection systems to reduce emissions, e.g. through spillages.

Maximum reliability requires engineers experienced in such systems.

References

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