Nick Clewes and Richard Boarder, Cement Consultancy Associates

Kiln fuel strategies

The selection of kiln fuels for a cement company is a multi-dimensional challenge, in which optimisation of many factors conflict. Lowest cost ambitions must be considered in relation to other factors – kiln run time must be maintained, while the fuel blend must be appropriate for the kiln technology and the kiln feed chemistry.

Socio-economic concerns, market development, and operational considerations are all important factors for achieving an optimal solution for a particular kiln or company. Each of these issues must be addressed in developing a strategy which is coherent with the company's business objectives.

Cement works, along with other fuel-burning industries, are often perceived as environmentally 'dirty,' and in the past this may have been a fair conception by the public. In many developed countries, however, the industry has voluntarily improved the environmental performance of its plants so this perception is unreasonable, but it still exists in many areas of the general public. This is not helped by the inconsistent approach to imposing standards taken by industry and local regulators. In some instances regulators would enforce a standard which had already been voluntarily adopted by the industry, and on other occasions they would enforce regulations handed down by government or shaped by political pressure, even where there was little sound science to back it up.

From a global point of view it is imperative that the cement industry is a good corporate neighbour and welcomes soundly-based environmental policies, and this generally has been the case. However with the increased use of waste and waste-derived fuels, public perception has been sensitised, especially by some organised pressure groups whose political ambitions are not aligned with the beneficial use of waste as fuel. Operating within this difficult political arena requires an open approach by all stakeholders and a practical and soundly-based regulatory environment in which to work.

Some governments have seen the role that a well-regulated cement industry can play within the national waste management strategy, providing a relatively high-efficiency energy-conversion opportunity for a wide range of local waste arisings. A notable example is the Norwegian government, which chose to use one of the country's cement plants as the disposal route for hazardous organic waste while recovering the locked-in energy, with no significant environmental impact.

Below: Landfills are not pleasant to look at but are potentially a major source of fuel for cement plants.

On the other hand there still remain some countries and regions where the incentive to use waste-derived fuels is minimal, especially where governments face severe social and economic pressures to use domestically produced fuel to support the local fuel industry.

The cement industry must therefore explain its position by engaging with the local community, the national government, and the regulators by whatever method is appropriate for the region. This should be done before starting to use a particular fuel, and is clearly part of the information provided when seeking planning permission for a new project.

By winning the argument the cement industry has an opportunity to contribute to the national waste strategy while securing lower cost fuel, with a lower overall environmental impact, to the benefit of all.

Markets for fuels

The markets for fossil and waste-derived fuels are by their nature materially different. The fossil fuel trade, once exclusively domestic, is now international. The use of indigenous fuels should always be considered initially as theoretically they should offer the lowest cost per unit energy delivered to the cement plant; examples of this are the use of oil in Saudi Arabia or coal in the United Kingdom. However, in free markets the cost of an imported alternative may well prove better value than the local product.

The UK example demonstrates this point well. Until the 1990s, almost all cement clinker was made in kilns fired by UK-sourced fossil fuels; primarily coal but some natural gas. Cost pressures caused by increasing domestic fuel prices and volume/price pressures caused by cement market imports pushed cement makers to consider using imported petcoke (in the late 1980s), and then imported steam coal. It is estimated that of the 2Mt(equivalent)/year of coal consumed by the industry over 70% was imported at that time. With the changed world economic situation of the early 21st century, the tightening of the bulk cargo shipping market caused the price benefit to change to the point where domestic coal became attractive again, and so the move back to UK coal began.

There is dynamism in the world coal market which needs regular review from the cement operators' perspective. This is often left to specialist groups or companies working on behalf of the cement operator.

The situation regarding waste and waste-derived fuels is currently somewhat different, and is always likely to have some fundamentally different characteristics. Whereas fossil fuels tend to be produced in large unitary locations – coal mines or oil refineries – waste arisings are from relatively small-scale sources, for example, as small as one 45 gallon drum per week. This waste often requires consolidation, and so a local service industry is necessary even before sufficient material is available for delivery to a pre-treatment facility or the cement works.

Furthermore, the need to pay for the disposal of waste, and the degree of biomass in the waste (where carbon trading is in place), are important dimensions when considering the use of waste and waste-derived fuels. Clearly, if the cement plant operator is paid to use the waste fuel – the so-called gate fee – the money available to install the proper plant and equipment to handle the waste and meet any compliance issues is more immediately available.

The differences in disposal costs can distort the market with respect to international trade; certainly within free markets such as the European Union there is some evidence of the movement of waste from high cost countries to lower cost ones. Though there are international treaties in place to prevent the dumping of wastes from the so-called first world into developing economies, the trans-frontier shipment of waste may still be possible for properly regulated recycling or recovery.

The waste market also suffers from price volatility, and there is a significant fixed cost element within the waste disposal industry, making the forecasting of fuel prices quite difficult in the short to medium term. Measures must be taken to ensure operational flexibility at the cement plant to enable the optimal medium term fuel mix to be achieved.

Operational considerations

Natural gas and fuel oils: Both these fuels may be considered as being 'manufactured' to a standard, which gives consistency of physical and chemical characteristics at least as far as cement manufacture is concerned. After the specific fuel is chosen the burner and control equipment is selected, and then within relatively small latitude the fuels selection is made, price then being the primary issue.

Coal and petcoke: In practice, we include here soft coal and coal wastes such as schlamm or pond fines. In all cases, the fuel must be prepared by drying and grinding into a fine powder prior to firing. There are many conventional mill circuits embodying a ball or now more commonly a vertical mill and a variety of gas exhaust systems ranging from direct firing to inert indirect firing.

The main issues that need addressing are how much flexibility is required by the operator and what level of stock is to be held. If coal blends are to be produced as all or part of the kiln fuel mix, then the decision as to

Below: Investment costs for alternative fuels projects are significant but will generate a rapid rate of return.

who is to do this must be made. Experiences with coal blending contractors can be mixed, but the use of pre-blending can give a degree of operational flexibility and can enable opportunistic cost savings particularly when more difficult fuels become available. For example, five solid fuels (coal/petcoke) in addition to up to four waste-derived fuels were routinely used on one plant to minimise costs.

Stock level calculations are clearly a function of location, logistics and the degree of risk which is acceptable to the company. Overstocking fuel impacts on both working capital and cash flow; low stocks can lead to operational difficulties and at worst kiln shutdown. However, some sort of on-site stock is required. Previously, gantry stores with crane recovery were used very extensively, but modern practice is to use automatic blending stores, preferably covered to prevent wind whipping and moisture pick up from inclement weather.

WASTE-DERIVED FUELS: Due to the nature of waste, particularly its chemical and physical variability, it is important to determine a specification which enables the waste to be used safely and with no quality impact on the product, and with no adverse environmental impact. Once done it is important to determine how the fuel is to be prepared. Clearly, there is a temptation for the cement company to take this responsibility; however, there are very special skills associated with the waste management industry and anyone entering this area should be particularly careful.

Though there are examples of cement works managing the waste directly, modern practice tends to be to have the waste-derived fuel delivered to specification. This may be done by independent companies, or by specialised companies owned by the cement company.

There are all sorts of business models which work well, but the one selected for a particular application must be sensitive to the local situation, particularly to the level of development of the waste management industry, and the regulatory environment. It is inevitable that anything that goes wrong with this type of fuel will be seen as the responsibility of the cement plant operator.

The use of these fuels requires an in-depth knowledge at the plant level of the process chemistry and associated mechanisms. Without this emphasis on the process and fuel analysis, the operator risks problems with clinker production whether by under-burning or blockages.

Conclusion

It is imperative that the cement operator considers carefully what its fuel strategy should be; and this must then be reviewed regularly. The local political and market environments must also be considered. The impact of the fuels' supply chains are important to the arrangements regarding storage levels and locations, pre-blending and delivery processes.

The use of waste-derived fuels in cement kilns as part of the total fuels strategy has significant financial benefit for the plant operator. However, the transition to the use of waste-derived fuels by cement plant operators needs careful consideration, analysis, management and technical support to implement the various stages required to realise the full potential of this valuable fuel source.

If these issues are properly thought through, then the plant operator can look forward to optimal fuel costs, with high supply reliability and operational flexibility, while making a significant contribution towards mitigating the global energy crisis.

The UK-based company Cement Consultancy Associates (www.cementconsult.co.uk) has the expertise to provide a range of professional and technical services to assist operators in developing a total fuels strategy as part of the day-to-day operation of a cement plant during these globally competitive, financially restrictive times.

Below: A tyre-derived fuel handling area at a UK-based waste-processing company.