Burning issues

by Daniel Lemarchand, Executive Managing Director, Teris

Incineration in a cement kiln is now being considered a viable option for the treatment of hazardous industrial waste. This process has been widely developed in Europe and the USA, and is now becoming popular in other countries. In this article, based on information provided by Teris, ICR look at pre-treatment processes, how different types of waste is accepted in various cement kilns, how the the process of incineration using a cement kiln destroys organic components and how mineral elements behave during the production of clinker.

The European Directive on Hazardous Waste Incineration, which was issued in December 1994, recognises that co-incineration in cement kilns is a viable solution for waste treatment disposal and energy recovery. In France, this Directive has been translated into a new law (December 1996) which imposes stringent environmental control on both the waste classes accepted into cement kilns and the stack emissions allowed. In the USA, the Environmental Protection Agency (EPA) has proposed new emission standards for cement kilns that process hazardous waste-derived fuel. These emission standards will be even more stringent than those applied to hazardous waste incinerators.

These regulations seek to assure environmental quality, and control mechanisms that allow cement kiln processing to be a viable, fully qualified method for the treatment of, and energy recovery from hazardous waste, as demonstrated by in-depth studies and numerous pilot trials in the US, as well as in France.

Using a cement kiln

There are many advantages in using a cement kiln to incinerate waste. By doing so:

- the neutralisation of acidic gases, sulphur oxides and hydrogen chloride by the active lime in the kiln load, in excess of the stoichiometry takes place
- the fixation of traces of heavy metals in the clinker structure occurs
- by-products, such as cinder ashes or liquid residues from gas cleaning are not produced
- fossil fuel use is diminished
- the calorific value from the waste is extracted
- there is a high flame temperature of 2000˚C
- excess oxygen is produced during and after combustion
- high turbulence and strong thermal currents are generated

Destruction of organic compounds

The new European Directive on Hazardous Waste Incineration (1994) also imposes that a temperature above 850˚C be used for at least two seconds for the incineration of non-chlorinated hazardous waste. In a cement kiln, the temperature reaches 1450˚C and the combustion gases stay above 1200˚C for five to six seconds, since these conditions are necessary to ensure the resulting clinker quality.

Under these conditions, the destruction and removal efficiency factor (DRE) of the most stable organic compounds exceeds 99.99 per cent, which is sufficient, even under stringent regulations such as those required by the US EPA.

In France, numerous trials were also made by the French Environmental Agency, ADEME, cement producers and the private wastes management sector. The trials also demonstrate that the DRE is above 99.99 per cent, even for the more stable compounds.

No solid or liquid residue

As a result of the very large quantity of lime present in the clinker process, the cement kiln may be said to act as a huge scrubber. Any traces of sulphur and chlorine that are found in the fossil fuel, the raw material, and the waste are fully neutralised because of the excess of lime.

Mineral elements from the raw materials, the fuel and the wastes are fixed in the crystalline pattern of the clinker.

Because of the neutralisation of acids by the lime, no additional scrubber system is required. In addition, all clinker production facilities include a dust collection system (generally an electrostatic precipitator or baghouse) that collects fugitive dust and is designed to meet local and national regulations. All collected dust (cement kiln dust or CKD) is then recycled and reintroduced into the process.

In most cases, therefore, the cement kiln process does not produce liquid or solid waste residues. Furthermore, the use of waste-derived fuels in the kiln has no effect on the characteristics of this dust. The US EPA for example, found no significant difference between CKD of this type in plants that burned fossil fuel and CKD in those that used waste-derived fuel.

Fixation of metallic elements in clinkers

During the process of cement kiln incineration, heavy metals, the majority of which come from raw materials, are fixed by the clinker into very stable chemical combination. Silicates that are formed are directly integrated into the clinker chemical structure. These metals have no impact on the physico-chemical properties of the clinker. This has been shown in several studies on the leaching of mortars performed for example by ATLIH in France and other searchers in the world.

Energy recovery and reduction of CO_2 production

The use of waste derived fuel in a cement kiln saves 300,000t of fuel in France alone. Recovering the energy contained in industrial waste therefore leads to considerable conservation of fossil fuels (fuel oil, petroleum products and coal). One hundred per cent of the calorific value contained in waste can be recovered, whereas waste incineration in dedicated kilns is less efficient, owing to the use of boilers and turbines.

In addition to energy recovery, there is also a corresponding saving relevant to CO_2 emissions released into the atmosphere, since waste replaces other fossil fuels producing greater CO_2 levels.

Pre-treatment facilities

Industrial waste production is generally scattered throughout the main industrial regions of each country, and is produced in different forms, ie solids, liquids and sludges. Using various ways, it is then stored in either drums, small containers, or in bulk, etc. In order to manage the waste efficiently for processing in cement kilns, grouping and pre-treatment facilities are recommended in order to transform the waste from its original state, into waste derived fuel suited to the cement process itself.

The basic principles involved in the production of waste derived fuel, are as follows:

- the chemical quality of the fuel must meet regulatory standards assuring environmental protection
- the calorific value must be stable enough to allow control of energy supply to the kiln, the objective being to arrive at a fairly homogeneous composition
- the physical form must allow easy handling of the material for transportation and a stable, adjustable flow of material in the cement plant

The basic operations accomplished in the pre-treatment facilities include:

- analysis of the waste
- emptying of the different packaging (drums, containers) to transfer the waste into larger storage facilities
- waste processing via mechanical equipment such as crushers, grinders and mixers to allow production of a desired physical state. ie liquid, solid, sludge
- preparation of a waste derived fuel, by the homogenisation of different waste to a specified calorific value and chemical composition
- the preparation of several derived fuels according to the different waste market
- liquid derived fuel based on solvents, using the process of fluidification, to introduce pasty waste (as painting sludges for example) in solvents
- liquid derived fuel, based on oil is the main technology used in dispersion
- solid derived fuel based on absorbents. The main technology is shredding and different mechanical mixtures are used to homogenise different types of waste

A wide range of waste

If a proper pre-treatment is assumed, cement kilns can accept waste from various sources. Potentially acceptable liquid waste for cement kiln incineration include waste solvents and oils, paints,glues, varnish and certain waste waters. Often large quantities of a high-value calorific waste may not even require specific pre-treatment.

Waste is accepted in cement kilns under the express conditions that their composition is in compliance with local regulations, and that no harmful effects on the environment will result from their use. In particular, the content of PCBs, chlorine, sulphur and metal is usually limited in both the waste and the emissions, according to local regulations.

According to the high efficiency of the cement kiln in burning waste, this process can also be used to burn waste water without any energy content. This decision is usually that of the particular cement company, in order to provide a more comprehensive service to their customers. A complete check up of the process is also required before the first trial, in order to gain perfect knowledge of the water and steam flows in the process. In Europe, the treatment of waste water is recognised as part of the global network for the treatment of waste.

Radioactive waste and infectious, clinical waste is not accepted for treatment in cement kilns.

Certain mineral waste contains lime,

Fuel from shredded tyres - a first for Spanish cement sector

TMI Systems in the United States has just completed the first phase of installation of a whole tyre fuel feed system for "Hisalba" Hornos Ibericos Alba, S.A. in Jerez, Spain. This new system is interfaced with an existing shredded tyre feeding system currently operating at the plant. When completely installed, the whole tyre feeding system will feed tyres onto the raw meal feed-shelf of the four-stage preheater kiln at the Jerez plant. The tyre feed rate will be based on tyre weight. This first phase of the installation includes a 150m^3 live-bottom hopper, tyre separator with refinement conveyors, tyre inspection and rejection conveyor, and tyre weight controlled feed rate equipment.

By feeding whole tyres, the plant will be saving the high cost of shredding tyres and increase the amount of tyre fuel the kiln can effectively burn - based on a lengthy test perform prior to purchasing the TMI whole tyre feeding equipment. Presently, the plant intends to use both whole tyres and shredded tyres.

The second phase of the system installation will involve installing a larger airlock tyre valve. Initially the system will operate utilising the existing airlock valve designed for shredded tyres, which limits the size of usable tyres to 600mm in diameter. Upon installation of the larger TMI whole tyre airlock valve, the system will be capable of handling tyres up to 1200mm diameter - which includes most lorry tyres. The second phase is due to be completed sometime early this year.

The plant intends to use the tyres at a rate of approximately 1500kg/h and allowing the plant to reduce coal usage by approximately 1900kg/h.

The first system, installed at the Hisalba plant in Lorca, Spain, feeds tyres to a two-stage preheater kiln utilizing a Cadence mid-kiln valve. The system was commissioned in July of 1998.

In addition...*TMI Systems has completed this month a test phase equipment installation for Blue Circle Cement, Tulsa, Oklahoma. This test phase will determine if whole tyres fed into the mid-kiln area of the long dry kiln will be a viable alternative fuel.*

silica, aluminum and iron oxides. These can be introduced as primary components in the production of clinker. This practice results in an economy of non-renewable quarry raw materials and even a corresponding economy in quarry size. This higher-quality waste can be introduced into the raw grinding process. In some cases, hydrocarbons are also present in these types of mineral waste and they must also be introduced into the kiln or into the preheater to ensure that they are completely destroyed.

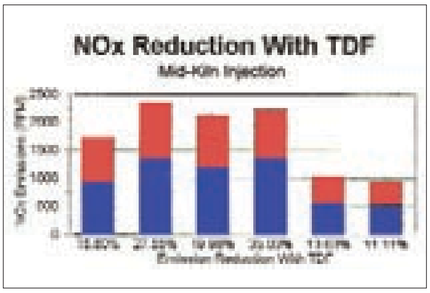
Potential non-hazardous waste streams

A large amount of solid waste, such as cardboard, wood, plastic, rubber, foam and carpet is presently disposed of in landfills. These types of waste are often contaminated with organic compounds or oils and, as landfills become more and more restricted, they will need to be treated in other ways, since this waste has a calorific value. It therefore makes environmental sense that their calorific value is utilised. Cement kiln incineration remains a viable solution for extracting the calorific value from this non hazardous waste as well.

Sludge from waste water treatment are issued from a wide range of industrial sectors. They contain mostly water, organic compounds and lime. Drying followed by cement incineration is a process under development. It will allow for the recovery of lime and calorific value, and will save non renewable energy and quarried materials.

Conclusion

Initiated during the 1970s as an answer to the petroleum crisis, waste incineration using cement kilns has become a sophisticated technology bringing together the professional know how from both cement



and waste profession.

Teris (SCORI) was created 20 years ago and began the incineration of waste in cement kilns with two cement French companies. From the outset, the waste involved in the process was mainly solvents and oily waste, but fairly soon, waste water, cutting oils and cleaning waters were incinerated.

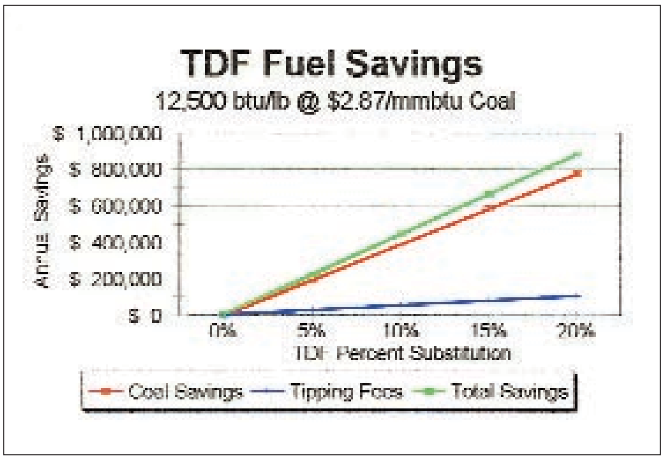
In order to develop the quantity of waste, the first pre-treatment platform was created in 1982. Since then, Teris have created many facilities to offer the waste-generating customer. These facilities are based on valorisation, ie chloride and sulphur valorisation.

Today, Teris supplies 22 cement kilns with waste and manages 15 pretreatment platforms (transit platforms and waste derived fuel productions). They handle more than 1Mt of waste, 600,000t goes to cement kilns. Teris is presently operating in most of Europe (France, Belgium, Spain, Germany and Portugal) and is starting overseas development in Australia, Thailand, Brazil and Korea.

NO_x emission reduction using tyre derived fuel

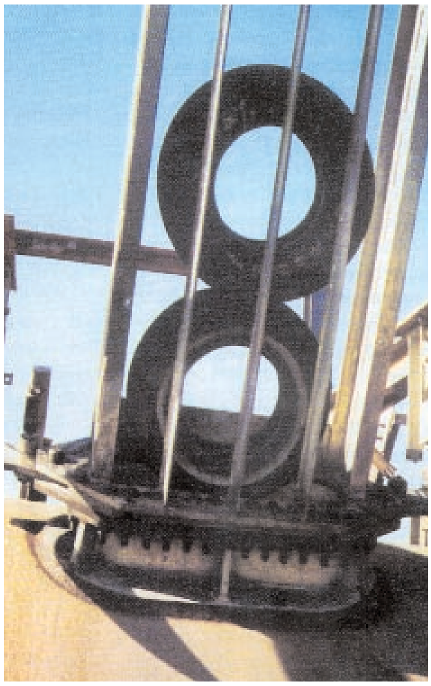
The inclusion of an automatic Tyre Derived Fuel (TDF) feed system by TMI Systems into a kiln fuel management program can provide a substantial reduction in nitrogen oxide (NOx) emissions while providing a substantial saving in fuel costs. The TDF solution is an environmental and revenue friendly solution to the NOx reduction requirements facing cement manufacturers.

At temperatures above 1300˚C, nitrogen and oxygen in the combustion air react to form thermal NOx. These conditions exist only in the burning zone of the kiln. The reaction rate is dependent on temperature and oxygen content.



NOx is formed from elemental nitrogen in the fuel. This reaction occurs at lower temperatures, typical of those found in the calcining zone.

NOX reduction is accomplished as TDF is introduced into the calcining zone of the kiln, with an accompanying reduction in coal feed. This results in lower combustion zone flame temperatures which reduces the formation of thermal NOx. Lower coal feed rates also result in less fuel NOx formation, as the nitrogen level in the TDF is less than the displaced coal. NOx from TDF combustion is not as likely to occur as calcining zone temperatures are below the threshold for thermal NOx formation. If



Cadence environmental energy mid-kiln burning installation

reducing conditions are present in the calcining zone, a further reduction in NOx exiting the combustion zone is possible. Sulphur emissions are often less as a result of TDF use as well.

Significant fuel cost savings are also made as a result of TDF use, as well as of reduced coal consumption and of tipping fees paid to the cement plant operator for the disposal of scrap tyres. Additionally, government grants are often available to encourage the integration of TDF into the cement manufacturing process as a means of dealing with the enormous solid waste problem that scrap tyres present. ❒