PEG INDIA PRESENTATION

SYSTEM DESIGN FOR HANDLING & PROCESSING OF WASTE FUELS AT CEMENT PLANTS

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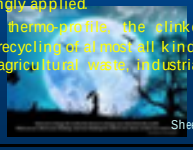
The utilization of secondary/ waste fuels in clinker manufacturing is successfully implemented in Europe, North America and partially in South East Asia. This has had a tremendous positive socio-economical impact on both, the economical figures of the cement industry as well as on the environmental situation.

In the other Asian region still primary fuels/coal is exclusively used for clinker manufacturing. The reasons for doing so are:

- Moderate prices and easy availability of primary fuels,
- Low standard application of environmental awareness,
- Low development grade of waste management systems (WMS)

However fuel prices are rising and the availability of primary fuels is limited. In addition awareness of environmental protection and laws for pollution controls are increasingly applied.

Due to the strict alkalinity and the thermo-profile, the clinker manufacturing process is ideal for the recycling of almost all kinds of secondary fuels (e. g. waste tyres, agricultural waste, industrial waste products).



So This is a great opportunity for the Indian Cement Industry to participate and benefit from the utilization of secondary fuels. This can be achieved by:-

- Savings by substitution of primary fuels /coal,
- Decrease of production costs due to disposal fees for waste materials,
- Possible reduction of CO2-Emissions and benefits from CO2-trading bonds according to the Kyoto Protocol and finally an
- Improvement of the image of the cement industry to an environmentally friendly recycling industry.

What are the advantages of the clinker manufacturing process for the utilization of waste fuels compared to incineration and traditional landfill procedures?

First of all, a utilization of secondary or waste derived fuels, so called WDF´s in the clinker manufacturing process is a real recycling - it is not just an incineration.

Moreover, due to the strict alkalinity (pH > 11) of the process practically all inorganic compounds, like heavy metal elements are immobilized in the clinkers minerals without negative influence on the quality of the product as those compounds are diluted below as significant values. In addition these elements are not re-mobilized during the hydration process of the cement and hence no pollution, for example of the ground water is possible, as this is a serious problem of landfills.

As proven by intensive investigations, the organic compounds of WDF´s are completely cracked down to a methane-like base molecule by an extreme high temperature profile of the thermal system of up to 1550 °C. This methane-like compound is easy to ignite and to combust.

Furthermore, due to the high gas velocities and the related short retention time in the thermal system the "window of de-novosynthesis of Dioxins and Furans" is very short and no significant reformation of those hazardous compounds takes place. In waste incineration plants, tremendous technical provisions are necessary in order to cover this problem.

CLASSIFICATION OF SECONDARY FUELS

The variety of secondary fuels is extremely wide and there are different possibilities of classification according to its properties or its origin.

Generally secondary fuels are divided into WDF and Regeneratable fuels. WDF includes solid and liquid waste of industrial origin, like electronic waste, used crating materials, waste tyres, used lubricants and photochemical process wastes. In addition municipal or domestic waste materials like plastic waste, sewage sludge and food rests are classified as WDF.

Re-generatable fuels are basically all solid, liquid and gaseous agricultural waste materials, such as wood chips, saw dust, agricultural husks, olive oil resins, palm oil rests, raps oil and bio- or compotation gases.

WASTE DERIVED FUEL

Industrial Waste Byproducts

- Waste solvents and other chemical industry wastes
- Waste oils and petroleum wastes
- Solid hazardous waste fuel
- Ship oil waste (Basel Convention waste)
- Tar balls from oil ships
- Diaper manufacturing waste
- Plastic waste from pharmaceutical packaging
- Waste from roof shingles and tar paper
- Spent aluminum potliner – treated and untreated
- Aluminum anode waste
- Paper pulp sludge
- Glycerin from biodiesel production
- Contaminated soils

Biofuels

- Palm kernel shells
- Rice kernel shells
- Biosolids – from sewage sludge
- Shredded woody wastes and sawdust
- Used railroad ties
- Rendering wastes and other animal processing wastes
- Waste cooking oils
- Landfill gases
- Filter cake – from oily waters and other organic containing cleanups

Consumer Wastes

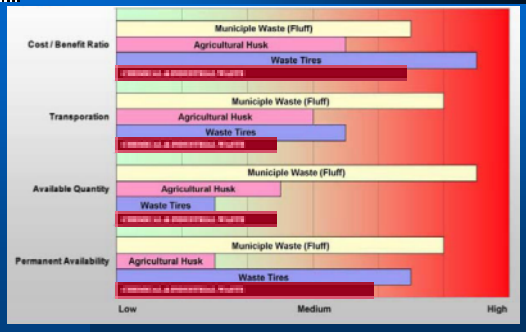
- Auto fluff
- Electronic disassembly wastes
- Buffer pads – from polishing
- Carpet scraps– pre can post consumer
- Plastic shred from recycling wire
- Off specification spirits (alcoholic beverages)
- Hospital wastes
- Tyres – whole and shredded
- Refuse derived fuels – and organic containing streams from recycling household refuse
- Battery cases

Alternative natural fuels
Tar sands
Oil shale
Please note that not all these fuels are suitable for all cement kilns. Each kiln and its unique process and chemistry must be evaluated to match appropriate fuels with kilns. Further, rigorous waste fuel quality control programs are needed to safely handle many of the above materials.

WHAT CAN BE DEFINED AS A WASTE DERIVED FUEL FOR SERVING THE PURPOSE OF CEMENT INDUSTRY

- The Material which has low salvage value as compared to its calorific value as a fuel,
- The material which is available in substantial quantities at logistically possible locations,
- The material which is readily used or can be processed economically to be fed in to the pyro-system,
- The material for which a techno-economically viable storage and handling system can be designed,
- Also the fuel which shall not further generate hazardous byproducts in significant quantities,
- To evaluate what can be termed as waste fuel we should compare all the secondary fuel with respect to few criteria's.

COMPARISION OF WASTE DERIVED FUELS ON FEW SIGNIFICANT CRITERIAS

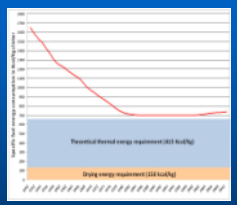


- The clinker and cement manufacturing is one of the most energy consuming large scale industrial processes and the energy consumption (appr. 64 % of the total costs) is the economical key factor dominating the costs for cement production.
- Moreover, due to the nature of the process (decarbonation of limestone and sintering by thermal energy) tremendous amounts of approximately 0.85 kg / kg clinker of CO2 are emitted. In addition there are other emission compounds like NOx, SOx, dust, etc.. Even with state of the art technology those emissions can be reduced only to a certain limit but not eliminated.
- The conservation of energy and the reduction of emissions are the major topics in the cement industry today. These topics are driven by the following factors:

- Availability and price development of conventional fuels for the generation of thermal and electrical energy.
- Competitiveness of each cement plant.
- Environmental laws and constrains (internationalized CO2 and other emission limits).
- Public acceptance of the heavy industry character of cement plants.

DEVELOPMENT OF THERMAL ENERGY CONSUMPTION IN THE CLINKER PRODUCTION

- During the last 58 years the aveage specific consumption of thermal energy for clinker production was reduced by more than 50 %. This is mainly attributed to the application of modern production processes, e.g. change from wet to dry production, introduction of the preheater / calciner technology and effiecient heat recuperation of clinker coolers, etc.).
- The actual specific heat consumption is already close to the theoretical required heat of formation of clinker and further significant steps towards lower energy consumption by new or improved technologies are unlikely.
- Hence, in many cases the investment costs to achieve relatively small energy savings by the installation of more modern pyro-technology are exceeding the economical feasibility and reasonability.



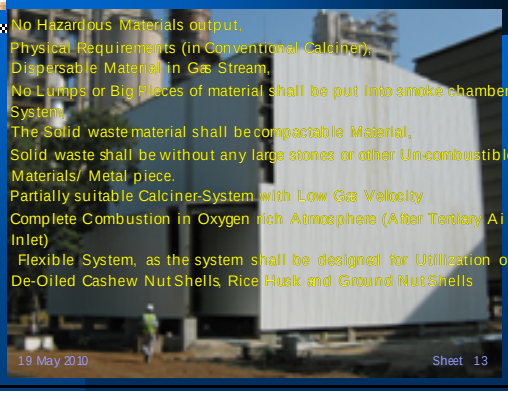
Typical development of specific heat consumption (Example: German Cement Industry)

Requirements for WDF Utilization: Key Process Parameters for Product & Quality

- Determination of Optimum WDF-Feeding Location (Retention time, Complete Combustion)
  - Main Burner
  - Inlet Chamber
  - Calciner
- Modification and Adjustment of Burner
- Adjustment of Fuel Split between Calciner and Main Burner
- Adjustment of Secondary and Tertiary Air Flow for Proper Oxygen Levels
- Optimization of Thermo-Profile in Kiln, Calciner and Preheater
- Adjustment of Raw Mixture Considering Ash- and Combustion Properties of WDF
- Selection of Suitable Refractories
- Control of Volatile Circuits (SO3, Cl, Alkalies in Hot Meal)
- Acceptable Concentration of P2O5 (Strength Development of Cement)

WDF Utilization: Other Requirements

- No Hazardous Materials output.
- Physical Requirements (in Conventional Calciner),
- Dispersable Material in Gas Stream,
- No Lumps or Big Pieces of material shall be put into smoke chamber/ System,
- The Solid waste material shall be compactable Material,
- Solid waste shall be without any large stones or other Un-combustible Materials/ Metal piece.
- Partially suitable Calciner-System with Low Gas Velocity
- Complete Combustion in Oxygen rich Atmosphere (After Tertiary Air Inlet)
- Flexible System, as the system shall be designed for Utilization of De-Oiled Cashew Nut Shells, Rice Husk and Ground Nut Shells



Conceptualisation of Plant Layout & Flow Sheet

Following aspects shall be kept in view, while developing the Concept layout, GA drawings & flow sheet :

- Space availability as per the existing setup of the Production unit.
- Distances have to be optimized due to protection from fire hazard and to economize the project cost
- The storage location shall be decided keeping in mind the traffic and layout constraints. Also due consideration shall be given to wind flow.
- The direction of trucks carrying (hazardous/other) waste entering into plant, parking bay along the storage and trucks leaving plant after unloading.
- Barricading the area of the alternate fuel storage and feeding shed.
- Monitoring of Temperatures at storage to avoid explosion risks

HAZARDOUS WASTE SORTING AND STORAGE

- Sort each waste into its appropriate hazard class immediately after the waste is unloaded,
- Handle and store each waste in a manner appropriate to its characteristics and hazards,
- Establish limits for the maximum quantity of to be stored in each storage area,
- Maintain minimum of 24 inches between rows of drums/ rows for aisle spaces in all storage areas.
- Protect storage from weather and temperature extremes,
- Consideration of Maximum length of time that material will be stored before being used. It can't be stored for too long.
- In case of Hazardous Liquid Waste Unloading will take place only for the tank which is not used for firing at that time.

Important Points for Designing of Storage

- The design and construction of a Hazardous Waste Storage facility must incorporate measures to prevent degradation of groundwater, surface water, air quality, and endangerment of public or employee health.
- Consult and comply with the fire code, building code, electrical codes and ensure construction requirements for flammable and/or reactive materials.
- Surround the facility with security fencing with security locks on gates and doors.
- Establish fire suppression equipment stations in an accessible location.
- Establish storage area(s) for personal protection and spill response equipment in accessible locations.
- The capacity of storage shall be defined with respect to it's availability on seasonal or regular basis.

IMPORTANT POINTS FOR DESIGNING MATERIAL UNLOADING AND HANDLING SYSTEMS

- Prevention of spillage and stacking of material at conveyors and preheater tower.
- If the fuel shall be feed/ fired in calciner/smoke chamber in by a manual controlled feeding system, frequency/ rate of feeding should be maintained strictly to avoid pulsation in the process.
- Material shall be in dispersible form
- A constant monitoring of process data and the variations while hazardous Solid waste firing is being done
- Precautions to be taken to avoid any damage due to back pressure generating from the system during upset condition of the kiln, if any.
- The new systems shall least hamper the maintenance space and accessibility
- If feeding WDF in bags, Solid waste Bags weight shall not be higher than 10 to 20 kgs.
- Precautions to be taken to avoid any damage due to back pressure generating from the system during upset condition of the kiln, if any.

SPILL PREVENTION AND EMERGENCY RESPONSE

Requirements.

- Adopt a written spill prevention and control plan to minimize the risk of environmental contamination from accidental releases.
- Procedures to minimize the occurrence of spills when handling.
- Description of secondary containment in storage and unloading areas.
- List of emergency equipment at the facility, the equipment locations, and a brief description of equipment capabilities.
- Procedures for removing spilled or leaked waste and accumulated precipitation from the sump or collection area in as timely a manner as possible, and decontamination procedures.
- System to keep records of any spills or incidents requiring implementation of spill prevention or emergency response plan, along with follow-up actions.

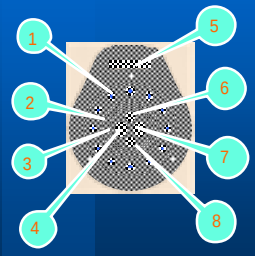
Facilities must be equipped with the following equipment:

- An alarm, air horn, or other signal system that will alert personnel to a spill.
- A device, such as a telephone or hand-held two-way radio or public address system capable of summoning emergency assistance.
- Portable fire extinguishers; fire control equipment, including special extinguishing equipment such as that using foam, inert gas, or dry chemicals that are compatible with the categories of hazardous substances stored at the facility;
- Water at adequate volume and pressure to supply safety showers, eye wash stations, water hoses, foam producing equipment, automatic sprinklers, or water spray systems. Water systems must be freeze protected.

Precautions

- Handling care in case of hazardous Solid, Liquid or Gas,
- Specific Personnel training before manpower mobilization,
- Pipelines used to transport hazardous or highly volatile liquids shall be tested at a pressure equal to 150% of the maximum allowable operating pressure (MAOP) for at least four continuous hours, Hydrostatic testing of hazardous liquid tank and piping up to safe testing pressures,
- There shall be two layers of pipe with proper inspection windows for any leakage of hazardous liquid to be contained in the second pipe layer. This also facilitate additional safety.
- Facility floor construction must be liquid-tight, constructed of steel-reinforced concrete, and sloped for containment and drainage. Alternative floor construction that is liquid-tight and provides equivalent protection is acceptable,

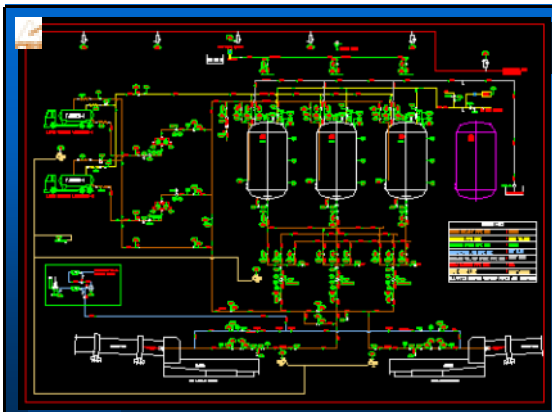
Multi-Channel Burners for Utilization of WDF in the Kiln



1. Jet Air Nozzles
2. Pulverized Coal / Animal Meal
3. Swirl Air Nozzle
4. Plastics Chips / Paper Pulp
5. Sawdust or Wooden Dust
6. Solvents
7. Waste Oil
8. Animal Fat

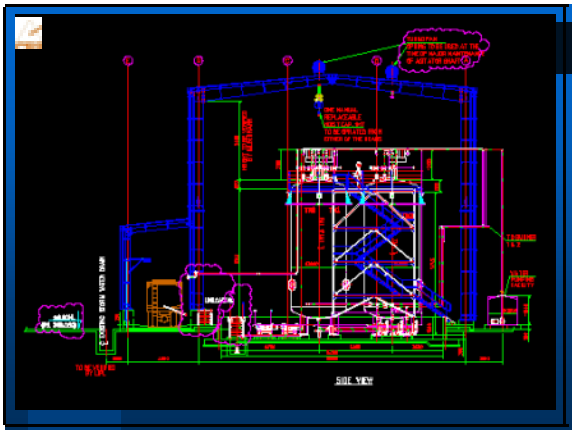
LIQUID WASTE FIRING THROUGH BURNER

- Injection of the liquid waste should be done through the centre of the burner and coal as a primary fuel can be injected through the outer annulus. Higher velocity at the burner tip is required in case of multi fuel firing and hence, necessity of an axial blower is envisaged in case the primary air quantum is low.
- Two phase injection nozzle for hazardous liquid waste firing is recommended to achieve sufficient fineness of the droplets
- Atomization of the primary air is envisaged and hence, any kind of compressor along with an air vessel is necessary to assure stable injection of the liquid waste. Air pressure of the compressor should be in the range of 6-8 bar for an atomization viscosity of 25-40 cSt
- Opening size of the nozzle diameter is of prime importance for firing of liquid waste due to its solid content (possibility of the nozzle to get plugged). Hence required opening would be determined after having the detailed analysis of the solid content in the hazardous liquid waste.
- Precautions are to be taken to avoid any damage due to back pressure generating from the system during upset condition of the kiln, if any.



Special Considerations for Liquid Waste Fuel (Sheet -1)

- Provision of Dike Wall
  - A. The Tank Farm area shall be at a low level concrete floor,
  - B. A dike wall is constructed surrounding the pit of Tank Farm area.
  - C. The total volumetric capacity of the inside space covered by dike wall shall be 120 % of the capacity of Liquid Waste Fuel capacity. This is considered due to possible spillage extreme case scenario.,
  - D. A separate spillage tunnel shall be considered at Tanker unloading area.
- Provision of Sump Pit
  - A. For minor leakage there should be additional provision for small sump pit inside the Tank Farm area main pit and capacity of the pit shall be 1 m X 1 m X 1 m.
  - B. The capacity of the small pit will be 1 m^3. This sump pit shall be connected common with Tank farm area and unloading bay.



Special Considerations for Liquid Waste Fuel (Sheet -2)

Provision for Fire Safety Arrangement

A. Nitrogen inert gas shall be used for breathing of tanks and tankers to prevent fire inside the tanks.
B. Water coding spray system is provided for cooling the tanks in case shell temperature is increased. This will prevent generation of fire inside the tanks.
C. Water hydrants system is provided around all the tanks pump area.
D. Smoke detectors/ optical detector along with foam fire fighting system are provided around Tank Farm area.
E. Flame arresters are provided in liquid transport pipes.
F. Portable Fire extinguishers, fire control equipments, special extinguishing equipment such foam, inert gas, dry chemicals that are compatible with substance stored at the facility.

- Provision of Electrical Earthing

A. The tankers, storage tanks and pipe line carrying hazardous liquid shall be provided with electrical earthing system for taking out static charge.
B. Connections to ground reinforced concrete limit the build-up of static electricity, when handling flammable products by metallic equipments and accessories.

Other Safety Arrangements

Any Grinding pump and unloading pump in truck unloading station shall be equipped with flow sensors against dry run. Temperature of each aggregate as well as pressure in pressure pipe of grinding pump shall be controlled.

There shall be agitator in all the tanks to work as stirrer. Each piping in storage tank shall be equipped with detonation guard. Storage tank shall be temperature controlled and pressure controlled. Overfill protection shall avoid overfilling of storage tank

The sensor at the tank ground assures that the base bearing of agitator is covered with liquid constantly. Spray nozzles at tank roof and half coiled pipe at tank wall are intended for cooling of storage tank

Flow meter and pressure transmitter control burner pipe. In case of an error in the kiln or decrease in pressure in burner pipe, redundant designed quick – acting stop valves located near the burner shall close.

After quick-acting stop valves close, the burner pipe will be blown out with compressed air. Pressure in compressed air pipe is controlled. There is a urtder pressure valve in gas perdulum pipe to protect against vacuum in tank truck

Considerations for Solid Waste Fuel

- In case of system stoppage for more than a week the complete conveying system shall be emptied.
- The rice husk/ solid waste feeding area near the Calciner should be clean enough and dust deposition should be avoided.
- Anti-static coated filter fabric is recommended for dedusting the system equipments.
- Any sort of spark ignition should be avoided. Installation of emergency fire extinguishing system near the installation of any system bin/ buffer bin is also necessary
- Catchments area with drain canals shall be considered to take care of leakage/ seepage of the liquid waste. This shall also be considered for any solid waste storages to take care of any rain water flooding.
- In case of system stoppage for more than 24 hours the feeding system and buffer bins shall be emptied.
- Proper hand railing with toe guards and fire exits shall be provided in conveyor gallery.

SYNOPSIS

Evolution of waste management
The AFP is only at the beginning of its development. Theoretically cement kilns can produce quality clinker by substituting totally their fuel by waste which translates into huge potential treatment capacity of waste (sufficient to treat all the wastes generated in any country per year). The only limitations reside in the preparation of the waste in order to match the fuel specifications. The list of candidate materials for use in a waste fuel program was so far limited mainly to few solids & liquids but extra investment in alternate fuel preparation equipment expand its range. For example, filter cake is a newcomer to the waste fuel program. So far this waste material was traditionally sent to (secure) landfill.
It is obvious that more and more waste management companies will offer such services to their customers and that the disposal cost will be lower than in the past. Companies operating their own incinerator should welcome any proposal to dispose their wastes at a lower fee than their actual operating cost.

CONCLUSIONS

Due to climate change and increased prices for primary fuels, the use of liquid waste as alternate fuel becomes ecologically and economically relevant. The specific heat quantity of waste makes the technology effective for cement industry.

Utilization of Waste fuels in clinker manufacturing requires careful and tailor-made analysis and planning covering:

- Secondary fuel resources, quantities and properties.
- Specific elaboration, design and modification of plant technology and operation.

The installed equipment should be flexible in order to cover variations in type and quantity of secondary fuels.

Furthermore, the equipment should be adjusted to local conditions: „What is applicable in Europe may not suit to local circumstances".

The technology for secondary fuels conditioning, handling, storage, feeding and dosing should consist of equipment familiar in cement plant operation and maintenance.

EPILOGUE

For nearly 30 years the Cement Industry has pursued a growing list of alternate fuels saving natural resources, reducing costs, decreasing emissions, decreasing the need for landfills and other disposal options and decreasing the CO_2 footprint of emissions.

We have personally been involved in working on a few varieties of these projects and thought that it might be helpful to have a standard procedure design and methodology to conceptualize these projects. But surely a deliberate effort from Cement Manufactures and more important a proactive approach from Government & Private – Technocrats, Environmentalists and Entrepreneurs are required to make this effort successful.

thank you .....