7th International DAAAM Baltic Conference
"INDUSTRIAL ENGINEERING
22-24 April 2010, Tallinn, Estonia

ANALYSIS OF FIRST WASTE-TO-ENERGY PLANT PRODUCTION LINE AT KUNDA NORDIC CEMENT AS

Jõgi, G.; Bashkite, V. & Karaulova, T.

¶ **Abstract:** *Many industrial companies have gone through an energy efficiency increase. These improvements are necessary, but ways gains obtaining are getting much more difficult. The current paper shows that Kunda Nordic Cement AS finds the better tools to improve energy efficiency, focusing in reducing fuel consumption, or using alternative (and cheaper) fuels. The project at Kunda plant is in line with both national and EU waste strategies, and holds strong backing in the Estonian Ministry of Environment. Estonia is only at the starting phase of using waste to energy plants. KNC with its unique kilns makes a great contribution to the promotion of this idea.*
Waste recovery is a multilevel process. Here, we look at how Kunda Nordic Cement AS is using recycling equipment to turn waste into RDF which is then used as fuel for the cement industry. Modelling and simulation of the new technological line for RDF receiving will specify the bottlenecks of the process.
Keywords: Alternative fuel, recycling, Waste to Energy, Refuse Derived Fuel.

1. INTRODUCTION

The enormous quantities of industrial and household waste recently have become a serious problem; they must be properly disposed of to prevent environmental disruption. This diversity of waste is difficult to dispose and requires high technology.

1.1 EU Waste Management

The Waste Framework Directive (COM) emphasised the importance of waste minimisation, the protection of the environment and human health as priorities, and advocated the waste hierarchy.
EU proposed waste management hierarchy, in the following order:
1. reduction
2. reuse
3. recycling and composting
4. energy recovery with heat and power
5. landfill.

Fig.1 The Waste hierarchy

According to the new Waste Framework Directive [1], the European Commission will propose measures to support waste prevention activities, e.g. by setting prevention and decoupling objectives for 2020. Also by 2020, at least 50 % of waste materials such as paper, glass, metals and plastic from households and possibly from other origins must be recycled or prepared for re‑use. The minimum target set for construction and demolition waste is 70 % by 2020.

1.2 Waste to Energy

The "Waste to Energy" (WTE) facilities include the following technologies [2]:

- Mass Burn (MB) "Waste to Energy" plants generate electricity and/or steam from waste by feeding mixed municipal waste into large furnaces dedicated solely to burning trash and producing power.
- Refuse-derived fuel (RDF) "Waste to Energy" plants remove recyclable or incombustible materials and shred or process the remaining trash into a uniform fuel. A dedicated combustor, or furnace, may be located on-site to burn the fuel and generate power; or the RDF may be transported off site in order to use it as a fuel for boilers that burn other fossil fuel.
- The "Waste to Energy" facilities are Modular "Waste to Energy" plants, which are similar to Mass Burn plants, but there are smaller mobile units that may be quickly assembled where needed.

In this paper will be considered and analysed RDF recovery process from waste in AS Kunda Nordic Cement in Estonia. Today it is the only company, what technology enables the process of simply prepared a large quantity of waste incineration plants. Solid waste energy for cement production is an opportunity for reuse of waste.

The cement industry has important environmental responsibilities because the cement manufacturing process requires high temperatures which consume about ten times more energy than the average amount required by any other industry. The average energy required to produce one tonne of cement is equivalent to the combustion of approximately 120 kg of coal.

2. USING WASTE AS FUEL

Alternative fuels are frequently prepared and blended outside the cement plant by specialist companies. Waste materials which are generally reusable as RDF include tyres, rubber, paper, textiles, exhausted oils, wood, plastics, industrial waste, hazardous waste and solid urban waste. Cement kilns require a homogeneous RDF composition which is uniform not only in shape and size but also in calorific value.

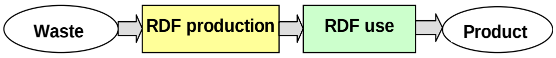

Fig. 2. Layout of waste using through RDF

To achieve uniform size, it is generally required that waste has to go through an adequate process of size reduction to make it reusable as a quality RDF. The material has to be uniform in size to facilitate transportation, and in many cases must be selected by a screen to obtain the optimal final size for the kilns, depending on the feeding location.

In terms of uniform heating value, it is important to guarantee a homogeneous composition of waste allowing the material to burn releasing the same constant quantity of heat. It is therefore important to blend the different material types before the size reduction process.

2.1. RDF Production Facility

RDF can be used in a variety of ways to produce energy. It can be used alongside traditional sources of fuel in coal power plants. In Europe RDF can be used in the cement kiln industry, where the strict standards of the Waste Incineration Directive are met [3].

The composition of solid waste varies significantly from country to country, due to cultural differences and generally reflects the level of industrialisation and level of paper and plastics used in packaging. Solid waste is a poor quality fuel and in a number of countries, pre-processing of waste to prepare an RDF is practiced to improve its consistency, storage and handling characteristics, combustion behaviour and calorific value.

Production of RDF generally involves one of two basic approaches [4]:

• Wet flock-type RDF preparation by shredding, screening, magnetic and eddy current separation, and possibly air classification, and

• The preparation of a dry densified RDF by intensive processing of municipal solid waste followed by drying and compaction into a pellet or cube.

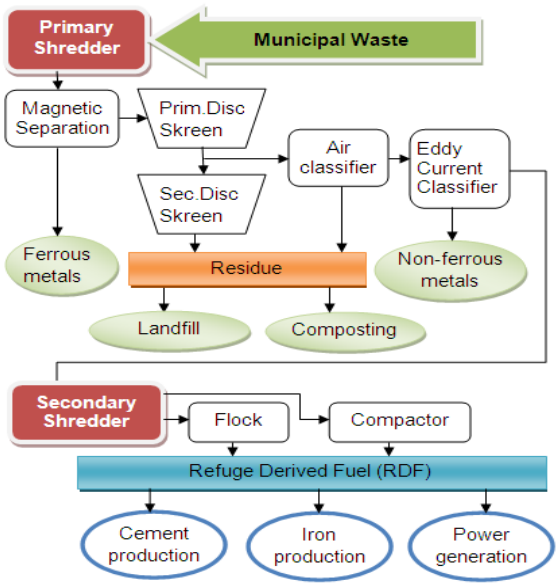

Fig.3 RDF production facility

A typical RDF production layout is shown in figure 3

2.2 Advantages of Using RDF in Cement Manufacture

The use of alternative fuel is a well-known and consolidated technology that guarantees numerous environmental benefits. Primarily, avoiding the consumption of non-renewable precious resources and consequentially lowering gas emissions since traditional fuel is actually replaced by a fuel derived from waste which would otherwise require other forms of disposal.

The burning waste produces toxic gases such as hydrogen chloride and sulphur dioxide which usually require extremely expensive filters to avoid their release in the environment. Conveniently, the raw material used to produce cement contains a high degree of lime and alkaline material which, when it is introduced into a kiln at very high temperatures (1600–2000°C), absorbs and neutralizes hazardous gases in the kiln chamber.

Moreover, cement kilns are able to use the energy generated by the waste material, while traditional waste incinerators are less efficient converters of the heat content of waste. The recycling process, and the use of good recycling equipment, is a vital component of the larger process which turns waste to fuel that is then used for cement production.

Today, plants for the conversion of fuels waste into energy should be designed to suit the technical, environmental as well as the economic demands of tomorrow.

3. KNC AS INITIATIVES

One of the last implementation on AS KNC was solution to reduce fossil fuels in the cement industry, and at the same time to reduce the environmental impacts associated with the use of fuels. The materials used in this article are opened and can be easily found [5].

The Kunda cement plant began using alternative fuels in 2000. Initially, different liquid residual products were used, such as waste oils, waste from the oil shale chemical industry and benzoic acid residue. In 2007, more than 36,000 tons of liquid waste fuels was burned in rotary kilns, providing about 10 percent of energy requirements, thereby reaching our target. In the future, it is expected that 85,000 tons of solid waste will be used as fuel each year [5]. At maintained production levels, this would save 140,000 tons of oil shale each year and decrease greenhouse gas emissions by 5 percent.

The proportion of waste for cement production is expected to increase in use of new technological line approximately by 35% of the total amount of the required fuel.

The project aims the sustainable use of energy resources and the promotion of waste recovery and reduction of environment pollution loads. In particular, the desire to reduce emissions of packaging, automotive and electrical and electronic equipment waste in landfills.
Project activities:

- the design of technological solutions;
- acquisition of equipment, building infrastructures;
- determine the suitability of the test run of technology;
- Analysis of the quantities of waste fuel and resource definition, negotiation with suppliers of waste.

In general, the new installation for dosing RDF to kiln is controlled by distributed control system. Before incineration the waste must be pre-processed: sorted, dried, pressed, etc.
For RDF production was used equipment of wellknown companies Saxlund International and Pfister GmbH, for air cleaning Scheuch GmbH filter.

3.1 Saxlund Equipment

Saxlund International offers a complete line of material handling and recycling equipment. In KNC AS are used follows Saxlund equipment:

- Push Floor Discharge System
- Screw Conveyor
- Chain conveyor
- Disc screen classifier
- Magnetic drum

Push Floor Discharge System
The Push Floor is driven by a hydraulic system that moves a number of parallel Pusher Elements or 'ladders' in reciprocating motion across the bunker flat floor. As it does so it digs the stored bulk solid material from the bunker and delivers it to a screw conveyor or other machines. Either the screw or the Pusher Elements themselves perform the required metering function from the bunker. (Fig. 4).

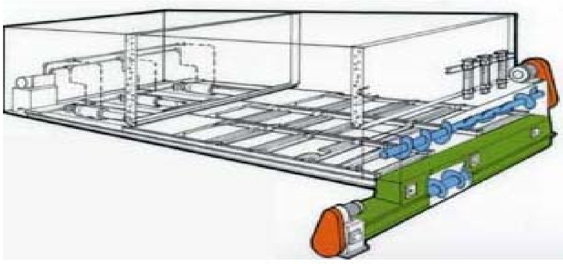

Fig.4. Push Floor Discharge System

Screw Conveyors. The product is conveyed from the draw-in orifice to the outlet. In being so, it is pushed along inside the enclosed trough by the helical screw gear.
Chain conveyor is a continuous operating machine within a bolted rectangular cross-section casing.
Disc screen classifier is designed for bulk material. Robust, high operating efficiency and low maintenance; these important characteristics make disc screens economical and environmentally friendly.
Magnetic drum (Fig. 5). Material is typically fed on to the surface of the drum by vibratory feeder or chute work. The magnet system holds ferrous metal to its surface allowing the non-magnetic material to fall away from the drum. Ferrous metal held on the surface is carried by the revolving drum to a position where the magnet system ends and it then drops away from the drum.

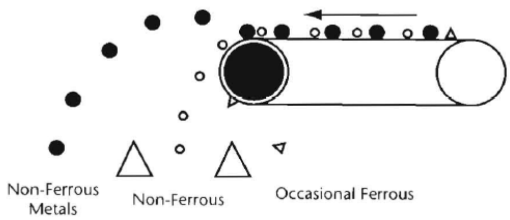

Fig. 5. Magnetic drum

3.2 Pfister GmbH Equipment

Pfister GmbH is one of the world's leading companies in weighing and dosing equipment as well as engineering services for the cement and minerals industry and coal-fired power plants.
Pfister (Fig. 6) Fuels are fed by a pre-feeding system via diverter flap to pre-hopper.

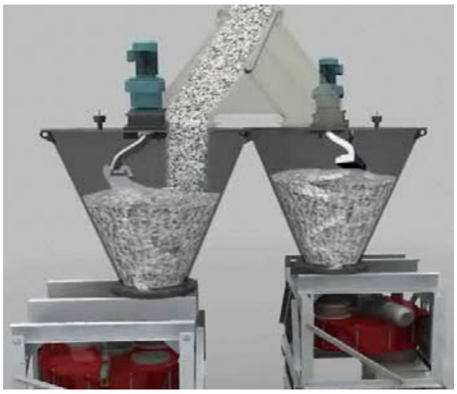

Fig. 6. Pfister equipment

Pfister's product range consists of classical linear dosing systems for dosing primary and secondary fuels. The performance range of these technologically highly developed systems spans from dosing of fine products such as coal dust, raw meal or fly ashes to dosing of coarse materials such as clinker, crushed coal or additives.

Material feeding into the pre-hoppers

The calibration pre-hopper above Rotor Weighfeeder works additionally as material buffer. A helical stirrer keeps the fuel in motion and ensures a constant fuel flow to the TRW-S/D. The material load inside the hopper is measured by load cells underneath the frame (Fig.7).

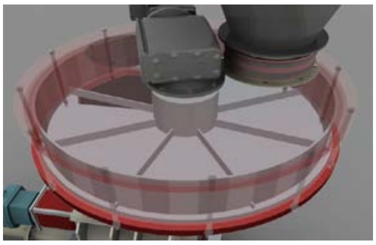

Fig. 7. Rotor Weighfeeder TRW-S/D

The bulk material transported by the horizontal rotor wheel from the inlet to the outlet falls down at the discharge opening by gravity.

Pneumatic fuel transport. Rotary valve feeds the material into the pneumatic transport system. Clean transport air from the blower is blown through the blowing shoe. Part of transport air is used for cleaning the chambers of Rotary valve. The air loaded with fuel is transported directly into the burner flame.

Online calibration during operation. During online calibration the material supply the pre-hopper is stopped. The static load cells underneath The TRW-S/D frame measure the loss in weight during the calibration period. This value is compared with the weighing data of the Rotor Weighfeeder TRW-S/D. If necessary the online taring can be executed.

3.3 Scheuch GmbH Technology for Cleaning Air

Sustainable development and conservation of clean air is a crucial challenge.

Scheuch GmbH technology is used

- for dedusting,
- the reduction of contaminants,
- heat recovery and the cleaning of exhaust gases.

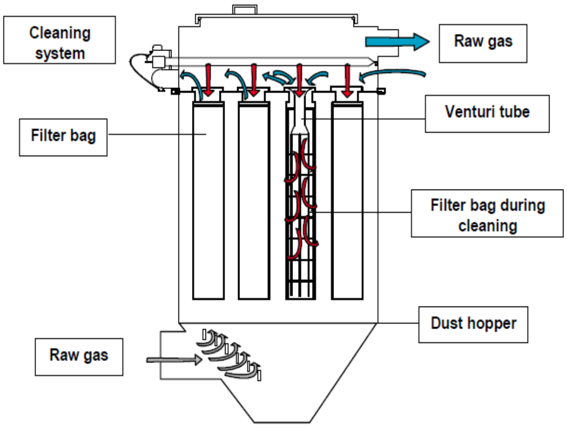

Fig. 8 Scheuch impulse-bag-filter

The Scheuch impulse-bag-filter is separator with electronic controller cleaning procedure effected by compressed air impulses serially during operation or chamber by chamber. Removing dry dust of process, exhaust gases in many different areas.

4. ANALYSIS OF THE SYSTEM

In this research we attempt to simulate the RDF obtainment process from the solid waste with the aim to analyse and find the bottlenecks in this process. It helps us to find proper ways for implementation of fail-safe work of the whole system. In figure 12 is introduced diagram of the process by using IDEF0 method (Fig. 9).

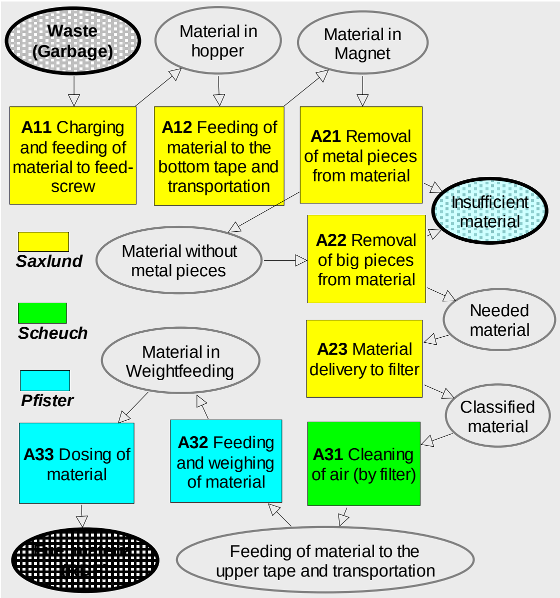

Fig. 9. Simulation model of the process

Simulation of this diagram shows the productivity of system with RDF if we burn 5 tons per hour (Fig. 10).

Location Name	Total Entries	Minutes Per Entry
A11	8	3.000000
A12	8	2.750000
A21	7	3.000000
A22	7	2.000000
A23	7	1.857143
A31	6	4.000000
A32	6	7.166667
A33	5	5.400000

Fig. 10. Productivity of the process

The Resource States diagram (Fig. 11) shows the bottleneck in Weighfeeder. It means the Weighfeeder is used in a wrong way and something has to be done in order to relieve the filling of Weighfeeder. Optimization of working load will help to get better result.

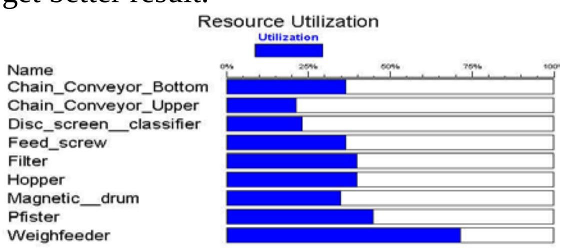

Fig. 11. The RDF system elements loading

5. CONCLUSIONS

This paper has shown that the use of RDF in cement kilns is a real technological solution both for RDF producers, urged to find a useful final destination for the produced material, and for cement plant operators, whose first objectives are the economics of production, optimal energy allocation, and limiting environmental impact.

The analysis of unique technological line has shown good results. Nevertheless, there are still some problems, such as RDF fuel high humidity and overloaded Weighfeeder. These bottlenecks have to be eliminated before the second pre-hopper is activated.

6. AKNOWLEDGEMENTS

This research was supported by Graduate school „Functional materials and processes“ receiving funding from the European Social Fund under project 1.2.0401.09-0079 in Estonia, and by Ministry of Science and Education project SF0142684s05

7. REFERENCES

1.ECOM(2008) 811 *Green paper on the management of biowaste in the European Union.* Commission of the European Communities, Brussels http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0811:FIN:EN:PDF

2. The Recovered Energy System™ http://www.recoveredenergy.com

3. Genon G.& Brizio, E 2008 Perspectives and limits for cement kilns as a destination for RDF, *Waste Management 28 (2008)* 2375–2385

4. Co-utilisation of Coal and Municipal Wastes Report No. COAL R212 DTI/Pub URN 01/1302 http://www.berr.gov.uk/files/file18670.pdf

5.KNC Sustainability Report 2007 http://www.heidelbergcement.com/ee/en/kunda/keskkond/tsement_ja_betoon.htm