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Part 3

ASH AND SLAG HANDLING

3.7. Analytics

3.7.32. Marketing of CCPs in Germany - Experience -Report of a German Company

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ABSTRACT

Over the past years hard coal fly ash produced in accordance with EN 450 has been successfully used in Germany and other European countries. More than 75 % of the annually produced 4.0 million tonnes of hard coal fly ash in Germany has been processed in cement bound building materials. The market for such products is today very stable. A decisive fact for this development was that the supply of hard coal fly ash always met the market needs in both quality and quantity. Beyond that there are other factors which influenced the utilisation of hard coal fly ash. Not only in Germany but also everywhere in the world the technical advantages of hard coal fly ash in cement bond building materials are very well known. Nevertheless, it seems to be not possible to utilize hard coal fly ash everywhere and to avoid landfilling. This experience report delivers an insight which factors played an important role in the development of marketing in Germany.

Keywords: fly ash, concrete addition, building material, European Standard

1. INTRODUCTION

Nowadays, the term “modern” means not only up-to-date but also seminal and sustainable. Economically, socially and ecologically sustainable developments are in accordance with sustainability. Thus, modern management of building materials stands for enduring, long-term economic successes that preserve the social and ecological environment for future generations. In modern societies not only natural raw materials are considered as resources. Increasingly materials are focussed on which have been discredited as waste materials in the past. People learn more and more from nature. Nature does not know the term waste. Everything has a sense and is basis for something new.

The concrete addition hard-coal fly ash is a building material, which - due to its development, properties and effectiveness - meets especially the requirements of sustainability. Worldwide more than 5.5 billion tonnes of hard coal per year are mined and for the supply of primary energy burned. A large part is used for the generation of electric energy. Based on modern combustion technologies approximately more than 600 million tonnes of pulverised hard-coal fly ash (PFA) per annum are produced worldwide. No resources are used for the production of fly ash nor are areas of unspoiled nature destroyed because fly ash is a by-product of power generation in coal-fired power plants. Due to its puzzolanic properties, PFA can partly replace cement as a building material - cement requires a high energy input for its production and it is based on non-renewable raw materials – as well as naturally occurring rock aggregates and fines. PFA improves the properties of concrete in which it is incorporated. It has been proven that concrete buildings which incorporate PFA are characterised by a longer service life and lower maintenance costs.

Already the Romans knew how to take advantage of volcanic ashes as building material. Buildings constructed with volcanic ashes as a component of binders can still be seen today. Thus, the use of ashes in construction is nothing new.

The following review shows that Germany worldwide holds a leading position in the utilization of power station by-products especially in the utilization of fly ash. One reason for that is that modern building material management has been successfully practised for many decades. The following retrospective delivers an insight into the historical development.

2. THE DEVELOPMENT OF HARD-COAL FLY ASH AS BUILDING MATERIAL

2.1 Building engineering code

Today, Germany holds a worldwide leading position in the utilization of power station by-products especially in the utilization of hard-coal fly ash. In Germany hard-coal fly ash has been utilized in concrete since the 1940s. The outstanding properties of hard-coal fly ash have been recognized in the course of time and confirmed by numerous scientific studies.

Extensive research already in 1965 revealed that with mass-concrete at least 50 Mass-% of cement could be replaced by hard-coal fly ash, and with reinforced concrete it have been at least 20 Mass-%. At that time the pioneers were aiming at achieving technical and economical effects by utilizing PFA for concrete manufacturer. Protection of environment and resources certainly played a minor role and was not a primary goal.

On the basis of comprehensive research results, in 1966 an application was submitted for a general building supervision approval for EFA-Füller® as a substitute material for cement used in concrete and reinforced concrete. The building and concrete code in force until then - DIN 1045, Edition 1959 [1] - Stipulation of Minimum Cement Contents - did not envisage such an application. The application resulted on 29th June 1970 in the first approval notice for EFA-Füller® RM [2]. The findings gained by the pioneers in the use of fly ash, together with the users, were taken over for the first time for the Standard for the Production of Concrete.

Another development step became apparent with the publication of the Yellow Print of the subsequent DIN 1045/72 in 1968 [3]. It was stipulated that, henceforth, hard-coal fly ash could be added to the cement content to the same extent as regulated by the building supervision approvals.

In the subsequent years, but especially after the introduction of DIN 1045/72 concrete standard, applications have been submitted in the German Federal Republic for the approval of the increased incorporation of hard-coal fly ash as a concrete addition. The approvals were granted by the Deutsches Institut für Bautechnik (German Institute for Building Engineering) in Berlin, and corresponding test certificates were issued.

The standardization has a special place in construction. New developments may actually only be introduced via definitions in standards into practice and thus generally applied. Before new building products and new application rules can find its way into the building standards, an intensive cooperation in standardization and technical committees is required. This work the Bundesverband Kraftwerksnebenprodukte e. V. (BVK) has taken over since 1976.

In 1994 CEN adopted EN 450 as a European standard. In the subsequent year DIN EN 450 [4] was introduced in Germany as an official building material standard. Since then hard-coal fly ash has been accepted as a standard building material. The state of knowledge achieved with hard-coal fly ash was reflected in DIN EN 450 as well as in the application rules of other standards. This forms the basis for the successful use of hard-coal fly ash as a concrete addition and for its marketing as a building material.

2.2 Economical and social influences

First steps in the development of PFA as a building material were closely connected with the development of concrete as a building material and in general with the development of the building in an industrial scale. Concrete which increasingly has been produced industrially in stationary batching plants and the increasing monolithic way of construction influenced more and more the construction industry. The need for high-quality building materials increased rapidly especially in the course of general and economic development of Germany after the World War II. Financial scarcity and the scarcity of natural resource helped to look for more cost effective solutions at the same high level of quality.

As a further point which should be not underestimated why the utilization of PFA as an economic line of business in Germany has established has to do with population density. The transportation costs have a significant influence on the coal combustion by-product business. Long distances of transportation lead to high transport costs, which ultimately must carry anyone. If the utility is not willing or able to take them over, the user of the materials must be prepared to absorb corresponding costs. A market-based environment with the free play of supply and demand helps to produce an economic optimum. In Germany at present a little bit more than 40 million m^3 of ready mixed concrete are produced in an industrial scale. The production is very stable at this level and is comparable to the per capita production of concrete other developed industrial countries. Starting from the total area of Germany in average more than 100 m^3 of ready mixed concrete are produced per km^2. In this quantity of ready mixed concrete 2.5 million tons of PFA are used which is a bit more than 60 kg per m^3 of ready mixed concrete on average.

Power station operators benefit from that development. They can be sure to sell its products in an ever-renewing market. The investment to open this market needs to be done only one time. The sales of PFA which fulfils the requirements of EN 450 and where capacities for the storage and loading of PFA are available generate revenues. From these revenues German utilities cover expenses for the generation and provision of high quality products today. This has been different in the past. At the beginning utilities had to calculate the utilization of PFA against the costs for disposal. Amongst other things, driven by the social and political conditions in Germany money which has been spent to cover the expenses for disposal became increasingly invested in the recovery and the development of a market for PFA. Supply and demand were more or less randomly in no mismatch, so that even from that point of view a free market could develop.

2.3 Marketing volumes

Concrete technology without PFA is now unthinkable in Germany. Most of the concrete produced in Germany now incorporates hard-coal fly ash as a concrete addition.

Since the middle of the 90th the use of PFA as an addition in ready-mixed concrete has remained almost constant at between 2.1 and 2.5 million t [5]. This level has been maintained even though the ready-mixed concrete industry suffered a drastic decline during the same period [6].

From the western part of Germany PFA is exported to Belgium and the Netherlands since close to the border a high production is available and customers abroad can be supplied cost-effective due to short transport distances. In East Germany, along the borders with Poland and the Czech Republic, however, the availability of PFA is low. German customers in this region are supplied from foreign power plants. PFA with certificate according to EN 450 is traded across borders since middle of the 1990th increasingly. Meanwhile, long-range trade structures have been developed primarily based by water which connects Northern, Middle and Southern Europe. PFA is recognized throughout Europe as a building material and is increasingly in demand from the European building material and construction industry.

In regions where PFA sufficiently is available and thus the concrete industry can rely on a supply meeting the demand, on average not less than 60 kg of PFA per m^3 of ready mixed concrete could from a technical point of view easily be used. The current demand for high-quality PFA for ready-mixed concrete, for the production of concrete products, for mortar production and in other cement-bonded building materials, is in the order of 3.8 million tonnes per year. Beyond cement-bonded building materials 0.2 to 0.7 million tonnes of hard coal fly ash are used in other application like earthworks, civil engineering and road construction. Only a very small amount is taken over by the cement industry for the production of blended cement.

3. MODERN BUILDING MATERIAL MANAGEMENT FUNDAMENTALS FOR HARD-COAL FLY ASH

In Germany almost 100 % of the PFA produced in hard coal fired power plants is utilised most of it in a dry state. Hard coal fired power plants do not need disposal sites any more. The entire production is marketed domestically or cross-border. The successful marketing of PFA requires specialized companies which have corresponding know how in building materials science, logistics and an extensive knowledge of the market.

But also the power station operator needs to meet certain requirements. An appropriate market for coal combustion by-products can develop only there where utilities are interested to market their by-products and where economy and ecology are in harmony with each other and an important corporate goal.

Modern building materials management presupposes direct contacts with the buyers. Only those who are familiar with the specific requirements of their clients are able to offer competent and consistent solutions. In the marketing of hard-coal fly ash the respective dealers have always concerned themselves with the specific demands of the buyers. In an every growing number of cases the application of hard-coal fly ash has repeatedly proved to be the most effective answer to the technical and technological questions of buyers in the field of concrete.

Close co-operative ties between the hard-coal fly ash sellers and buyers have always resulted in a process of rapid feed-back. Consequently, direct access to the final consumers which means to the concrete market remains the principal precondition for the successful sale of hard-coal fly ash, and everything possible is being undertaken to ensure that this direct access is also maintained without any restrictions in the future.

Another important criterion is the quality of the products and services within the framework of supplying hard-coal fly ash. Clients expect a uniform building material in keeping with generally valid rules and agreed specifications so that they can adapt their products accordingly. And the minimum requirements expected of hard-coal fly ash as a concrete addition are defined in DIN EN 450-1. Quality-orientated control of fly ash production according to characteristic values such as ignition loss, fineness and free lime content, the composition of the fuels and specifically adjusted plant parameters such as the sifter, burner and coal mills, have long been state of the art in German hard-coal-fired power stations. Standard product properties are ensured within the framework of in-house production control and quality assurance in keeping with DIN EN 450 “Fly Ash for Concrete - Part 2: Conformity evaluation” [7].

The quality of the rendered service is just as important for the client as the actual quality of the given product. Logistical problems on account of insufficient storage capacity in power stations are a matter of the past. Large silos are available at virtually all power station locations to avoid supply bottlenecks. The largest at present available silo in Germany for the intermediate storage of PFA has a capacity of 80,000 tonnes. Modern loading equipment ensures that a smooth supply of fly ash can be maintained by road, rail or waterway transport. Requirements-conform availability of hard-coal fly ash is therefore now always assured.

Last, but not least, there is marketing that forms the basis of modern building materials management. A distinction is made between technical and commercial marketing.

Technical marketing involves the measures that are necessary to maintain and improve the technical application possibilities. This also includes the work of technical bodies and standardisation committees which is primarily conducted by the European Association for Power and Heat Generation VGB PowerTech e.V. (VGB) with the support of BVK. Furthermore, BVK is also concerned with public relations activities and drawing up material and application related market information as a major contribution towards strengthening the image of PFA as a building material.

4. HARD-COAL FLY ASH AND ECOLOGY

It is not only in Germany that ecology subjects are playing an ever-growing role in social awareness and in other spheres. The generation of energy in future is being discussed in all social areas in the light of this aspect. Hard-coal will continue to remain at least medium term a mainstay energy carrier and account for a significant share of the supplied forms of energy. Public acceptance of hard-coal power stations is of particular interest to the operators of such modern power generating facilities. Currently, approximately 30 % of the investment costs for modern hard-coal power stations are devoted to facilities that keep the environment clean. Nowadays, such installations and their efficient operation form an integral part of the process to generate energy from hard coal. In future a continued high acceptance level of hard-coal-fired power generation will only be assured in its entirety, i.e. commencing with the purchase of the coal to the operation of hard-coal-fired power stations and the economical use of the firing residue by-products.

The fly ash invariably produced during the generation of electricity from hard coal is an outstanding example in this context. In modern hard-coal power stations it is possible to produce hard-coal fly ash in such a manner that it can be economically recycled for commercial use without involving any additional cost-intensive processing operations.

The use of PFA can eliminate the need for cost-intensive landfills so that the land can be used for other purposes. In a densely populated country like Germany it will be extremely difficult to find such suitable land in the vicinity of power stations. Moreover, such landfills represent an additional environmental hazard and do not exactly contribute to the general acceptance of hard-coal power stations. Therefore modern power plant operators invest in the utilization activities instead of binding their capital with the construction and operation of landfills, which are always limited in terms of their capacity. The marketing of PFA in concrete is once established a perpetual ongoing process since the

demand for high quality building materials regenerates constantly.

The effects of economical resources management through the use of PFA as an addition for concrete are particularly diverse. For instance, the hard-coal fly ash actually replaces some of the cement that is used to produce concrete. Consequently, considerable quantities of limestone, as the principal raw material for the production of cement, do not have to be quarried. This also means that the energy intensive and environment burdening process of cement production can be diminished accordingly.

Although the market prices for CO_2 emission certificates are currently on a very low level the reduction of the emission of CO_2 plays further an important role in the building material industry. PFA contributes to save CO_2 emissions. The cement industry is particularly affected by the limitation of the emission rights. The production of one tonne of CEM I releases approx. one tonne of CO_2. This amount of CO_2 is not only due to the firing process that supplies the energy for the chemical transformation of limestone into cement clinker. A considerable share of the carbon dioxide is also the result of calcination (process CO_2) and therefore unavoidable. Moreover, the use of specific fuels hardly offers any scope for a further reduction because the theoretically minimum amount of necessary energy has been almost reached. Small amounts that can be disregarded compared with the first ones mentioned can be attributed to electricity consumption.

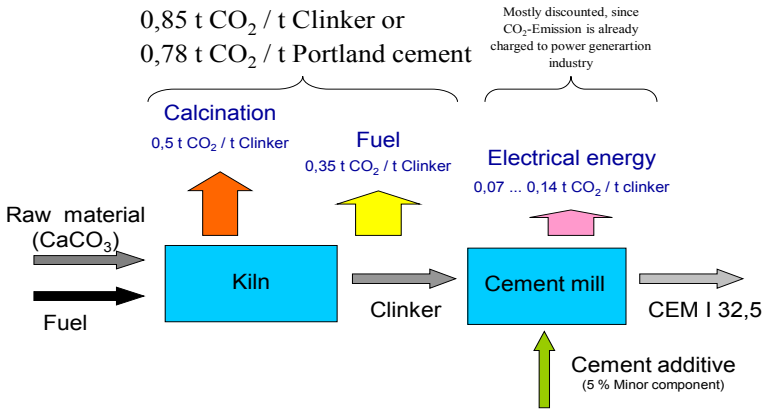

Figure 1 - CO_2-balance in the production of CEM I

Modern building materials technology takes this into account. Through the use of cement substituting substances, CO_2 emissions are reduced. In many European countries, this topic is both technically but also in terms of the available quantities of industrial by-products already exhausted.

The utilisation of hard-coal fly ash counts three times concerning ecology. At first disposal of ash is avoided; at second natural resources can be saved and at third due to its properties the durability of the concrete enhanced hence as much as possible PFA should be used in cement bond applications.

5. CONCLUSION AND OUTLOOK

In Germany today a stable market for PFA is available. Modern concrete technology without PFA has become indispensable in Germany. Many points have contributed to this development. In Germany, the development has been dominated by market economy principles and the free play of supply and demand. Technical developments and a corresponding marketing did of course not fail the desired effect. Today utilities, companies, which have specialized in the marketing of such products and the building material industry, participate from this development. Last but not least the environment participates on three accounts.

Through the use of PFA approximately 3 million tons of CO_2 are saved annually. Landfills, which properly executed cause significant costs and also pose an environmental risk, are no longer required.

Increasingly the decision of the German government to generate electricity more and more from renewable sources affects the business. The consumption of hard coal for the production of electricity is declining, which inevitably has diminishing quantities of coal combustion by-products as a result.

Which impact these developments will have on the market for coal combustion by-products remains to be seen.

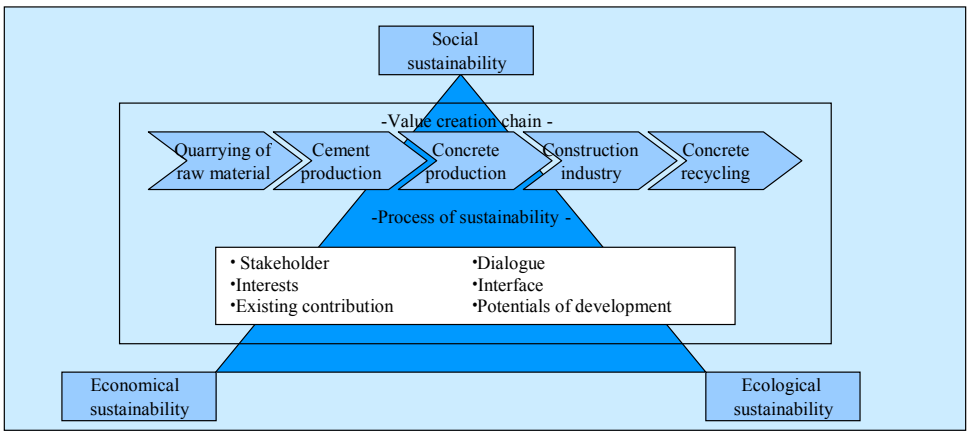

Figure 2 - Integration of the three sustainability dimensions by appraisal along the value-added chain [8]

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