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THE UTILISATION OF SOLID WASTES as SOLID FUEL in SOME EU-COUNTRIES

E. Erdin, A. Ürüt, G. Şen and A.Alten

Faculty og Engineering, Environmental Engineering Department, Dokuz Eylül University, 35160
Buca, Izmir, Turkey
Emails: eerdin@deu.edu.tr; afsaru@ttnet.net.tr; gorkem.sirin@deu.edu.tr; akin.alten@deu.edu.tr

ABSTRACT

According to regulation 2000/7/EG, it is explored that whether solid wastes(SW) should be used as additional fuel with conventional fuels for production and also in SW Combustion plants. The allowable limit to combust hazardous wastes is %40 as maximum. But domestic wastes should contribute at higher percentages. Every EU-member state must adopt this regulation to its national regulations till 28.12.2002. This paper summarize the researchs done according to this regulation.

INTRODUCTION

Process Definition

Germany and Austria are using SW as additional fuel in production [1].

For this purpose several firms like Herhof – Umwelttechnik GmbH has develop technologies, so that domestic solid wastes (DSW) as additional fuel. According to the technology developed, DSW are processed bio-mechanically in"dry stabilisation plants" and converted to solid fuel and stored. During this process, easily bio-degradable organic parts of the SW are degraded and heat is generated, which will incerase the ambient temperature and a kind of vapour produced. Than vapour is removed and drying will take place. By mechanical processes inearth materials are removed and the calorific value (CV) of the product is increased to 15-18 MJ/kg [2].

Combustion process will produce hazardous by-products and emissions, if not practised properly. According to EU-reglations combustion products (particles) must be processed at least for 2 seconds at 800-1100 C. Also all the prevention and protection precautions must be taken, to not violate air pollution criterias and trashhold limits [3].

According to new regulations and directives come up in force at 2004, it is banned to store SW in landfill areas without processing, and the organic Carbon content of waste should not exceed %5. Thermically processing seems to be an appropriate solution, where SW can be used as additional fuel [4]. In Austria SW are used as additional fuel in cement, pulp & paper factories and thermical power plants [5]. Disease causing and restricted feeds are also combusted in this plants [6].

MATERIAL BALANCE ANALYSES

For a incineration plant following parameters must be taken into account for Material Balance Analyses:

1. Analysing the problem and the target,
2. Definition of the system, limitations and relations between processes,
3. Preparation of tempoFral balance sheets according to the preservation principal of material,
4. Application of the suitable metering programme, test the sensitivity,
5. Literature search, sample collection and analyses for defining the material balance,
6. Representation of collected datas with modells and graphics; development of material data bank system
7. Parameters and limit values:
    - Calorific value ≥ 11000 kj / kg KA
      TOC……… ≤ %3
      %Incineration loss……... ≤ %5
    - Type of wastes to be combusted,
    - Meaning of additive fuel, its importance.

It's ver important to sustain a continous quality for additive fuel. Some scientists in Leoben University are making researches to sustain this quality. The researches are speed up in order to meet EU-and national norms. Not later than 01.01.2004 solid wastes, which are not processed, should not be disposed in Austria. There procedure is as follows;

1. – sample collection,
   - sample preparation,
   - validation,
   - developing analyse procedure.
2. valuation of the first step[7].

THE RESIDUES FROM THE COMBUSTION OF SOLID WASTES

Table 1. The Residues from the Combustion of Solid Wastes

Residues		Kg/ton Solid Waste (DM)
Ash (grate, boiler ash)		250 – 350
Produced in gas treatment unit;		
	Filter dust	20 – 40
	Wet sorption	8 – 15
	Dry sorption (partial)	15 – 35
	Dry sorption	25 – 45
		≈ 350 – 450 kg DM

As seen from the table, by combustion the weight loss of municipal solid wastes (MSW) is only %60. The inearth residue, ash, should not be utilisede generally. So that threre exist a 100 kg residue, which must be disposed.

From 01.01.2004 the additive fuel projects in EU countries will gain more importance and support. The environmental technology investments for new EU member countries is almost 120 bilion Euros, where 24 billons are needed only for solid wastes technology(11).

The Landfill Regulation in force in Austria will promote the planing and construction of Waste Combustion Plants (WCP). Several waste combustion plants will begin operation in near future like; in Zwentendorf/Dürnrohr-300,000 ton/year; in Arndstein-

250,000 ton/year; in Lenzing-250,000 ton/year and a special WCP with 450,000 ton/year capacity(12,13).

It's possible to produce dry additive fuel by dry stabilatee method to consume for different purposes.

A plant in Asslar –Wetzlar, which begins opertaion at 1997, will produce dry stabilate, and consumes as additive fuel. The CV of the product is 17,000 kJ / kg, and serve as a secondary fuel for 4,7 MWh capacity.

In ALBA-Waste Seperation Plant, Berlin, from processing of construction and commercial wastes 50,000 ton/year additive fuel is produced and used instead of coal, natural gas and fuel oil.

In ALBA from heterogen mixtures, homogen fuel is produced. It has a SW processing capacity of 200 ton/day. The metals are separated by magnets and residues are send to cement factories as fuel.

The high CVd MSW is processed in ALBA and BRAM will be produced, which will be used in cement industry as additive fuel. Another plant in Pawkaw-Berlin will produce BRAM from wood, paper, cardboard, plastic, textile, and mixed materials with a capacity of 50,000 ton/year.

There will be produced 190,000 ton/ year waste which should be used for BRAM production [8]. The desired CV for the product is 11.000 – 24.000 kj/kg. the allowable chemical concentrations are given in Table 2. (mg/kg DM)

Table 2. The Allowable Chemical Concentration of BRAM

Parameters	Max. Value	Parameters	Max. Value
Cd	10	Pb	350
Hg	1,5	Cu	750
Thallium	3	Co	20
Arsenic	20	Ni	100
Crom	200	Berilyum	2
PCB	<5	S	%1
PCP	<5		

In St. Michael/Leoben, Auton Maya GmbH firm will construct a modern solid waste processing plant to produce additive fuel with the diesired quality.

Anton Maya GmbH will collect domestic and small and medium sized enterperises (SME) wastes and seperates recycable wastes, construction waste with its 40 employees. They will also operate a compost plant. A 1,8 m diameter and 8 m long rotating drum sieveTambur will seperate coarse and fine fractions and metals. The coarse fraction will be processed again in 40 mm sieves to seperate into light and heavy parts (glas, plastic, textile, paper, cardboard and wood) and send to cement factories as additive fuel[9].

THE UTILISATION OF SOLID WASTES AS "ADDITIVE FUEL" IN CEMENT INDUSTRY

The possible environmental and quality impacts of additive fuel utilisation in cement industry is searched since 1960's. According to recent developments in Germany, Austria Switzerland and Netherland ;

- Emissions will not increased,
- The ptoduct quality is not decreased,
- The amount of waste, which must be handled is decreased, where they should be utilised as fuel, and hazardous wastes are also removed.

For this reasons since last 25 – 28 years several plants are constructed in Germany [10].

To produce cement additive fuel is porcessed with lime and quartz, where the be heated at 850^{0}C and send to rotating furmace, than cinderation has started. Row material is processed at 1450^{0}C in cinder zone, cement clinkers are combusted at 2000^{0}C flame heat. The residance time for flue gas at 1600–2000^{0}C temperature is 3 – 5 seconds.

From rotating furnace materials are send to clinker cooler, where they'll be crystallised and with lime addition cement is produced. Rotating furnace is heat from primary lightning and the temperature must be as 1800^{0}C, where homogen fuel is needed, so that natural gas, coal dust and fuel oil are combusted with huge amount of air. The temperature at the enterance of the furnice must e kept at 800–1000 ^{0}C. During the clinker combustion cinder and ash be produced, and its inearth part will directly add to the process.

Another advantage is that the flue gas from processes is treated during combustion. Heavy metals and acidic materials are kept in cement, only dust is catched and to the process beginning to used as row material.

In Table 3 there is comparison of coal and solid waste processed as additive fuel (BRAM) ;

Table 3. Comparison of Coal and Solid Waste processed as additive fuel (BRAM)

Parameters	Birim	Primary Fuel, Coal			BRAM PracticValue
		Min.	Max.	Practi. VAlue	
Water	% Ağırlık	2,0	12,0	6,6	33
Dry Matter	% Ağırlık	88,0	98,0	93,4	67
Calorific Value	Kj / Kg	21.500	24.000	23.027	11.700
Antimon	mg/kg TM	-	-	-	6,7
Arsenic	mg/kg TM	1,0	99,0	37,1	4,69
Berillium	mg/kg TM	0,9	4,0	3,3	0,402
Lead	mg/kg TM	20,0	267,0	119,3	167,5
Cadmium	mg/kg TM	0,4	10,0	7,9	4,69
Crom	mg/kg TM	2,0	165,0	74,5	33,5
Cobalt	mg/kg TM	6,0	10,0	1,5	2,01
Cupper	mg/kg TM	30,0	45,0	6,5	234,5
Nicel	mg/kg TM	13,0	420,0	114,0	10,05
Mercury	mg/kg TM	0,1	1,5	0,9	0,67
Sellenium	mg/kg TM	0,9	8,0	3,8	0,603
Thellur	mg/kg TM	0,1	2,0	0,9	0,034
Tallium	mg/kg TM	0,1	8,0	0,9	0,335
Vanadium	mg/kg TM	20,0	775,0	163,3	3,35
Zink	mg/kg TM	40,0	214,0	177,8	442,2

In Table 4 the comparison of the final products are shown. It shuould be stated that there is no big differance observed.

Table 4. The Comparison of the Final Products

Parameters	Normal Balance (mg/kg)	BRAM Additive Fuel (mg/ kg)
Arsenic	6,5	5,9
Berillium	0,78	0,73
Lead	29,4	34,8
Cadmium	1,52	1,57
Crom	36,9	36,9
Nicel	42,7	40,6
Mercury	0,23	0,24
Selennium	1,4	1,3
Thellur	0,94	0,92
Tallium	0,66	0,65
Vanadium	51,0	47,5
Zink	377,0	393,0

Soest Cement Factory, Germany will supply %70 of its energy need form additive fuels like BRAM etc.

- BRAM doesn't adversely affect the quality of product,
- BRAM doesn't adversely affect the enviroment,
- There exist sophisticated technological innovations to proce BRAM from SW,
- Hazardous matterial concentrations of BRAM is not much higher than that of coal,
- BRAM doesn't produce emissions,

There exist several advantages of processing SW in WCP;

1. There is no hazardous wastes in its emissions,
2. While combusting 1 ton of SW there is produced 1 ton of CO_2. Where additive fuel emissions are free of CO_2.
3. By using BRAM fossil fuel resources are preserved.
4. The capacity of existing WCP are sufficient for today, so that there is no need for extra capital and operation investments.

GAVI-VAM WIJSTER COMBUSTION PLANT, NETHERLAND

In reality the plant is designed for combustion of municipal solid wastes (MSW). But it will also process industrial wastes which has a low CV to produce additive fuel, with an approximate capacity of 750,000 ton/year. Since the increase in the CV of MSW will decrease the amount of waste processed in the plant. Its established capacity is as mass (ton) x CV (kJ/kg;KW/kg), which is the same as the plant planned to constructed in Izmir.

It has begin to operation at 22th April 1996. The length of the plant is 400 m,width 100 m. Its invetment capital is 850 Million DM and serves for 139 districts with 3 Million residents. In the plant there exist also a landfill and a compost plant, which has a total area of 150 ha.

The SW analyses used for designing the plant is given in Table 5. The general process flow is;

* SW processing units; sieving, cutting, homogenisation, which has 3 bands with a loading rate of 3x 40 ton/h, the resultant fuel sizes is between 40 - 180 mm, particles which are smaller than 40 mm send to landfill.

* Combustion System (opposite flow grate system); loading rate: 3x 18-24 ton/h , CV of SW: 9,000-14,000 kJ/kg avg 12 MJ/kg.

* Vapor character; lateral vacuum boiler, vapor amount 3x69,5 ton/h, feeding water temp 150˚C, vapor temp 405°, vapor pressure 44 bar, gas temp is 210°C.

* Flue gas treatment; total system: electrofilter, spray dryer, cotton filter, two-stage washing, two-stage oxidation cataliser, dust flow rate 3x 124,500 m^3 /h. The gas temp is lowered to 170˚C. At pre-washing stage HCl and HF are eliminated, at the second stage with lime addition SO_2 is eliminated.

* Energy production; total system: generated condensation turbines, installation yield 54.0 MW

* Special vapor consumption 4.4 kg/kWh, vapor pressure 2,0 bar, received vapor amount 55 kg/second.

* Received vapor pressure 17/7/0,8 bar, excess vapor pressure 0, 095 bar, generator yield 67.5 MVA.

In Table 5 the comparison of the domestic waste fractions are shown.

Table 5. Domestic Waste Fractions

Parameters	Before Processing %	After Processing %	<40 mm %	Scrap %
Organic	34.3	8.6	25,7	
Paper/Cardboard	19,8	18,4	1,4	
Plastic Folio	4,9	4,9	0,0	
Hard Plastic	3,8	3,5	0,3	
Glas	3.9	0,2	3,7	
Iron	2,5	0,5	0,0	2,0
Non-ferrous Metalls	0,6	0,5	0,1	
Textile	3,3	3,3	0,0	
Stone	5.2	2,6	2,6	
Wood	5,6	5,6	0,0	
Tetrapak	1,8	1,8	0,0	
Cellulose	2,9	2,9	0,0	
Sand	9,0	0,0	9,0	
Others	2,4	2,1	0,3	
Total	100,0	54,9	43,1	2,0

VAM firm operate the plant and the process cost is 180 DM/ton. Its designed and planed to operate with a SW loading rate of 735.000 ton/year, where the recycable amount of SW is %55, so that 430.000 ton/year waste is combusted. When the quality of SW increased (the recycable matrials are collected sepeately,etc.) the SW amount coming to the plant is nor sufficient to facilate under economically feasible conditions.

DÜSSELDORF WASTE COMBUSTION PLANT

The first WCP was constructed at 1965 in Düsseldorf, which has a capacity of 340.000 ton/year to serve for 1.000.000 residents. Today its capacity is increased to 450.000 ton/year and its technology is improved.

Normally it is designed for MSW, but it will process other wastes with high CVs according to the regulations, and produce additive fuel. In this plant commercial, volumunes wastes, high calorific special wastes and even low calorifici special wastes and green wastes are combusted.

In Table 6 The Material Balance for the SW coming to the Plant at 1992 is shown.

Table 6. The Material Balance for the SW coming to the Plant at 1992

Waste Type	Amount, ton/year
MSW	250 000
Comercial SW	90 000
Volumunes SW	37 000
High caloific special wastes	19 000
Low caloific special wastes	32 000
Green wastes	22 000

With 6 boilers 1.000.000 ton/year vapor is produced. The capacity of 4 boilers is 40.0 ton/h, 1 boiler is 30 ton/h, and other is 38.0 ton/h. It has vapor temp of 500˚C, and a pressure of 95 bar. The feed water temp is 150˚C and stack gas temp is 230˚C.

There is set a semi-dry-spray absorbant unit just behind the boilers. After the electro-static filter there is constructed a active carbon (AC) filter to collect the hazardous emissions, like dioxines. Then AC is combusted in the furnaces. Behind the AC there is a DENOX unit , which will electronically show all the air pollution parameters.

The avg CV of the processed SW (except green, bioorganic and dry wastes) is 10.900 kJ/kg. There is a furnace temp of 900˚C. When the CV of SW is high than it should be increased as high as 1.200˚C.

Wuppertal Combustion Plant, is also with its improved technology is an environmentally frienly plant, which is also the first combustiom plant taking a ISO14001 certificate, whose manager is a Turkish person.

ASSLAR-WETZLAR DRY BIO-STABILATE TECHNOLOGY

This method was developed by HERHOF GmBh at 1975 in ASSLAR. According to the dry bio-stabilat technology (DBST) wastes are biologically stabilised, so that they should be stored for long time and used as additive fuel.

Since 1968 compost will be produced in Izmir. From time to time it will be faced marketing problems. Under those conditions it seems to be beneficial to protect the compost by DBST. The product will has a CV higher than that of low quality lignite.

There will be made a pre-feasibility study on the waste character collected in Izmir, and it is observed that the waste composition of Izmir is very similar to that of seperately collected waste in German capital cities (%40 organic, %9 paper/cardboard, %2,2 textile, %3,4 glas, %6,3 recycable material, %1,5 metal, %3,7 plastic, %13,3 tetrapac, %15 fine waste, %5,6 others).

It has been planned to transfer this technology to Izmir at 1977 by SCNORR, but it has been not realised.

DBST is aiming to increase the CV of SW from 7.000-8.000 kJ/kg to 11.000 kJ/kg and produce an economically feasinle additive fuel, by lowering the emissions, like CO_2 before final disposal of the SW.

According to this technology SW are put into a bunker and then send to a mill, and its size is reduced to smaller than 150 mm. And this material has been composted with BOX method in 7-10 days. According to material balance 100 kg of waste with a water content of %40, will processed into a 66,9 kg bio-stabilate. Its has a %2,9 organic content and %30,2 decomposition leachate. Than ferrous metals are collected with magnets, so that %63,3 mixed stabilate remained. It has been passed through different sized drum sieve. If it will be passed from 100 mm pore sized sieve than %40 of medium CV and %23,3 of high CV bio-stabilate is produced. If 40 mm pore size is used than %33,1 of medium CV and %30,2 of high CV bio-stabilate is produced.

With this method %35 of material loss is achieved, with a water content of %15. Its CV is increased up to %35-45, and its CV should be increased as hgh as 18.000 kJ/kg.

The process water which is condensed in the system will collected, treated and reused, its excess is discharged under good controlled conditions. Since it is a closed system at any stage of the process there should'nt be observed any environmentally adverse conditions, like dust, noise, waste air or water.

CONCLUSION

SW produced should be handled in many different ways. Parallel increasing consumptions trends not only the amount of SW but also the need for fuel has been increased. The utilisation of SW as fuel seems to be promising solution for both problems, not only for Europa but also for Turkey.

NOMENCLATURE

DM: dry matter
TM: Total matter

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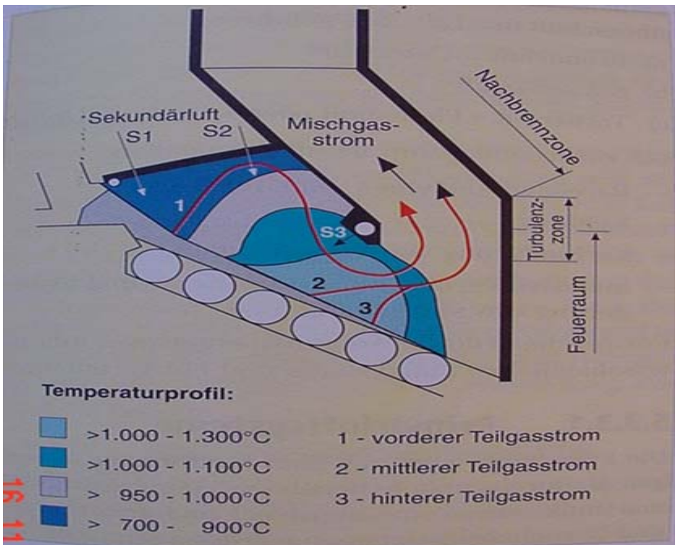

Bild 5.39 Teilgasstromverlauf und Temperaturprofil für Gleichstromfeuerungen [11]