

THE EFFECT OF THE DUTCH BUILDING MATERIALS DECREE ON THE BY-PRODUCTS FROM COAL-FIRED POWER STATIONS

M.P. van der Poel
N.V. Sep - Dutch Electricity Generating Board
Arnhem, the Netherlands

Summary

The Dutch government published the Building Materials Decree in November 1995. This new legislation sets the boundaries for imissions of organic and inorganic components from building products into the soil. The immision of building materials according to the Building Materials Decree is calculated from the results of regulat leaching test on these building materials. This paper will highlight the effect of the Building Materials Decree on the by-products from coal-fired power stations.

1. The Building Materials Decree

The Building Materials Decree, referred to as the Building Materials (Soil and surface Waters Protection) Decree is published in November 1995 and applies to the use of building materials in a work on or in the soil or in surface water.

Building materials in the meaning of this decree are characterised as granular (stonelike) building materials used outside. If the total contents of silicon, calcium and aluminium (with the exeption of metallic aluminium) in a building material together amount to more than 10% m/m of the total building material, it is a building material in the meaning of this decree.

The aim of the decree is to set the environmental conditions from the point of view soil and surface waters protection for the use of primary and secondary materials on or in the terrestrial soil, in the surface water and on or in the soil beneath surface water.

Although the decree primarily lays down rules with a view to protecting the quality soil and surface waters, it intends also to contribute towards achieving other

environmental policy objectives, such as reuse. Because of the continuity of reuse for some building materials special categories are incorporated. For the unmoulded use of fly ash from power plants no special category is being incorporated because the continuity of the present applications is not in issue.

2.1 By-products from coal-fired power stations

Three energy sources are mainly used for the large-scale generating of electricity in the Netherlands. In 1995 these are coal (45%), gas (47%) and nuclear fuels (8%). Most of the carbon from coal is converted to heat during combustion between 1300 and 1700 °C, depending on the type of burner. The inorganic fraction in the coal is left as ash, produced by the fusion of clay minerals. Water loss combined with rapid cooling of the hot flue gas in the power station exhaust system prevents the elements forming crystal structures, and the minerals are turned into a glass-structure. The process is similar to that which takes place during a volcanic eruption. Fly ash therefore is about 70% glass.

Fly ash and bottom ash from coal-fired power stations and products derived from these, are stonelike secondary building materials in the meaning of the Building Materials Decree. For the power industry fly ash and bottom ash from pulverised-coal power stations are the most relevant by-products in relation to this decree.

2.2 Fly ash

The hot fluegas is fed through electrostatic filters which remove remove 99% of the fly ash. In 1995 the Dutch power stations produced 878,000 tons of pulverised coal fly ash. The produced fly ash can all be utilised. The greatest part goes to the cement industry and concrete industry to be used as:

- partial substitute for cement
- filler used in the manufacture of Portland fly ash cement
- raw material for clinker production
- filler and binding agent in concrete
- substitute for cement in cellular concrete.

Fly ash is also utilised as:

- filler in asphalt mixes
- raw material for the production of artificial gravel.

All the applications of fly ash in the Netherlands are so called moulded applications which means that leaching is determined by diffusion.

2.3 Bottom ash

Bottom ash is produced by the melting and sintering particles of ash in the boiler. Because of the gravity, bottom ash falls down into collecting tanks with water underneath the boiler. Bottom ash is also a product that can be utilised very well.

Bottom ash is mainly utilised in the application of:

- road construction
- concrete block manufacture.

3. Immission standards

The starting-point for determining a maximum permissible load on the soil is that the multifunctionality of the soil must be guaranteed. As it is not realistic to employ building materials without some burden on the soil, a marginal soil-load is accepted on the assumption that this does justice to the starting-point of maintaining multifunctionality.

Marginal soil-load has numerically interpreted as:

a load on the soil resulting from leaching from the building material which mathematically results in an increase in the solid phase of the soil of no more than 1% of the contents of pollutants in relation to the long-term targets for soil in 100 years, averaged over one metre of standard soil deemed to be homogenous.

It is assumed that in general this marginal soil-load will also protect the groundwater in a sufficient way.

On the basis of the marginal soil-load concept and the average background level in the Netherlands, the maximum permissible immission standards for inorganic

substances were determined. When determining these immission standards, it was necessary for a number of substances to rise the immission level to allow the continued use of building materials. That means that in general the immission standards are low, especially for mobile elements. For this reason it is not allowed to use un moulded fly ash, for instance as a layer in road constructions, any longer. This particularly because of the initial leaching of Molybdeen.

In appendix A and B leaching characteristics of fly ash and bottom ash are given.

4. Classification in categories

Building materials are divided into category 1 and category 2 building materials.

- category 1: the building materials referred to in this decree as category 1 may be used without taking isolation measures. However, control measures should be taken to prevent the building materials mingling with the soil and to allow removal.

- category 2: building materials with a greater immission into the soil than the marginal load of 1% may only be used as category 2 building material if the immission can be reduced to below the maximum immission standards belonging to this category. Permanently controlled isolation measures are necessary for materials belonging to category 2. Isolation measures are understood to be measures which virtually rule out any contact of that building material with rainwater or groundwater when that material is used. Regulations for these isolation measures and the control and monitoring measures appurtenant to these measures are stated in the decree and elaborated in a ministerial decision.

5. Determining of standards

The composition standards for inorganic substances and the immission standards for inorganic substances in category 1 and in category 2 building materials must be determined by one of the laboratories designated by the Environment Minister and the Minister for Transport, Public Works and Water Management.

With the aid of difficulty functions and correction factors immission into the soil as a result of emission from a building material will be calculated - after leachability from that building material has been determined in the laboratory in accordance with the

draft Dutch standard NEN 7340. Defining the functions and correction factors has been a very difficult process. This because the long-term behaviour over a period of 100 years by extrapolation from the results of laboratory tests is a rather theoretical approach. In this framework it can be told that studies by the Dutch Electricity Generating Companies have stated that the behaviour of fly ash in the laboratory is different from the behaviour of fly ash under field conditions.

6. Directions for use

One of the departure points of the decree is that it is the task of the party using building materials in a work to ensure that the building materials in question do not become mixed with the soil or aquatic sediment during the life of the work, and that they are indeed removed when the work in which the building materials have been used is removed. These obligations apply in principle to all building materials - with the exception of clean earth - whose use is permitted under the decree, irrespective of where they are used.

In addition to the duty of removal a number of other directions for use formulated as general rules have been incorporated in the decree. In figure 1 the directions for use for the various categories of building materials when used on or in the soil are given.

Figure 1

	Soil Protection Act (Landfill) Decree	
Immission ↑	Special category Slag's from waste incineration plants	
U2 >	Category 2 building materials - isolation measures: * 0,5 m above mean highest groundwater level * isolation (capped from above) - control measures in connection with duty of removal: * minimum quantity 10,000 tonnes (1,000 tonnes for foundation layers in road construction) - other control and monitoring measures (management and maintenance)	
U1 > Building Materials Decree not enforced	Category 1 building materials - control measures in connection with duty of removal (generally normal management and maintenance)	Special category tar-holding asphalt aggregate
	G	S org

Composition ⇒

G :Composition value for standard soil

S_{org} :Limit-value for organic components

U1 :Leaching limit-value for category 1 building materials

U2 :Leaching limit-value for category 2 building materials

7. Approvals and other forms of proof

On 1 January 1988 the decree will come into full force for all building materials. The user of a building material is than required to have available information on the

composition of that building material and the expected immisions as a result of that material being used.

For nearly every building material whose application requires a report in advance the information on composition and immission must accompany that report. These materials are category 1 earth, all category 2 building materials and building materials containing tar-holding asphalt aggregate.

For the remaining category 1 building materials the competent authority may request the mentioned information from the user, up to five years after the building material has been used. In effect, this duty means that the user should demonstrate or be able to demonstrate that he is employing a category 1 or a category 2 building material.

The user can provide the proof concerning the quality of the building material by handing over an approval recognised by the Minister of Housing, Spatial Planning and the Environment and the Minister of Transport, Public Works and Water Management on the basis of certification of the product.

As a recognised approval the product certificate and the attestation can be distinguished. The product certificate means a certificate stating a product conforms to certain product specifications. However this certificate does not mean that the building material will satisfy the requirements of the Building Materials Decree in every instance and every application, as this also requires a test of the specific application to the immission requirements.

An attestation, in relation to the Building Materials Decree, indicates that a building material, which has a certain composition and leaching properties as described in the product certificate, if employed as stated in the attestation, satisfies the composition and immission requirements of the decree. The attestation will therefore in effect make a statement about a specific building material in a certain use in relation to the category in which that building material and use fall.

The user may also attempt by other means - such as a manufacturer's declaration - that the building material satisfies the composition and immission requirements of the decree. To do so, the decree imposes on the user the duty to engage an accredited

of equivalent foreign laboratory to access composition and immission. These assessment must be carried out in accordance with the rules set in or by virtue of this decree.

A building Materials Decree Approvals Manual, in which guidelines and test criteria are laid down, is currently in preparation.

8. Consequences for fly ash and bottom ash

With the publication of the Building Materials Decree for the power industry development toward achieving environmental certification of construction materials in relation to fly ash and bottom ash has reached an important phase.

Because of the Building materials Decree and the leachability of fly ash, this building product has to be used in moulded applications. Leaching of moulded applications is determined by diffusion.

For bottom ash selenium (Se) is a critical element. In thin layers however the application of not certificated bottom ash as a category 1 building material is almost 100%. Certificated bottom ash can be used in its entirety as a category 1 building material. In 1996 the first bottom ash under certificate (attestation) is supplied.

References

- [1] Dutch decree of 23 November 1995, containing regulations on the use of building materials {Building Materials (Soil and Surface Waters Protection) Decree on or in the soil or in surface waters}.
- [2] Milieugienische kwaliteit van primaire en secundaire bouwmaterialen in relatie tot hergebruik en bodem- en oppervlaktewaterenbescherming, RIVM-rapp.no. 771402006, RIZA-rapp. no. 93.042 [dec.1993].
- [3] Annual report of 1995 from NV GKE/Mliegasunie.

APPENDIX A

RIVM

research for
man and environment

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database

Building material:		EC-vliegas																																			
Identification number:		NV8052.wk1																																			
17-Dec-93		leaching characteristics									L/S=10 columntest in mg/kg									composition									aqua regia in mg/kg								
adjusted values granular materials																																					
element	U1	U2	S1	N	mean	sd(n-1)	minimum	maximum	n-U1	n-U2	log(mean)	log(sd(n-1))	outlayer	det.lim.	N	mean	sd(n-1)	minimum	maximum	log(mean)	log(sd(n-1))	n-S1	outlayer	det.lim.													
As	0.88	7.00	375.00	12	0.283	0.321	0.022	0.987	1		-0.946	0.615			76	41.789	35.221	1.539	208.728	1.486	0.403		*														
Ba	5.50	58.00	7500.00	5	2.166	1.278	0.032	3.200							62	977.349	630.713	300.000	4627.473	2.936	0.247		*														
Cd	0.03	0.07	10.00	17	0.004	0.004	0.000	0.011			-2.861	0.803			72	0.906	0.902	0.067	11.708	-0.224	0.458	1	*														
Co	0.42	2.50	250.00	2	0.018	0.011	0.010	0.025							44	29.229	15.251	3.278	82.956	1.399	0.308		*														
Cr	1.30	12.00	1250.00	17	1.729	1.393	0.160	4.673	9		0.056	0.463			72	87.633	39.069	18.732	280.980	1.902	0.229		*														
Cu	0.72	3.50	375.00	7	0.080	0.101	0.007	0.685					*	D	64	119.488	82.731	30.105	943.290	2.010	0.287	2	*														
Hg	0.02	0.06	5.00	1	0.000	0.000	0.000	0.000							39	0.174	0.159	0.013	1.338	-0.916	0.450		*														
Mo	0.28	0.91	125.00	16	5.810	5.143	0.350	15.260	16	11	0.459	0.624			57	15.911	11.302	2.208	284.325	1.137	0.334	1	*	D													
Ni	1.10	3.70	250.00	10	0.064	0.089	0.010	0.676			-1.357	0.608	*	D	50	51.839	37.061	1.204	228.129	1.564	0.461		*														
Pb	1.90	8.70	1250.00	9	0.051	0.045	0.004	0.109						D	66	56.345	49.616	2.074	220.770	1.570	0.458		*														
Sb	0.05	0.43	50.00	5	0.203	0.182	0.004	0.370	3						61	4.876	3.121	0.535	26.091	0.595	0.344		*														
Se	0.04	0.10	50.00	8	1.335	1.328	0.010	3.700	5	5					59	8.805	8.409	0.738	109.047	0.783	0.474	1	*														
Sn	0.27	2.40	250.00	NA	NA	NA							NA	NA	14	36.858	48.253	2.876	223.448	1.290	0.648		*	D													
V	1.60	32.00	1250.00	9	3.969	2.669	0.350	17.490	9		0.546	0.464	*		65	168.884	75.392	45.492	561.960	2.196	0.203		*														
Zn	3.80	15.00	1250.00	5	0.213	0.135	0.065	1.017					*		74	141.408	119.800	9.368	802.100	1.980	0.452		*														
Br	2.90	4.10	500.00	NA	NA	NA							NA	NA	38	2.355	2.194	0.201	14.049	0.227	0.438		*	D													
Cl	600.00	8800.00	5000.00	4	17	6	11	25							32	65	81	9	2355	1.643	0.521		*	D													
CN-comp	0.07	0.38	125.00	NA	NA	NA							NA	NA	NA	NA	NA	NA	NA				NA	NA													
CN-vrij	0.01	0.08	25.00	NA	NA	NA							NA	NA	NA	NA	NA	NA					NA	NA													
F-tot	13.00	100.00	4500.00	3	4.134	2.136	2.894	31.550	1				*		43	73.711	112.738	0.268	488.370	1.318	0.901		*														
SO4	750.00	22000.00	25000.00	6	3088	914	1342	3842	6						17	1909	1458	0	4282	2.671	1.410																
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y													

NA: No information available, ERR: standard deviation zero.

APPENDIX B

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Building material:		EC-bodemias																										
identification number:		NV8053.wk1																										
17-Dec-93		leaching characteristics									L/S=10 columntest in mg/kg									composition				aqua regia in mg/kg				
adjusted values granular materials																												
element	U1	U2	g1	N	mean	sd(n-1)	minimum	maximum	ns-U1	ns-U2	log(mean)	log(sd(n-1))	outlayer	det.lim.	N	mean	sd(n-1)	minimum	maximum	log(mean)	log(sd(n-1))	ns-S1	outlayer	det.lim.				
As	0.88	7.00	375.00	61	0.108	0.098	0.002	0.520			-1.151	0.478	*		87	5.483	8.019	0.800	34.100	0.535	0.441	*		D				
Ba	5.50	68.00	7500.00	54	2.857	2.398	0.200	14.800	8		0.334	0.378	*		78	543.040	993.199	48.000	1214.350	2.564	0.431							
Cd	0.03	0.07	10.00	81	0.004	0.009	0.000	0.050	3		-2.858	0.548	*	D	87	0.123	0.187	0.010	12.144	-1.115	0.481	1	*	D				
Co	0.42	2.50	250.00	57	0.030	0.034	0.001	0.700	1		-1.782	0.524	*		84	20.217	15.783	2.400	80.345	1.128	0.428							
Cr	1.30	12.00	1250.00	81	0.024	0.030	0.001	0.240			-1.830	0.448	*	D	88	112.095	112.912	4.500	350.150	1.630	0.704							
Cu	0.72	3.50	375.00	61	0.053	0.099	0.010	0.740	1		-1.550	0.492	*	D	87	38.459	32.024	5.500	864.200	1.421	0.409	1	*					
Hg	0.02	0.08	5.00	54	0.003	0.001	0.002	0.005			-2.553	0.151	*		81	0.228	0.053	0.007	0.300	-0.668	0.191							
Mo	0.28	0.91	125.00	58	0.144	0.135	0.010	0.500	7		-1.028	0.419	*		73	3.114	3.584	0.420	20.880	0.298	0.425	*		D				
Ni	1.10	3.70	250.00	81	0.097	0.134	0.005	1.200	1		-1.364	0.594	*	D	88	49.983	34.259	8.700	141.550	1.567	0.387							
Pb	1.90	8.70	1250.00	81	0.055	0.131	0.008	0.680			-1.679	0.493	*	D	86	20.781	10.425	3.000	61.090	1.281	0.255	*						
Sb	0.05	0.43	50.00	48	0.018	0.007	0.002	0.100	1		-1.833	0.248	*		78	1.923	2.349	0.200	12.865	-0.031	0.582	*						
Se	0.04	0.10	50.00	57	0.045	0.040	0.008	0.250	24	5	-1.480	0.378	*		84	1.788	3.888	0.037	28.820	-0.048	0.521	*		O				
Sn	0.27	2.40	250.00	53	0.024	0.010	0.010	0.050			-1.887	0.193	*	D	80	18.099	131.988	0.200	2249.900	0.008	0.710	2	*	D				
V	1.80	32.00	1250.00	58	0.395	0.818	0.040	6.800	4		-0.831	0.473	*		88	86.815	72.658	9.100	275.850	1.728	0.488							
Zn	3.80	15.00	1250.00	80	0.307	0.392	0.068	2.800			-0.842	0.333	*		87	42.791	35.752	8.200	208.800	1.479	0.402	*						
Br	2.90	4.10	500.00	NA	NA	NA								3	0.447		0.447	1.773				*		D				
Cl	600.00	8800.00	5000.00	4	149	140	28	350							8	254	163	45	1974			*		D				
CN-comp	0.07	0.38	125.00	3	0.100	0.000	0.100	0.100	3						NA	NA	NA						NA	NA				
CN-vrij	0.01	0.08	25.00	3	0.100	0.000	0.100	0.100	3	3					NA	NA	NA						NA	NA				
F-tot	13.00	100.00	4500.00	4	1.492	0.891	0.500	2.668							4	35.948	2.808	32.035	37.250									
SO4	750.00	22000.00	25000.00	56	398	409	2	3150	8		2.418	0.497	*	D	44	1324	2081	112	17200	2.858	0.496	*						

NA: No information available, ERR: standarddeviation zero.