PREVENTION OF WATER POLLUTION AND PLAN FOR THE EXPLOITATION OF THE ASH TIP OF THE LA ROBLA CONVENTIONAL POWER STATION

Ceferino ALVAREZ FERNANDEZ
Antonio FERNANDEZ URIA
Miguel BONED NIELL
EPTISA - Arapiles, 14 - 28015 MADRID

ABSTRACT

The La Robla Conventional Power Station in the province of León is situated south of the locality of the same name, on the alluvium of the River Bernesga. The fuel used for the Power Station is coal, which results in a considerable production of ash. Consequently the formation of an ash tip is required in order to meet safety requirements with a minimum or nil environmental impact.

The study showed that the hydrogeological conditions maintain both the miocene detritic aquifer and the quaternary alluvium outside a possible pollutant affection of the ash tip.

Furthermore, an exploitation plan is set out for the ash tip minimizing the ash front exposed to wind. An exploitation system is proposed in which the valley will be filled forming three terraces with steps 20 metres high.

GENERAL SITUATION OF THE ZONE

The La Robla Conventional Power Station (León) is situated south of the locality of the same name, on the alluvium of the River Bernesga.

The ash and slag tip of the power station is located on the south-western slope of a hill ridge constituted by sandstones and oligocene conglomarates which are practically impervious excepting a zone of surface meteorization of slight thickness. This hill is situated between the Rebocán stream and River Bernesga, in the proximities of the confluence of both. (Fig. 1).

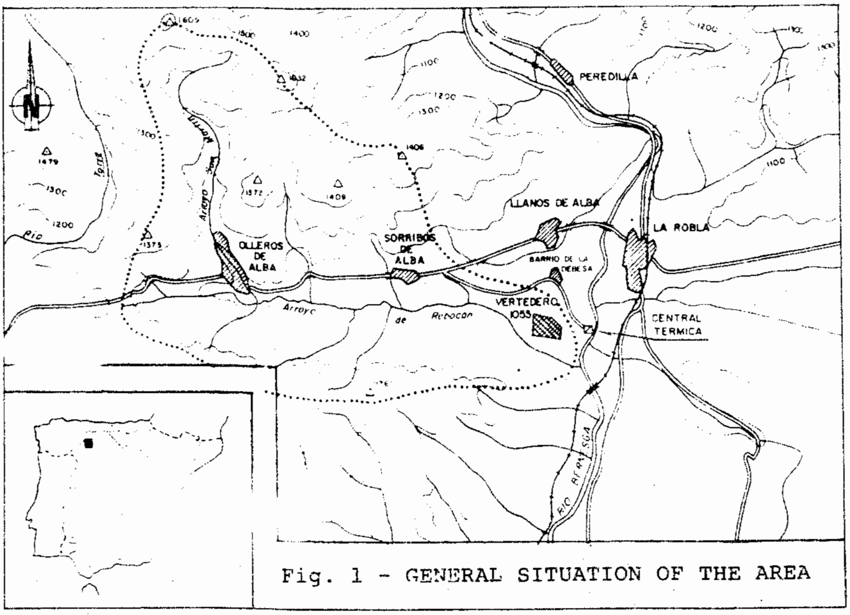

Fig. 1 - GENERAL SITUATION OF THE AREA

The waste from the Power Station (800,000 m3) partly fill the valley of the Rebocán stream covering an area of 38,000 m2. With the entry into service of Unit II of the Power Station, the total ash production will be 375,000 tonnes per year.

GEOLOGY AND HYDRAULIC OPERATION

The most significant materials in the area are:

Palaeozoic materials. (Devonian-Carboniferous): Series of sandstones and shales interleaved with lime slabs and folded and faulted calcoschists.

Mesozoic materials. (Cretaceous). Kaolinised sands and fine gravels at the base and marly limestones in the upper section.

Tertiary materials. (Oligocene-Miocene): Thick pudding stone of siliceous edges with interleaved very cemented sandstones and compact clays, on which the miocene materials (sands, oozes, clays) are situated discordantly, laid out in lenticular layers dispersed in a ooze-clayey matrix. The contact between both formations is situated in the valley of the Rebocán stream.

Quaternary materials. Represented almost entirely by the alluvia from rivers and streams (gravels, sands, oozes and clays). Their thickness reaches 10 m in the proximities of the power station.

The only materials presenting a hydrogeological interest within a radius of 4 km around the power station are the tertiary and quarternary.

The first mentioned are loaded by the infiltration of rainwater (577 mm/year) in the interfluvia and the discharge after a more or less extended circulation on planes approximately orthogonal to the River Bernesga, takes place in its valley (Fig. 2).

In these circumstances the river constitutes a watershed of the underground flow. The same situation is presented, on a smaller scale, in relation with the Rebocán stream towards which there is a certain circulation from the miocene materials of its right bank (Fig. 2).

The quaternary materials, loaded in part by the contributions from the underlying miocene, are hydraulically connected to the River Bernesga. (Fig. 3).

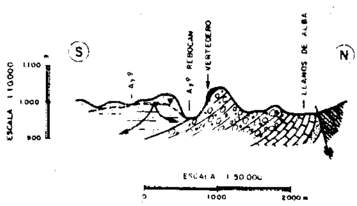

Fig. 2 - GEOLOGICAL SECTION

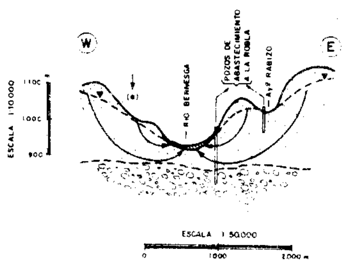

Fig. 3 - GROUNDWATER FLOW

POLLUTION OF WATER BY THE ASH TIP

In order to evaluate the possible impact of the ash tip, 10 samples of surface and ground water in the surroundings of the power station were analysed. Table 1 presents a summary of these analyses.

As it was impossible to obtain samples of the natural lixiviate of the ash tip during the hydrogeological survey campaign, for the effects of orientative calculations the analysis of the mean values of the surface runoff and infiltration analyses of a conventional power station similar to La Robla has been taken as probably representative of the lixiviate. (Table 2, columns 1 and 3).

PRESENT SITUATION

The pollution risk by the influence of the ash tip has been studied in the twofold aspect of surface and ground water.

Surface Water.

Owing to the topographical position of the ash tip and the structure of the materials on which it rests (Fig. 2), the only surface water that may be affected is that of the Rebocán stream. This possible affection would occur because the surface runoff from the ash tip or the shallow undergroun runoff of the lixiviate through the meteorized zone of the oligocene conglomerate, reached the stream.

In the first case, the effect would be an increase of solid: in suspension in the water of the atream, which could be extracted in the planned decantation pool. The effect of solubilization of chemical elements in the path from the tip to the stream is minimized by the notable flow rate on the high gradient slopes and the marked degree of their imperviousness, derived from the pozzolanic properties of the ash.

In the second case, assuming that the maximum volume of water infiltrated in the surface of the tip (22,000 m3 per year) will drain through the meteorized area, the drain (lixiviate) flow rate would be 0.70 l/sec. As the high wate: flow rate of the stream upstream of the tip is 89 l/sec, the minimum dilution factor, f_D, would be 7.10.

The effect of dilution on the concentrations of the lixiviated elements is indicated in Table 2 (columns 2 and 4). This effect would place the concentrations of soluble elements, before their incorporation into the River Bernesga well below the limits accepted in normal rivers or the Technical Health Regulations. The fact that the water of the Rebocán stream is not affected by the tip is confirmed by the practical identicality of analyses 1 and 2 in Table 1. The high water flow of the Bernesga (5.3 m3/sec) would make

TABLE 1. SUMMARY OF CHEMICAL ANALYSES
(Concentrations in mg/l)

	REBOCAN STREAM		SUPPLY	
	UPSTREAM OF TIP (1)	DOWNSTREAM OF TIP (2)	POWER STATION (3)	LA ROBLA (4)
Ph	7,97	7,99	7,38	7,16
RS	149,00	164,00	297,00	150,00
Cl^-	3,50	3,50	21,30	8,80
$So_4^=$	17,70	17,70	30,70	1,00
HCO_3^-	170,80	176,90	213,50	183,00
$CO_3^=$	-	-	-	-
Ca^{++}	52,80	51,20	76,80	57,60
Mg^{++}	4,90	8,80	4,90	0,90
Na^+	4,60	4,60	8,05	4,60
K^+	0,78	0,78	1,95	0,78
Cu	0,25	0,25	0,25	0,25
Fe	0,25	0,25	0,25	0,25
Mn	0,25	0,25	0,25	0,25
Cr	0,25	0,25	0,25	0,25
Zn	0,25	0,10	0,10	0,10
Al	0,10	0,10	0,10	0,10

TABLE2. ANALYSES ADOPTED AS REPRESENTATIVE OF THE COMPOSITION OF THE LIXIVIATE AND EFECT OF ITS DILUTION
(Concentration in mg/l).

	SURFACE WATER (lixiviate)	DILUTION IN REBOCAN STREAM ($f_D=7.10^{-3}$)	INFILTRATION WATER (lixiviate)	DILUTION IN REBOCAN STREAM ($f_D=7.10^{-3}$)	DILUTION IN MIOCENE AQUIFER. ($f_D=0.02$)	ADMISSIBLE LIMITS (RTS,1.982)
Ph	8,6	-	7,95	-	-	9,50
RS	80,50	0,60	2.196,00	17,00	44,00	1.500
Cl^-	7,50	0,05	23,00	0,17	-	350
$So_4^=$	21,50	0,16	1.300,00	10,10	26,00	400
HCO_3^-	49,50	0,39	172,00	1,30	-	-
$CO_3^=$	7,70	0,05	12,80	0,09	-	-
Ca^{++}	20,30	0,15	109,50	0,85	-	200
Mg^{++}	1,00	$7x10^{-3}$	50,50	0,40	1,00	50
Na^+	-	-	-	-	-	-
K^+	-	-	-	-	-	-
Cu	0,00	-	0,02	$1'5x10^{-4}$	-	1,50
Fe	0,32	$2'5x10^{-3}$	0,45	$3'5x10^{-3}$	0,009	0,20
Mn	0,00	-	1,60	0,01	0,032	0,05
Cr	0,00	-	0,40	$3'0x10^{-3}$	0,008	0,05
Zn	0,13	1x20	0,20	$1'5x10^{-3}$	-	5,00
Al	4,20	0,03	0,50	$3'8x10^{-3}$	0,01	0,20

the concentrations of the dissolved elements negligible by further dilution.

Groundwater.

The only aquifer materials which are liable to be affected by the presence of the tip are the miocene detritc sediments and quaternary alluvia of the Bernesga.

The miocene aquifer can only be affected by a lateral charging of the polluted water from the tip, either through the meteorized surface of the oligocene conglomerate with which it may be in contact south of the Rebocán stream, or through the faults or fissures detected in this conglomerate.

In both cases the charging volume would be minimal as most of the lixiviate would most probably drain (owing to the topographical conditions) into the Rebocán stream where it would be diluted in the proportion mentioned.

An additional factor which would be opposed to this lateral charging is the discharge which appears to occur from the miocene sediments towards the Rebocán stream (Fig. 2), of much greater size than that from the tip. In effect, the differential measure of discharge made shows that, as against the 89 l/sec upstream of the tip, the Rebocán stream has a flow rate of 118 l/sec downstream of same. The increase of 29 l/sec is not attributable to the drainage of water infiltrated into the tip (0.7 l/sec).

According to the conservative and simplistic hypothesis that the whole of the annual drainage of the tip (0.7 l/sec) "charges" the miocene aquifer, there would be an approximate dilution factor, f_D, of 0.02 in the area of the assumedly instant mixture. In this assumption the concentrations of the elements which could most affect water purity: RS, $SO_4^=$, Mg^{++}, Fe, Mn, Cr and Al (Table 2, column 3) would be reduced to those stated in column 5 of the same table, minimizing the risk of pollution.

Furthermore, the risk that the possible lateral charging could represent would be attenuated, in addition to by this dilution effect, by the high absorbency attributable to the major argillaceous component of the miocene sediments.

The alluvia of the Bernesga, in which the power station supply collecting points are located, are free of all effects upstream of the confluence of the Bernesga and Rebocán stream. Downstream, they are considered to be likewise unaffected, in particular those on the left bank of the river, as this constitutes a hydraulic barrier in the flow system of these materials.

The present wells supplying La Robla are safe from any possible influence from the tip, apart from by the above mentioned river barrier, by the fact that they collect water from the charging zone of the miocene aquifer, in Cerro del Rabizo (Fig. 3). The analyses for both the power station wells and La Robla collecting points (Nº 3 and 4, Table 1) yield no evidence of unusual concentrations of the elements analysed.

FUTURE SITUATION

The entry into service of Unit II of the power station will mean an increase in ash and slag production and a progressive development of the area of the tip according to the forecasts described below. The increased area will not modify substantially the hydrogeological conditions of the environment but will entail a greater volume of lixiviate with concentrations of soluble elements comparable to present ones.

The forecasts for the year 2000 are an area of terraces (preferential infiltration area) of 196,000 m2 and a volume of infiltrated water (for a mean annual precipitation of 577 mm) of 113,000 m3/year which, if drained in the same period, would represent a lixiviate drain flow of 3.6 l/sec. In these conditions the dilution factor in the Rebocán stream would be 0.04 with which a lixiviate of 2196 mg/l of dry matter (Table 2, column 3) would be diluted to 88 mg/l. The later dilution in the Bernesga would make the pollutant impact of the tip on surface water negligeable.

Groundwater would be most affected by the fact that 60% of terrace T3 (67,000 m2) would be directly installed above the miocene aquifer which would represent a charge of 38,000 m3/year of water with a certain pollutant power, which will remain unknown until the composition of the lixiviate in natural conditions is determined.

A detailed study based on reliable data of the behaviour and hydraulic parameters of the miocene sediments will permit a more objective assessment of the risk this situation may represent.

EXPLOITATION PLAN FOR THE ASH TIP

The total ash production, for the 25 years of the life of the units, will be 7,575,000 tonnes, equivalent to 6,312,500 m3.

The location of the ash tip is the valley of the Rebocán stream, and its exploitation is made starting from the highest level (1,055 m) of the northern part. To date the volume tipped is some 800,000 m3 starting with the top terrace which has an area of 38,000 m2.

The ash and slap tip will fill the whole of the lower part of the valley of Rebocán stream so it is necessary to channel the said stream in a main in order both to allow the drainage of the surface runoff and also prevent this water becoming polluted by contact with the slag ash.

This main should make it possible to drain the minimum rises of the zone, and its section must be some 9.6 m2. The length is of the order of 900 m, with a mean gradient of 2.2%.

It has been planned that it should rest on a layer of sand, which constitutes the upper part of the principal drain of the water infiltrating through the tip.

When the rainwater infiltrates through the ash of the tip, its ion concentration will rise, as can be seen from the chemical analyses conducted in the laboratory. In order to prevent possible pollution of boreholes and wells, it is necessary to collect the infiltrated water to treat it chemically, if necessary, before returning it to the River Bernesga.Therefore it is necessary to lay a drain to collect the water. This drain will be formed by two high permeability layers. the lower, some 70 cm thick, will consist of gravel and the upper, some 30 cm thick, will be steel.

At the outlet of the drain there will be a decantation pool to collect the drained water and decant the solids in suspension carried by this water.

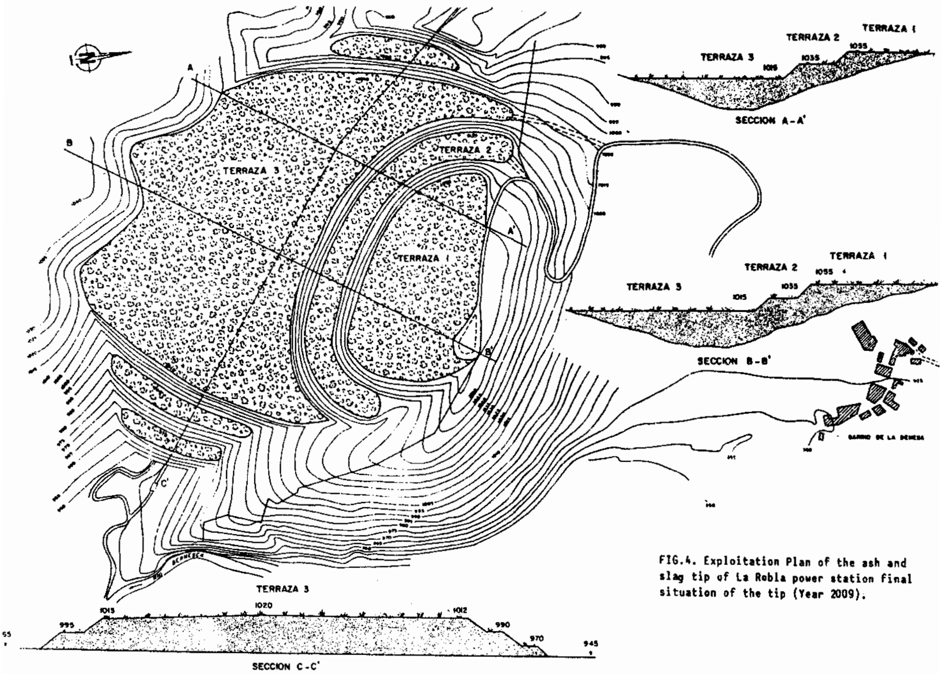

FIG.4. Exploitation Plan of the ash and slag tip of La Robla power station final situation of the tip (Year 2009).

Ditches at the foot of each slope are planned to collect run-off water for the drainage of surface water.

The tip must be exploited in such a way that the front of ash exposed to the wind is as small as possible. A method of exploitation is proposed whereby the valley will be filled forming 3 terraces with steps 20 m high; one at level 1,055 m, the second at level 1,035 m and the third at level 1,015 m. These terraces will be covered with a layer of 20--30 cm of topsoil and brooms will be planted, which will have a twofold purpose: first, the reduction in possible soil erosion, and second the restitution of the landscaping of the valley.

Figure 4 shows the final configuration of the tip in the year 2009.

CONCLUSIONS AND RECOMMENDATIONS

For the effects of control of the possible pollutant impact of the tip on the surface and groundwater, we suggest a periodic control of the water purity in the decantation pools and the planned general drain.

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