LEVELS OF RADIOACTIVITY IN GRIT BLASTING MATERIALS

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Introduction:

The problems of the build up of naturally occurring radioactive materials within the scales and silts accumulating in gas and oil production and processing plants are well known. (1) Whilst surveying for these materials it became apparent that very occasionally high survey readings were being produced which could not be associated with elevated levels in scales or silts in the plant being investigated. Further measurements established that the source of these elevated levels was in fact grit from recent cleaning operations which had not been properly cleaned away. It was therefore decided to look at the activity levels in grits more systematically to see if a real problem did or could exist.

Method:

Grits were obtained from a variety of commercial sources. In the UK. silica and sand are prohibited with regard to their use in blasting materials (ground quartz type rocks) Most industrialised countries have similar regulations UK (2), Belgium (3), Netherlands (4), France (5) and Germany (6)

Grits are therefore generally manufactured from slag from copper or steel processing, chilled iron particles or cast iron particles. The commercial name of some would however still indicate a direct mineral source. Unfortunately it was not always possible to obtain information as to which type a given sample was and chemical analysis results at this point are not available. Samples were subject to γ spectral analysis, generally in two centres to ensure reproducible results.

Results:

The results from the γ spectral analysis of the various samples are given in table 1.

Table 1. Activities in representative Grit Samples

Grit Number	Type of Grit	Ra-226 Bq/g	Ac-228 Bq/g	Cs-137 Bq/g	Am-241 Bq/g
1	Copper Slag	0.09 ± 0.02	0.01 ± 0.05	0.003 ± 0.001	0.003 ± 0.001
2	Cast Iron	less than 0.005	less than 0.005	less than 0.002	less than 0.002
3	Iron Slag	0.05 ± 0.02	less than 0.005	less than 0.002	less than 0.002
4		less than 0.03	0.05 ± 0.01	less than 0.003	less than 0.002
5		less than 0.05	0.10 ± 0.01	less than 0.002	less than 0.002

The samples which have been obtained from the slag arising from one of the refractory processes can all be seen to contain some of the naturally occurring nuclides. Only the activities of Radium 226 from the Uranium 238 series and Actinium 228 from the Thorium 232 series are recorded. Although measurements have not currently been made it is thought more than likely that these isotopes are in equilibrium with the respective parent radionuclides. The radionuclides lower down the series exhibited different levels of equilibrium. One sample can also be seen to contain very small amounts of both Cs-

137 and Am-241. This trapping of the natural and artificial radioactive cations by the slag is not surprising. Work carried out for other purposes shows that in practice slag is an exceedingly efficient method of fixing radionuclides and the results in table 2. show the ability of slag to trap the naturally occurring radionuclides present on scrap iron in radioactive barium sulphate scale. Over 95 % of the activity put into an electric arc furnace was trapped and immobilised into the slag produced (7). By varying the amount of slag produced it was possible to vary the activity per gramme indicating the an approximately uniform distribution was occurring.

Table 2. Uptake of Radium-226 and Actinium-228 (Radium-228) from scale contaminated iron melted in an induction furnace. From data provided by Clyde Shaw Ltd.

Melt Wt. kg	Input Ra-226 kBq	Activity Ac-228 kBq	Slag Wt. kg	Slag Ra-226 kBq	Activity Ac-228 kBq	Output Ra-226 kBq	Activity Ac-228 kBq
12,900	199	130	1310	0.15	0.11	197	138
9700	149	98	1820	0.10	0.05	182	91
8700	134	88	1320	0.12	0.03	158	40
5000	77	51	1620	0.08	0.03	130	49
4800	74	49	1540	0.08	0.03	123	46
6000	92	60	1700	0.08	0.03	136	51
6800	105	69	1500	0.08	0.03	120	45

Similar work carried out by Boynton and Lambley (8) and Gomer and Lambley (9) looking at the ability of slag to trap the radioactive cations on contaminated steel again showed that some of the cations present could be successfully moved into the slag leaving the now decontaminated steel behind. The technique removed virtually all the caesium isotopes into the slag, but the Cobalt-60 all went into the steel. From all the experiments, once the slag cooled the trapped cations were exceedingly stable and the leach rate was immeasurably small.

Discussion:

It would seem likely therefore that naturally occurring radionuclides present in the source ores or other materials present in the kiln are likely to be accumulated in the slag. Likewise many artificial radionuclides which deliberately or inadvertently find themselves in the furnace are also going to accumulate in the slag.

The activity levels at which the legislation in various countries classifies materials containing naturally occurring radioactivity as radioactive varies enormously. Some levels are given in table 3. As can be seen compared to the levels measured in the grit samples in most countries none of the grits would be considered as being radioactive. However in some the levels could be approached and in Germany the level for radium -226 would actually be exceeded by some of the grits measured.

Table 3. Brief Summary of some activity levels at which different countries consider material radioactive.

United Kingdom	0.37 Bq/g of Ra-226 (RSA 93) but under " Rare Earths" Exemption Order 14.8 Bq/g of Radium
Holland	100 Bq (total)/g
Germany	0.05 Bq/g for Ra-226
Malaysia	0.1 Bq/g (total)
Australia (South Australia)	35 Bq/g and 5 x 10^3 Bq (Ra-226)

The very use of the grits is going to produce an aerosol of fine powder. The people actually doing the blasting should be wearing sufficient protective equipment to ensure that the inhalation of the material is minimal. None of the levels measured approach the 10 Bq/g Radium-228 or 1 Bq/g Radium-226 levels the NRPB (10) recommend as operational level below which no one is likely to exceed a dose of above 1 mSv/y. Air monitoring measurements have not been made to confirm this.

Recommendations:

Our experience would indicate that non-slag type grits from smelting processes will not present any problems at all and can be used without any further tests being made. Copper or iron slag based grits may cause a problem depending on the national definition of what is classed as radioactive. Likewise mineral based grits may also cause a problem in some countries. If national limits are low then suitable analysis should be carried out on a representative sample of the grits prior to use. The levels of activity detected would indicate that the normal precautions taken during grit blasting operations are sufficient to ensure that no exposure limits for non-classified workers will ever be approached.

References:

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