SUMMARY OF HEALTH EFFECTS OF COAL FLY ASH

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The origin of the coal and the type of coal-fired power station in the Netherlands are the same as in Israel. Coal fly ash produced in the Netherlands is similar to those produced in Israel and the results of the research done on coal fly ash in the Netherlands are applicable to Israel.

Coal for producing electricity was replaced completely around 1974 by heavy fuel oil and natural gas. After the oil crises in 1974 the Dutch government decided that coal should be introduced as a fuel for generating electricity again. A large national research program into the bottlenecks of quick introducing coal favoured the smooth introduction. One of the modules was “Humane toxicological properties of different types of coal ash and the health risks for employees in the fly ash processing industry “ Test on cells, animal experiments and a review of epidemiological studies were performed. The conclusion of the report from 1987 is:

“Based on the current, limited available information of a number of small epidemiological studies, it appears that there is no increased health risk involved for the employees in coal-fired power stations and in fly ash processing industry, as long as the requirements laid down for nuisance dust in the occupational environment are met”

With respect to carcinogenicity, the authors concluded in 1987:

“No carcinogenic effects in de lungs or in other organs are observed with exposure to coal fly ash after long term animal tests, as far as two years”

Prof.Dr. P.J. Borm of the research group Health Risk Analyses and Toxicology of the University of Maastricht in the Netherlands, later professor at the University of Düsseldorf in Germany and a member of the German TLV committee, has again ten years later reviewed the literature in order to establish if new facts were published. His conclusion was All information obtained in the nineties, confirms the conclusion of the 1987 report that employees in coal-fired power stations and in fly ash processing industry experience no increased health risk, as long as the requirements laid down for nuisance dust in the occupational environment are met”
KEMA (Dr. R. Meij) wrote in 1997 a detailed report about the state of art of the health properties of coal fly ash and indicated for which subjects the proof was not hard enough. An additional research program was started in order to consolidate the proof of the non toxic properties of coal fly ash. The report was updated in 2000 and 2003. The results are briefly summarized below per subject.

**a) Introduction**

Toxicity is determined by:
- doses = concentration x exposure time
- the chemical form or speciation
- the method of exposure: ingestion, inhalation and skin contact
- the individual

It appears that inhalation is the only relevant route.

**a) Heavy metals**

Extensive measurements have been performed on coal, furnace bottom ash and coal fly ash (in the UK called PFA) for different power station and a great number of coals. Fifty-five elements were measured. The TLV (threshold-limited value) of most of the compounds/elements are given for the inhalable fraction. Therefore the concentrations were established as a function of the particle size. By which the concentration of the total but also of the inhalable fraction could be establish. The speciation (the chemical form) was also determined by measurements and thermo dynamical calculations. All the results are put into a model (the KEMA TRACE MODEL®), by which the composition of the coal fly ash (total and inhalable fraction) can be predicted as a function of fuel composition. A methodology was introduced to establish whether the coal fly ash can be considered as a nuisance dust or not (the KEMA DAM® = Dust Assessment methodology). It appears that in all cases the exposure to workers are far below the TLV and that the coal-fly ash can be considered as a nuisance dust.

Special attention was paid to the Cr(VI) content. The results for total chromium is give in the next table.

<table>
<thead>
<tr>
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<th>Cr\text{total} in mg\cdot kg^{-1}</th>
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<tbody>
<tr>
<td>Coal</td>
<td>18 ± 6</td>
</tr>
<tr>
<td>FBA</td>
<td>117 ± 14</td>
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<tr>
<td>PFA total</td>
<td>130 ± 15</td>
</tr>
<tr>
<td>PFA-inhalable</td>
<td>130 ± 15</td>
</tr>
<tr>
<td>PFA respirable</td>
<td>182 ± 40</td>
</tr>
<tr>
<td>Fly dust (fly ash)</td>
<td>204 ± 130</td>
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</tbody>
</table>

% Cr (IV) lies between 4 - 9% (mean 6%), so Cr(VI) level in coal fly ash is about 8 ppm and is no problem.
b) Particle size distribution
On average the following results are found
• 21 µm is geometrical diameter
• 31 µm is aerodynamic diameter
• 55% is inhalable fraction
• 5% is respirable fraction
• 20% is PM10 fraction
• 1% is PM2,5 fraction

c) Quartz
Quartz is only toxic in the respirable fraction. Although the α-quartz content of coal fly ash lies about 10%, the content in the inhalable fraction is only 0,1%. However about 60% is embedded in the particle and only about 40% is at the surface. Therefore, no TLV will be crossed. Furthermore, the quartz is changed by passing high temperatures. Review of five epidemiological studies at 1 970 employees at coal-fired stations in the UK (Bonnel, Schilling and Massey) indicates that coal fly ash does not give pneumoconiosis and in cytotox. tests it is non-fibrogenic. Many tests in the Netherlands did give the same results. There is no reason to assume that PFA induces Progressive Massive Fibrosis (PMF), so occupational limits of quartz should not be applicable towards PFA.

d) Radioactive aspects
The limits in the Netherlands for non radiological workers are strict (1 mSv/a). The real exposure lies in the region of about 1% of the limit.

e) Dioxins
Measurements of dioxins in the coal fly ash indicate that the concentrations are very low: between 0 – 0,06 pg I-TEQ•g⁻¹. The sum of the detection limits (upper bound) of 17 compounds lies between <1,3 - <1,6 pg I-TEQ•g⁻¹.

f) Polycyclic aromatic hydrocarbons (PAH)
No PAH could be detected below the detection limits. The sum of the detection limits of 16 compounds (upper bound) lies <1 ppm (mg•kg⁻¹).

Conclusion
Coal fly ash (or PFA) can be considered as a nuisance dust.
In the EWC (European Waste Catalogue) it is designated as a non hazardous waste.
Literature


