THERMAL BEHAVIOUR OF RADWASTE – EXPERIMENTAL STUDIES

W. U. Boetsch, D. Gründler
Institute for Safety Technology (ISTec) GmbH
Schwertnergasse 1, D-50667 Cologne, Germany

J. Thiel
Federal Office for Radiation Protection (BfS)
P. O. Box 10 01 49, D-38201 Salzgitter

ABSTRACT

According to our experiences fire accidents are of highest significance for the operational safety of a repository for radioactive waste. In case of fires dose limits in the environment are not to be exceeded which is ensured by the design of the waste packages.

Various experiments were performed to target at the adjustment of theoretical models within safety and risk analysis of such installation. The investigations included the study of the release mechanisms caused by combustion of radioactive waste and the melting of radioactive metallic scrap as well as the research of the behaviour of an inactive waste drum in an open fire and the release ratio out of waste simulation material. The experimental design as well as a detailed description of set-ups and boundary conditions was already presented at the WM 04. Therefore, the present paper will discuss the results and conclusions of this project which allow a more realistic look at the risks caused by fire accidents and their consequences for safety assessments.

INTRODUCTION

The operational safety of a repository for radioactive waste is mainly achieved with the control of the risk of fire accidents. In order to develop a comprehensive approach for the determination of release fractions under fire conditions a broad research project has been carried out by the Institute for Safety Technology (ISTec) in Germany on behalf of BfS (German Federal Office for Radiation Protection). The aim of this project has been to provide parameters to be used in theoretical models being developed within the framework of safety analysis for repositories. Parameters of interest were heat transfer parameters and nuclide specific temperature depended release rates for various wastes. Additional to this the, general behaviour of different waste types under fire conditions could be observed as well.

The research project consisted of four elements:

1. Heating-up of drums in a fire under various fire scenarios.
   Varied parameters are fire load and ventilation rate. The aim of this investigation is the validation of computer codes and the derivation of heat transfer parameters.
2. Analysis of the release mechanism "combustion".
   In order to gain representative results the release behaviour of the combustion plant of the Jülich research centre in Germany has been studied. The nuclide specific release fractions are derived from activity balances (feed, off-gas and ashes).
3. Release ratio out of metallic waste.
   The release fraction for metallic scrap has been analysed in technical scale at the Siempelkamp melting plant.

4. Inactive investigations of model samples.
   These samples simulate various waste products such as cemented waste, concentrates, mixed waste, metallic waste, resins and combustible waste. All samples are precisely doped with app. 30 different elements. The release rates for distinct temperature steps were measured element-specifically.

Due to the fact that the entire experimental set-up and the applied measurement procedures were described in a poster session on WM 04 in detail already, the recent paper focuses on the derivation of results and consequences out of the project. The description of the experiments will therefore be shortened. For more detailed information about this part of the investigations, please refer to the proceedings of WM 04.

Experimental Set-Ups

The brief introduction into the structure of the experimental studies is given the following.

Validation of Fire Simulating Computer Codes

Experimental heating-up of typical waste drums in a fire under various fire scenarios has been performed at the iBMB (Institut für Baustoffe, Massivbau und Brandschutz) of Braunschweig University of Technology, Germany. These pool fire experiments were important for the validation of the available fire models and codes, like CFAST, for the prediction of potential consequences of fires.

Within the pool fire test series the incineration plant OSKAR of iBMB has been used [1]. This facility has 3 possible openings for the natural ventilation of the fire room. At the ceiling hot gases and smoke can be extracted and cleaned by a fan system with filters. During the experiments gas and surface temperatures, gas composition, velocities and heat flux densities have been measured.

Ten different scenarios were carried out. A typical barrel type waste drum has been installed as a double vessel container. The inner barrel consisted of tinplate and was filled with styrene di-vinyl-benzene copolymer with sulfur acid groups (ion exchanger granulates). The gap between the inner and outer steel barrel has been filled with concrete. Both the fire room and the drum were instrumented with thermocouples.

Release Rates of Incinerated Radioactive Wastes

Focus of the examinations of balances of an industrial incineration plant was the analysis of the release mechanism "combustion". In order to gain representative results the release behaviour of the combustion plant of the Jülich research centre has been studied. The nuclide specific release fractions were derived from activity balances (feed, off-gas and ashes).

The Jülich JÜV-50/2 incinerator at the FZ-Jülich Research Center, Germany, is designed for the incineration of solid and liquid radioactive waste [2]. The incinerator's operational capacity is 50 kg/h based on a heat content of 20.000 KJ/kg of waste. The annual capacity is limited due to the license to 140 Mg/a (120Mg/year of solid waste and 20 Mg/year of liquid waste).

The JÜV 50/2 incinerator is a commercially operated facility. Therefore waste treatment is given by economy and operational logistic as well as by legal requirements such as Federal Immission Control Ordinance or German Radiation Protection Ordinance.

Release from Metallic Scrap

The release fraction for metallic scrap has been analyzed in technical scale at the Siempelkamp melting plant. The samples were packed in drums, which were heated in an inductive melting oven [3]. The studies were carried out for pure black and white steel as well as for zinc-coated and varnished metals. These samples were representative materials from nuclear power plants.

A total of 7 experiments were carried out with several representative sample materials. Each sample composition was placed in a common 200 l steel drum. The sample materials was "real" radioactive waste which had to be packed into the 200 l drums to ensure the purity of each sample charge and to install the thermocouples in a well defined 3-dimensional arrangement. Vent openings were cut into the head of the drum to allow controlled air circulation of the drum content.

The experiments were carried out subsequent to a standard melting process to gain from the residual heat. After all measuring equipment was installed the furnace was heated up inductively. Regarding to the filling level and sample material the examined drums were heated up to 800 ° C for one hour and the nuclide specific release rates are measured.

During the entire experiments (heat-up and dwell time) off-gas samples were collected constantly. The off-gas was led through a filter station equipped with changeable glass fiber filters. About 20 filters per experiment were collected. After weighing the filters to achieve balance data concerning the mass release, they were analyzed radiological (gamma-spectrometric, detection time 3600 s, nuclide specific).

Inactive Investigations of Waste Samples

Another experimental sequence of this research project was the investigation of inactive samples which represent all main waste streams. One declared aim in it was to complete the knowledge of the properties of these inactive elements which occur in chemical and physical compounds similar to real radioactive waste. Therefore, the transferability of these results to the circumstances of real waste had to be checked as well.

The samples simulated various waste products such as cemented waste, concentrates, mixed waste, metallic waste, resins and combustible waste. All samples were precisely doped with the following different elements:

Li, Na, K, Cs, Be, Mg, Ca, Sr, Ba, Al, Sn, Pb, P, As, Sb, Bi, S, Se, Cu, Zn, Cd, Sc, Y, Ti, Zr, V, Cr, Mo, Mn, Fe, Co, Ni, Ru, Pd, Ce, Sm, Eu, Th

As representatives for the main waste streams the following materials were used as carriers:

I. Cemented waste:

- Inactive elements applied dissolved in solution, solution is used to prepare cement sample
- inactive elements applied on dry cement sample

II. Mixed waste:

Representative mixture from rubber, paper, textile etc. doped with dissolved elements

III: Metallic waste:

Steel wool is sprayed with element solution and dried before testing

IV. Concentrates:

- boric oxide doped with dissolved elements
- boric oxide mixed with doped and dried cellulose

V. Ion exchange granulates:

Common ion exchange granulates are doped with solution from dissolved elements

All release investigations with inactive samples were executed at the chemical laboratory of ANALYTIS in Wesseling, Germany. Most of the required instruments were standard equipment of an analytical laboratory. Only the reactor had to be constructed in respect of the required gas tightness for a quantitative gas determination.

After preparing the sample and placing it in the gastight reactor both was heated up to distinct temperatures to measure the specific release rates of the doped elements out of each carrier material. To achieve this the temperature was increased and held in the steps 200°C, 400 °C, 600 °C and 800°C for one hour. A stream of Argon was led through the reactor to assure the quantitative rate of yield of released elements at each temperature step. All released gas was led through acid and alkaline solutions. The washing solutions were changed every new temperature step and transferred to the quantitative analysis unit to determine the amount of released material at a distinct temperature. Analyzing units were ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy), ICP-MS (Inductively Coupled Plasma Mass Spectroscopy) and AAS (Atom Absorption Spectroscopy).

Data Output and Analysis

The number of output data resulting from the above described experimental series is according to our expectations enormous. Only the investigations of inactive waste samples for instance led to nearly 4000 single values [38 (various elements) x 5 (4 different temperature steps + 1 blank sample testing) x 3 (washing solutions) x 7 (different waste carrier materials)], which needed to be analyzed and interpreted.

The number of relevant data concerning to the release mechanism combustion was clearly less complex because of individual circumstances related to the character of the incineration plant. The JÜV 50/2 incinerator is a commercially operated facility. Therefore waste treatment is given by economy and operational logistic as well as by legal requirements such as Federal Immission Control Ordinance or German Radiation Protection Ordinance. These circumstances led to only few incineration cycles balanceable for the above declared purposes. The investigation of release ratios of combusted waste depended on clear balancing of the in- and output amounts of one incineration cycle. Unfortunately the analysis of radioactive releases in the off-gas and ashes appeared to be practicable in only very few cases because of cross contamination effects and impurities during the campaign wise operation. Therefore only more or less qualitative statements could be achieved. As far as balances could be drawn the release ratios former meet theoretical assumptions in comparable dimensions, which vary for the release mechanism combustion in release percentages between 10^{-2} and 0.4 in dependence of their boundary conditions.

The results from the investigations of radioactive metallic scrap at the Siempelkamp Company in Krefeld met the theoretical estimations of prior model calculations for assumptions being made for safety assessment analysis for German repository sites. The data were generated by balancing the activity of the radioactive wastes as well as the released

radioactivity detected on the off-gas filter units of the experimental set-up. Prior to and after the execution of the experiments the nuclide specific activities were determined accurately. Table I gives a list of integral released radioactivity for Ag-110m, Co-60 and Cs-137.

Table I. Integral Released Radioactivity for Ag-110m, Co-60 and Cs-137

drum	Radioactivity (Input)			Radioactivity (off-gas)			Radioactivity (release)		
	Ag-110m	Co-60	Cs-137	Ag-110m	Co-60	Cs-137	Ag-110m	Co-60	Cs-137
	[Bq]	[Bq]	[Bq]	[Bq]	[Bq]	[Bq]	[%]	[%]	[%]
1	--	5,330E+05	1,290E+05	--	1,385E+01	3,383E+03	--	0,003	2,622
2	--	5,000E+05	1,210E+05	--	5,445E+00	1,957E+02	--	0,001	0,162
3	--	2,200E+05	1,290E+05	--	1,503E+01	2,456E+01	--	0,007	0,019
4	--	6,220E+05	7,380E+04	--	7,138E+00	1,387E+01	--	0,001	0,019
5	--	6,760E+05	8,020E+04	--	3,978E+00	1,223E+01	--	0,001	0,015
6	1,186E+05	2,845E+04	1,524E+03	2,023E+01	4,099E+00	8,694E+00	0,017	0,014	0,370
7	1,046E+05	5,862E+05	7,676E+03	2,790E+01	7,402E+00	2,068E+01	0,027	0,001	0,269

For the calculation of the release ratios in case of a fire only the release mechanisms sublimation was considered. The sublimation in general is a release pathway which determines the release of volatile substances such as iodine or tritium. However, it can also be of importance for other elements, in particular for Cs. The released percentage of activity depends on the duration and the temperature level of sublimation. The amount of released activity can be theoretically estimated on the basis of the thermodynamic data of the substance and Lewis´ law. These calculated ratios match very well with the results of the executed experiments at the CARLA melting plant. The calculations were made for safety considerations of waste containments for disposal at the (planned) German disposal at the former iron ore mine KONRAD.

The experiments at the iBMB of the Braunschweig University were carried out not only for the validation and verification of common computer codes, but also to observe the growth of a heat front into a waste drum in case of a fire. CFAST as a heat zone modeling computer code showed to be suitable for the calculation of a real fire. Figure 1 gives an impression of the comparability achieved between experiment and simulation.

Experiment **Simulation**

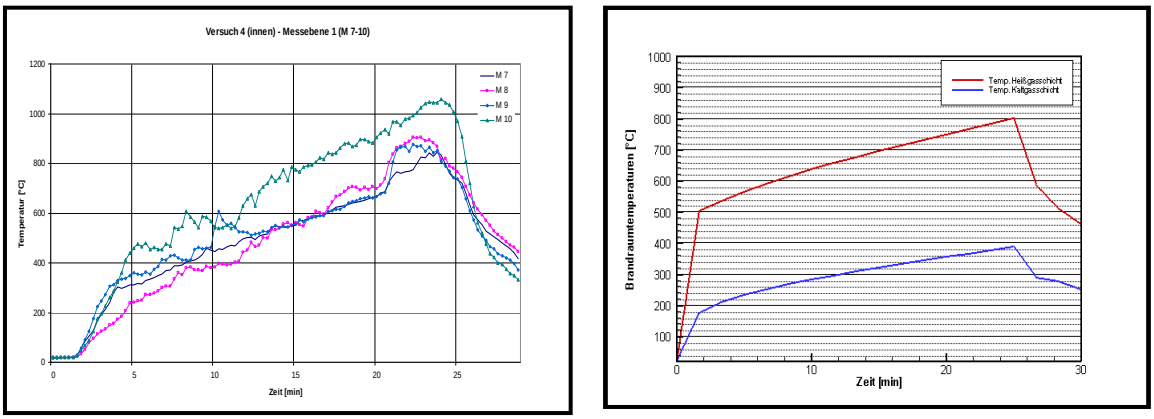

Fig. 1. Distribution of temperature within the fire chamber (green and pink curves in the experiment distribution are relevant)

Not only the thermal expansion within the fire chamber was measured and controlled but also the thermal development on the surface of the prepared waste drum filled with ion exchange resin could be estimated. The prediction of the development of the heat flow at the drum (heat flow drum top, drum centre and drum bottom) appeared to be done by the computer code CFAST in a satisfactory way as well, compare figure 2.

Experiment **Simulation**

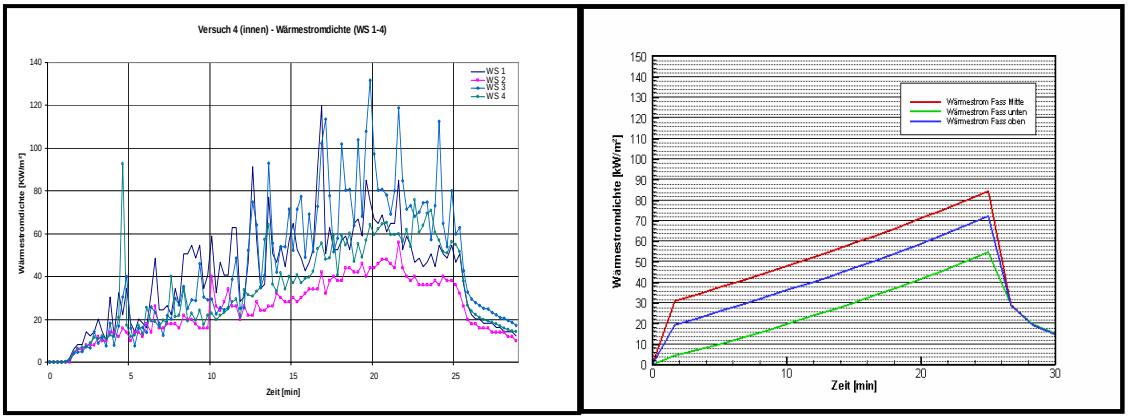

Fig. 2. Heat flow at the waste drum (measured and calculated with CFAST).

As mentioned above the investigation of the inactive waste samples caused an enormous amount of raw data which needed to be interpreted and set in further calculations.

In some cases the build-up of the achieved release rate of an element (for instance Sb on a concrete carrier) wasn't plausible because of the non-typical release behaviour at lower temperatures. Salt recombination due to increasing temperature and processes related to the dynamics of chemical equilibration might be the origin for such implausibility. The transferability of the direct results of this experimental sequence is therefore restricted to more or less general additive information about the physical release behaviour of elements and less suitable for the direct application in nuclear concerns. The applicability of the results can be examined due to the correlation from release values with temperature distribution in a heated waste containment to allow the calculation of release rates of waste products in waste containers.

Principally there are four relevant mechanisms for the release of radioactivity as a result of thermal stress:

1. Pyrolysis is understood as the thermal decomposition of material. This takes place if the temperature exceeds a certain threshold. The gaseous decomposition products escape from the waste package and burn outside if they are ignited. With the pyrolysis gases a certain percentage of radioactivity is released (app. 5×10^{-3} for Cs).
2. In the event of the assumed thermal stress condition, combustible waste will burn if the sufficient amount of air is supplied to it. As mentioned earlier the release percentages because of combustion are approximated between 10^{-2} and 0,4. Added to these released percentages may be the resuspension of the residues of combustion.
3. Vaporization of water causes a transition of radioactive substances into the gaseous phase. This mechanism is particularly relevant for cemented wastes and concentrates. These wastes contain a great amount of vaporizable water in their pore volume or water of crystallization.

4. Apart from the release of radioactive substances by means of co-vaporization radioactive substances are also subject to direct vaporization or sublimation.

In the case of cemented wastes a combination of the release mechanisms pyrolysis (in the hot surface layer) and co-vaporization is possible. As far as metallic scrap is concerned the only relevant release process is sublimation of radionuclides.

Crude compacted waste may consist of pure scrap or mixed wastes like textile and paper. In the case of an overwhelmingly metallic composition the relevant release mechanism is sublimation of radionuclides. In all other cases the leading process is pyrolysis.

These mechanisms of release of radioactivity were to be further investigated by the inactive sample experiments at the Analytis Laboratory at Wesseling, Germany. Table 2 gives the impression of a typical data output sheet from one experimental sequence.

Table II. Typical data output from inactive sample investigation (mixed wastes, cutting)

Sum								release ratio						
200 °C		400 °C		600 °C		800 °C		200 °C	400 °C	600 °C	800 °C	Element	blank value	amount
mg/l	µg	mg/l	µg	mg/l	µg	mg/l	µg	%	%	%	%		mg/l	mg
0,17519	17,52	0,13282	13,28	0,10017	10,02	13,37	1337	0,035	0,027	0,020	2,674	Pb	0,01	50
0,05405	5,405	0,00897	0,897	0,01897	1,897	266,2	26615	0,011	0,002	0,004	53,230	Cd	0,0006	50
< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,0018	< 0,0018	< 0,0018	< 0,0018	Cr	0,003	50
< 0,018	< 1,8	< 0,018	< 1,8	< 0,018	< 1,8	< 0,018	< 1,8	< 0,0036	< 0,0036	< 0,0036	< 0,0036	Cu	0,006	50
< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,0018	< 0,0018	< 0,0018	< 0,0018	Ni	0,003	50
0,03075	3,075	0,02777	2,777	0,0198	1,98	6,617	661,7	0,00615	0,00555	0,004	1,323	Zn	0,003	50
0,16135	16,13	6,05486	605,5	0,10279	10,28	< 0,045	< 4,5	0,03227	1,21097	0,02056	< 0,009	As	0,015	50
11,411	1141	118,05	11805	0,935	93,5	0,141	14,1	2,2822	23,61	0,187	0,028	Sb	0,01	50
0,08272	8,272	0,33028	33,03	< 0,06	< 6	< 0,06	< 6	0,01654	0,06606	< 0,012	< 0,012	Se	0,02	50
0,13571	13,57	0,20356	20,36	0,24502	24,5	0,219	21,85	0,027	0,041	0,049	0,044	Ca	0,007	50
0,01785	1,785	0,01397	1,397	0,01787	1,787	0,016	1,63	0,002	0,001	0,002	0,002	Mg	0,003	100
< 0,12	< 12	< 0,12	< 12	< 0,12	< 12	< 0,12	< 12	< 0,026	< 0,026	< 0,026	< 0,026	Na	0,04	47
1,26766	126,8	0,3264	32,64	1,19175	119,2	1,854	185,4	0,098	0,025	0,092	0,144	K	0,03	129
0,11429	11,43	0,02456	2,456	0,10514	10,51	0,116	11,62	0,023	0,005	0,021	0,023	Ba	0,0015	50
0,00693	0,693	< 0,0045	< 0,45	0,013	1,3	0,006	0,607	0,001	< 0,0009	0,003	0,001	Sr	0,0015	50
0,34713	34,71	0,29331	29,33	0,31484	31,48	0,341	34,06	0,069	0,059	0,063	0,068	Al	0,003	50
< 0,003	< 0,3	< 0,003	< 0,3	< 0,003	< 0,3	< 0,003	< 0,3	< 0,0012	< 0,0012	< 0,0012	< 0,0012	Be	0,001	25
< 0,0018	< 0,18	0,00318	0,318	< 0,0018	< 0,18	0,005	0,455	< 0,00036	0,00064	< 0,00036	0,001	Mn	0,0006	50
0,01332	1,332	0,01833	1,833	0,01731	1,731	0,036	3,604	0,003	0,004	0,003	0,007	Fe	0,001	50
< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,009	< 0,9	< 0,0018	< 0,0018	< 0,0018	< 0,0018	Co	0,003	50
< 0,03	< 3	< 0,03	< 3	< 0,03	< 3	< 0,03	< 3	< 0,006	< 0,006	< 0,006	< 0,006	V	0,01	50
0,04577	4,577	1,93018	193	7,12009	712	13,37	1337	0,00915	0,38604	1,424	2,675	Sn	0,01	50
0,03127	3,127	0,12777	12,78	< 0,03	< 3	< 0,03	< 3	0,00496	0,02028	< 0,005	< 0,005	P	0,01	63
< 0,0045	< 0,45	0,00675	0,675	< 0,0045	< 0,45	0,03	3,025	< 0,0009	0,00135	< 0,0009	0,006	Li	0,0015	50
0,016	1,6	0,02	2	< 0,015	< 1,5	< 0,015	< 1,5	0,00508	0,00635	< 0,005	< 0,005	Ti	0,005	31,5
< 0,009	< 0,9	0,061	6,1	< 0,009	< 0,9	< 0,009	< 0,9	< 0,0018	0,0122	< 0,0018	< 0,0018	Mo	0,003	50
< 0,045	< 4,5	11,4975	1150	6,37375	637,4	0,255	25,54	< 0,004	0,97436	0,54015	0,02164	S	0,015	118
< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,036	< 0,036	< 0,036	< 0,036	Ru	0,06	50
< 0,03	< 3	0,803	80,3	0,35188	35,19	0,388	38,78	< 0,006	0,161	0,070	0,078	Bi	0,01	50
< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,036	< 0,036	< 0,036	< 0,036	Ce	0,06	50
< 0,06	< 6	< 0,06	< 6	< 0,06	< 6	< 0,06	< 6	< 0,012	< 0,012	< 0,012	< 0,012	Sm	0,02	50
< 0,018	< 1,8	< 0,018	< 1,8	< 0,018	< 1,8	< 0,018	< 1,8	< 0,0036	< 0,0036	< 0,0036	< 0,0036	Eu	0,006	50
< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,18	< 18	< 0,036	< 0,036	< 0,036	< 0,036	Th	0,06	50
< 0,003	< 0,3	< 0,003	< 0,3	< 0,003	< 0,3	< 0,003	< 0,3	< 0,0006	< 0,0006	< 0,0006	< 0,0006	Sc	0,001	50
< 0,0045	< 0,45	< 0,0045	< 0,45	< 0,0045	< 0,45	< 0,004	< 0,45	< 0,00225	< 0,00225	< 0,00225	< 0,00225	Y	0,0015	20
< 0,036	< 3,6	0,053	5,3	< 0,036	< 3,6	< 0,036	< 3,6	< 0,0072	0,011	< 0,0072	< 0,0072	Zr	0,012	50
< 0,06	< 6	< 0,06	< 6	< 0,06	< 6	< 0,06	< 6	< 0,012	< 0,012	< 0,012	< 0,012	Pd	0,02	50
0,00201	0,201	0,01245	1,245	0,00211	0,211	0,651	65,07	0,0004	0,00249	0,00042	0,13015	Cs	0,0002	50

These achieved values needed further preparation to be fed into calculation models to identify thermo dynamical properties of the investigated elements and their carrier materials under thermal stress. Therefore the values needed to become time depended by transferring the absolute percentage or concentration value into the corresponding ratio (dividing by time). In a next step well defined release ratio values were to be estimated by the use of the following equations:

Pyrolysis

$$f_{Pyrolysis} = \frac{V_{T>300°C,\max}}{V_{total}} \times 5E-3$$

with

$V_{T>300°C,\max}$: Maximum partial volume with T>300 °C

Pyrolysis and vaporization of water

$$f_{Pyro.vap.} = \frac{V_{T>300°C,\max}}{V_{total}} \times 5E-3 + \frac{(V_{100°C>T>300°C} + V_{T>300°C})_{\max} - V_{T>300°C,\max}}{V_{total}} \times 5E-4$$

with

$(V_{100°C>T>300°C} + V_{T>300°C})_{\max}$ Maximum partial volume with T>100 °C

Sublimation

$$f_{Sub} = \frac{1}{\rho \times \delta} \times \sum \left(\frac{V_{T>300°C}}{V_{total}} \times \dot{m}_D(400) + \frac{V_{100°C>T>300°C}}{V_{total}} \times \dot{m}_D(200)\right) \times \Delta t$$

with

$\dot{m}_D(T)$ Temperature depending mass transfer coefficient for CsJ

$\rho \times \delta$ Layer thickness of a contamination x density

Δt Period of a calculation run

$$\dot{m}_D(T) = \sigma_C \times \frac{M_D \times \exp(-A/T + B + C \times \ln(T))}{R \times T}$$

with

σ_C Mass transfer in kg m^{-2} s^{-2}

M_D Molar mass

R Gas constant

T absolute temperature

A,B,C coefficients fort he calculation of vapor pressure

Unfortunately, the attempt to calculate well-defined values using the well known theoretical frame failed. The interpretation of the experimental results needed to be from the phenomenal point of view. As displayed in figure 3 the temperature dependent element specific release behaviour of each estimated element appeared to be classifiable in three basic behaviour classes:

1. Release ratio almost constant (see example curve "Fe")
2. Release ratio drops and rises (see example curve "Ba")

3. Release ratio constantly rises (see example curve "Pb")

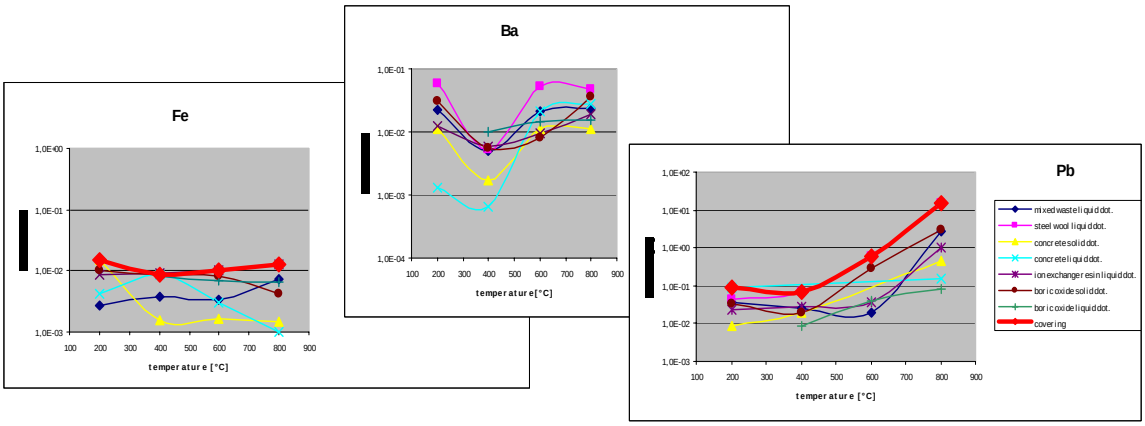

Fig. 3. Element specific release behaviour according to different carrier materials

The distribution of these three classes appears to be well balanced over the total of all observed releases. It is remarkable that only the "class-3-type" meets the theoretical assumption, which includes a steady build-up of release with increasing temperature. Regarding to the influence of the carrier material on the release dynamic there is no striking relation between substance material, temperature and release observable. This leads to the conclusion, that the basic chemical and/or physical models need to be reconsidered which is worked on just now.

CONCLUSION

The presented sequence of experiments was performed to complete the knowledge of the release behavior of radioactive nuclides in the case of fire and to verify and validate existing theoretical models or computer systems. Regarding to long term safety considerations of a disposal for radioactive wastes or the qualification of waste containments it was necessary to identify conservative assumptions or models to prevent avoidable uncertainties.

The experimental series showed that on the one hand already derived assumptions result from suitable theoretical models like it could be proved with the investigation of metal scrap for instance. On the other hand, there are results as well which can't be explained with common theoretical models. ISTec is working on the development of new models which allow the handling of more realistic boundary conditions and parameters. This might cause a reconsideration of the waste group classification system being used in Germany for risk assessment analysis. The investigations of the release behaviour of inactive substances and the interpretation of their results suggest that the influence of the carrier material (which is comparable to the waste group classification) is not as potent as expected and assumed. A correction of the classification of the waste group system therefore might be necessary and lead to more reliable safety calculations for fire accidents in the future.

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