THE EFFECT OF Cs AND Sr ON THE MECHANICAL PROPERTIES OF BLAST FURNACE SLAG INORGANIC POLYMER FOR RADIOACTIVE WASTE IMMOBILISATION

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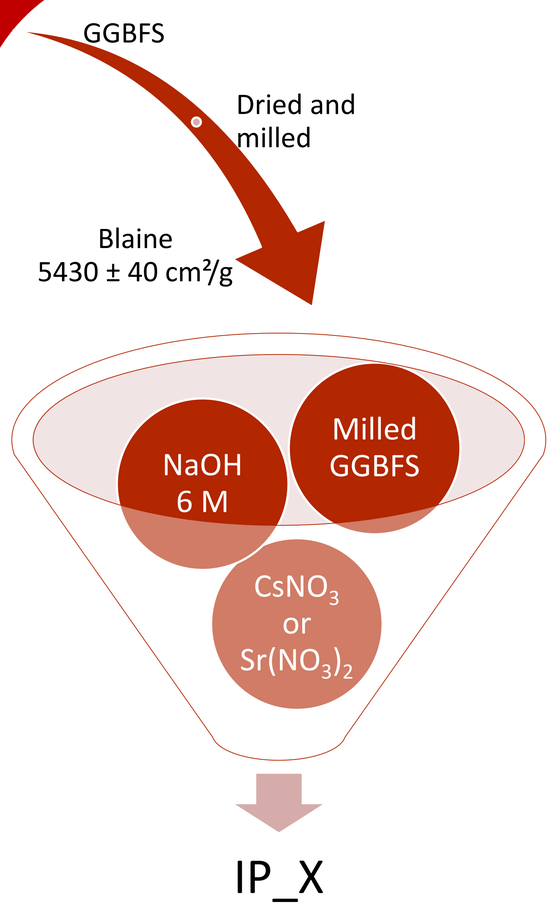
Abstract

To address health and environmental risks associated with long term storage of radioactive waste (RAW), a continuous search for novel immobilisation matrices exists. The use of inorganic polymers (IPs) for this end forms the basis of this study. Although being a very promising option, it is highly important to study the impact of introduced elements on IP-characteristics. IPs doped with different amounts of $CsNO_3$ and $Sr(NO_3)_2$ were developed from ground granulated blast furnace slag (GGBFS), to study the effect of Cs^+ and Sr^{2+} on IP-characteristics.

IP design



wt% Cs^+ or Sr^{2+}	Label
	IP_0
0.50 Cs^+	IP_0.5Cs
1.00 Cs^+	IP_1Cs
2.00 Cs^+	IP_2Cs
0.49 Sr^{2+}	IP_0.5Sr
0.98 Sr^{2+}	IP_1Sr
1.90 Sr^{2+}	IP_2Sr

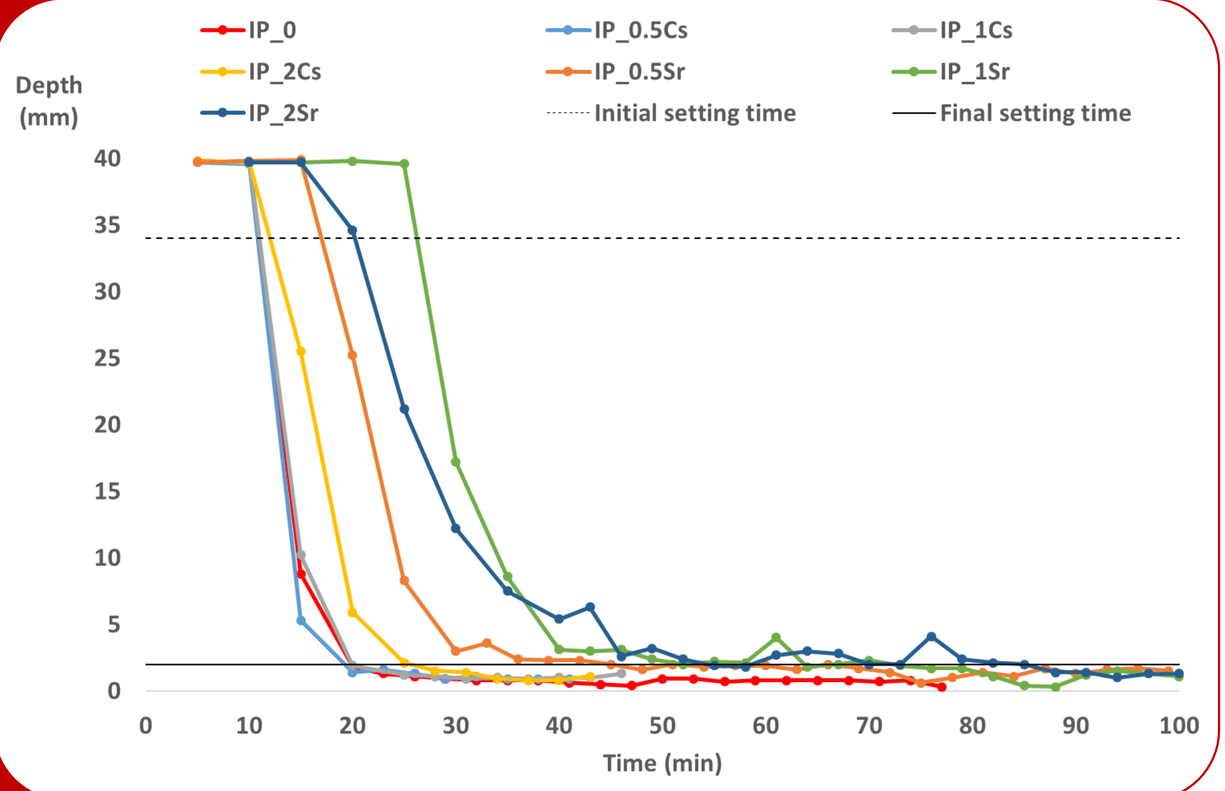
Liquid/Solid 0.37

EPMA

Results of micro-chemical analysis of the IP-binder (uncertainty is 1 σ).

Constituent (wt%)	IP_0.5Cs	IP_1Cs	IP_2Cs
Cs_2O	1.4 ± 0.1	1.9 ± 0.4	3.8 ± 0.4
Cs^+	1.3 ± 0.1	1.8 ± 0.4	3.6 ± 0.4
	IP_0.5Sr	**IP_1Sr**	**IP_2Sr**
SrO	0.43 ± 0.01	0.6 ± 0.1	1.0 ± 0.2
Sr^{2+}	0.36 ± 0.01	0.47 ± 0.09	0.9 ± 0.1

Setting time



Strength

Flexural (f_{cf}) and compressive (f_c) strength (uncertainty is 1 σ).

MPa	1 day		8 days		28 days	
Sample	f_c	f_{cf}	f_c	f_{cf}	f_c	f_{cf}
IP_0	23 ± 5	9	43 ± 2	13	64 ± 3	11
IP_0.5Cs	28.5 ± 0.1	13	46 ± 5	14	74 ± 1	8
IP_1Cs	31 ± 1	11	64 ± 10	14	68 ± 5	8
IP_2Cs	32 ± 2	11	52 ± 7	15	65 ± 7	10
IP_0.5Sr	13 ± 2	9	32.5 ± 0.9	9	45 ± 6	12
IP_1Sr	15.8 ± 0.1	8	26 ± 9	7	32 ± 2	10
IP_2Sr	11.8 ± 0.4	7	23 ± 5	7	30 ± 2	11

Conclusions

Adding Cs^+ and Sr^{2+} affects the characteristics of GGBFS-based IPs in the following manner:

- The setting time of the IP-gel is delayed slightly when adding up to 2 wt% Cs^+, while adding Sr^{2+} strongly delays setting, even at 0.5 wt% doping.
- The final compressive strength of the IPs is reduced with about 50 % when adding Sr^{2+}. Addition of Cs^+ does not negatively affect the compressive strength. A slightly positive effect is observed with 0.5 wt% Cs^+ doping.
- Micro-chemical analysis shows that uptake of Cs^+ in the IP-binder is about 4 times higher than uptake of Sr^{2+}.

Future work:

- Testing immobilisation potential by use of leaching-tests
- Calculating the amount of GGBFS-precursor that dissolves during the alkali activation process in order to determine the fraction of introduced Cs^+ and Sr^{2+} that is actually incorporated in the IP-binder.