Use of Geopolymers in the Disposal of LLW/ILW in the Czech Republic

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Geopolymers in Radioactive Waste Management webinar

NUCLEAR RESEARCH INSTITUTE

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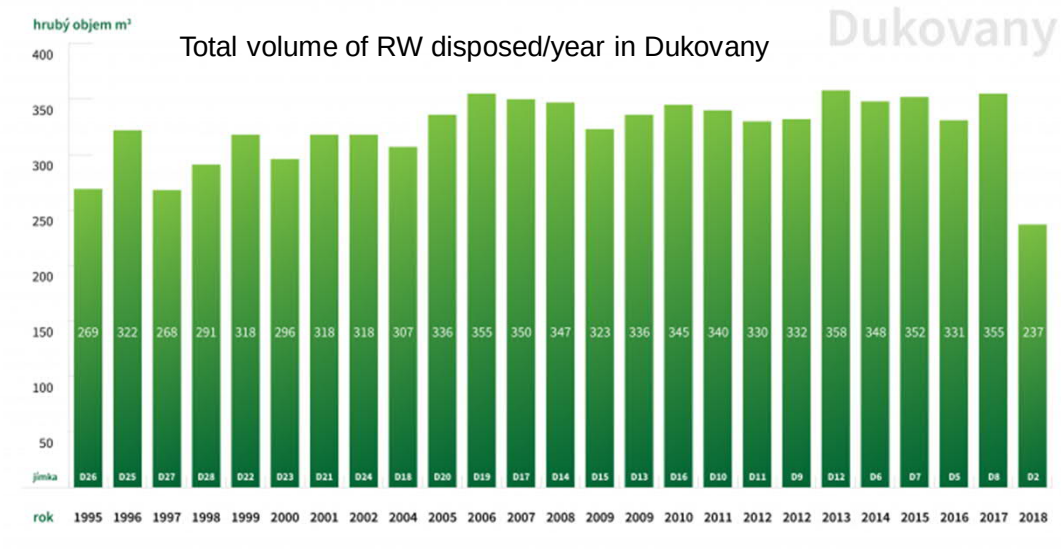
MAIN USE OF GEOPOLYMERS IN RW MANAGEMENT IN CZECH REPUBLIC

- **Conditioning of LLW/ILW spent resins and sludges, originating in NPP operation**
- **mostly in semi-liquid state, with varying portion of sludge fraction**
- **disposed in Dukovany LLW/ILW repository**
  - vault systém repository
  - types of matrixes: cement, geopolymer, bitumen, unsolidified RW
  - filling: cement

Dukovany disposal site



Total volume of RW disposed/year in Dukovany

HISTORY OF GEOPOLYMER USE

- regulator (SONS) required conditioning of long term stored spent resins and sludges in Czech NPPs (ČEZ a.s.) since 90ties
- considering Dukovany WAC, geopolymers were preselected
- matrix development took place both in Czech Republic and Slovakia

SiAl©
(Aldeco/AMEC/Jacobs)

- experience in Slovakia since 2003 (regulator approval)
- development and testing process in CZ since 2003
- approved together with WAC revision in 2006

Alusil ©
(Chemcomex)

- developed and approved in 2011
- independent testing (SURO, VUJE, CTU, UJV)
  - 2013 – 2015; 2017 - 2021

GEOPOLYMER APPROVAL (DEFINING WAC)

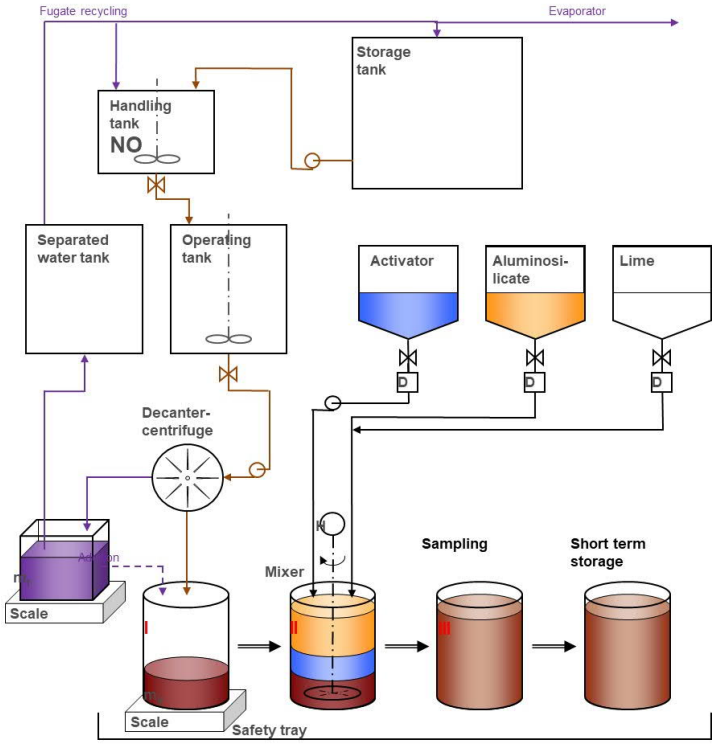
- **A specific studies performed, supporting licening**
  - compresive strength
  - leachability + diffusuion coefficient
  - sorption coefficients Kd
  - radiation stability
  - biodegrabiilty
  - content of water (influence of frost)
  - dustiness
  - content of water and change of compressive strength with time
  - combustibility and explosivity
  - **safety assessment of waste acceptance to the repository**
    - evaluation if the dose to the representative of reference group on the repository does not exceed 250 μSv/year under defined scenario

GEOPOLYMER APPROVAL (DEFINING WAC)

- **A specific studies performed (laboratory + test approval)**
  - **compresive strength** (10 MPa)
  - **leachability** 4% (0,04% for >3. 10^9 Bq/m^3) + diffusion coefficient
  - sorption coefficients Kd
  - radiation stability
  - biodegrabiilty
  - content of water (influence of frost)
  - dustiness
  - content of water and change of compressive strength with time
  - combustibility and explosivity
  - **safety assessment of waste acceptance to the repository**
    - Max. filling up to 20% of aktivity (limit for the drum + the vault + stability reason)
    - Comparison with cemented matrix

GEOPOLYMER APPROVAL (DERIVING WAC)

Both matrixes approval programme was accompanied with series of laboratory and technology/Industrial tests



Alusil© Chemcomex industrial line (tested in UJV Rez)

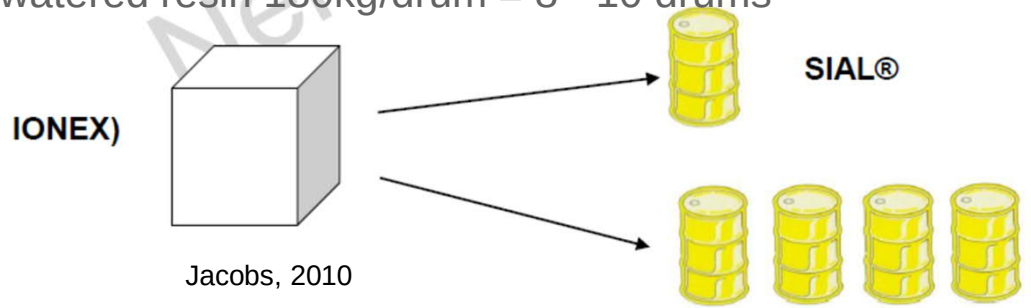
Alusil© Chemcomex: max loading of the drum

SiAl© Pre-treatment in EDU NPP (Faltejsek et al. 2021)

GEOPOLYMERS IN USE

- **Both commertial products are based on conventional geopolymer recepy, tailored for the incorporation of specific waste**
  - they could be tailored according to immidiate properties of RW
  - specific parameters are observed during process (e.g. pH, size of sludge fraction, fraction of organic/inorganic fraction)
  - direct conditionin in the drums
  - each batch has to be tested for leachability and compressive strength
- choice of the product by the end user (ČEZ, a.s.) is based on commertial tender

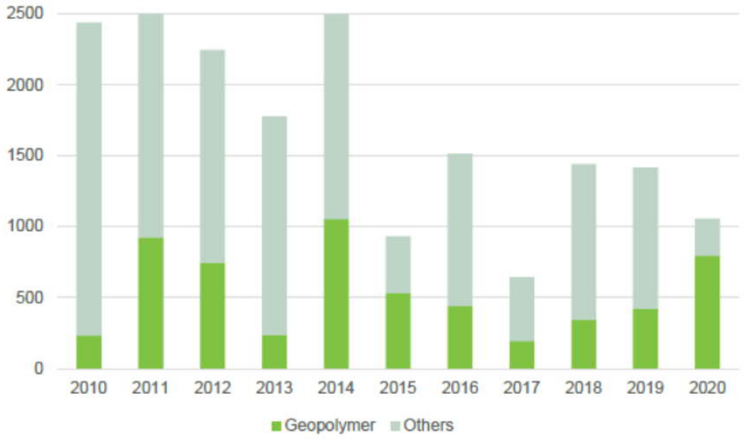
- **Enable important decrease of radioactive waste production**
- **cement**: **1m³** of dewatered resin 40kg/drum = approx. 32 drums
- **geopolymer:** **1m³** of dewatered resin 130kg/drum = 8 - 10 drums



Jacobs, 2010

TOTAL NUMBER OF DRUMS, CONDITIONED WITH GEOPOLYMERS (BOTH TYPES)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total drums	2439	2499	2246	1774	2497	933	1510	645	1439	1413	1056
Geopolymer drums	236	923	747	241	1053	536	442	195	345	423	796
ratio	10%	37%	33%	14%	42%	57%	29%	30%	24%	30%	75%



Thank you for you attention

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