



Persulfates

Soil Remediation Applications

Persulfates – A Versatile and Efficient Active Component

Persulfates are a widely used active component for the remediation of chemically contaminated soils, particularly for the ISCO-method (*in situ* chemical oxidation). Here, an aqueous solution of persulfate is selectively introduced into the affected zones in the soil to decompose present contaminations *in situ*. Thus, ISCO is an optimal method for the destruction of contaminants of high local concentrations. Originally developed in North America, ISCO also evolved to become one of the leading methods in Europe.

Persulfates yield a higher oxidative power than most other remediation agents in use. Their main decomposition product is sulfate, which can be regarded as least problematic from a toxicological point of view. Consequently, persulfates are ideal for the treatment of a wide spectrum of chemical contaminants that can be decomposed by means of oxidization. Examples are solvents based on aliphatic and aromatic hydrocarbons, halogenated alkanes and alkenes, low-molecular polycyclic aromatic hydrocarbons (PAH), BTX, mineral oil residues, pesticides and many more.

Synergies in combination with persulfates also exist in combination with other commonly applied remediation techniques, such as based on tensides and potassium permanganate. In contrary to the latter one, application of persulfates will not lead to an increase of the heavy metal content of the soil after treatment.

United Initiators are producing all persulfate types relevant for soil remediation in the required high quality and purity.



UI's Product Portfolio for Soil Remediation

NPS/SPS Sodium persulfate

- **Free of nitrogen**
NPS from United Initiators does not contribute to an increase of the nitrogen load in the soil. In contrary to our competition, we are producing NPS directly from sodium sulfate and not by conversion of ammonia salts and can offer this nitrogen-free grade from both European and Chinese production.
- **High solubility (more than 500 g/l at 20 °C / 70 °F)**
Enables convenient handling and preparation of aqueous solutions.
- **High oxidization potential, facile activation**
- **High purity (> 99 %)**
- **Standard packaging**
25 kg / 55 lbs in PE bags
1000 kg / 2200 lbs Big Bags
1000 kg / 2200 lbs per pallet

Packaging qualification according to the highest international standards enables safe handling and storage.

KPS Potassium persulfate

- **Free of nitrogen**
KPS from United Initiators is also produced by conversion of potassium salts without use of ammonium and does thus not contribute to an increase of the nitrogen load in soils.
- **High fineness, lower solubility in water than NPS**
Facilitates dosing and allows preparation of aqueous slurries.
- **Increases half-life after injection under ground**
Thus suitable for use in permeable systems with controlled persulfate release.
- **High oxidizing potential, facile activation**
Effective destruction of contaminants
- **High purity (> 99 %)**
- **Standard packaging**
25 kg / 55 lbs in PE bags
1000 kg / 2200 lbs Big Bags
1000 kg / 2200 lbs per pallet

Packaging qualification according to the highest international standards enables safe handling and storage.

Product Portfolio for Soil Remediation

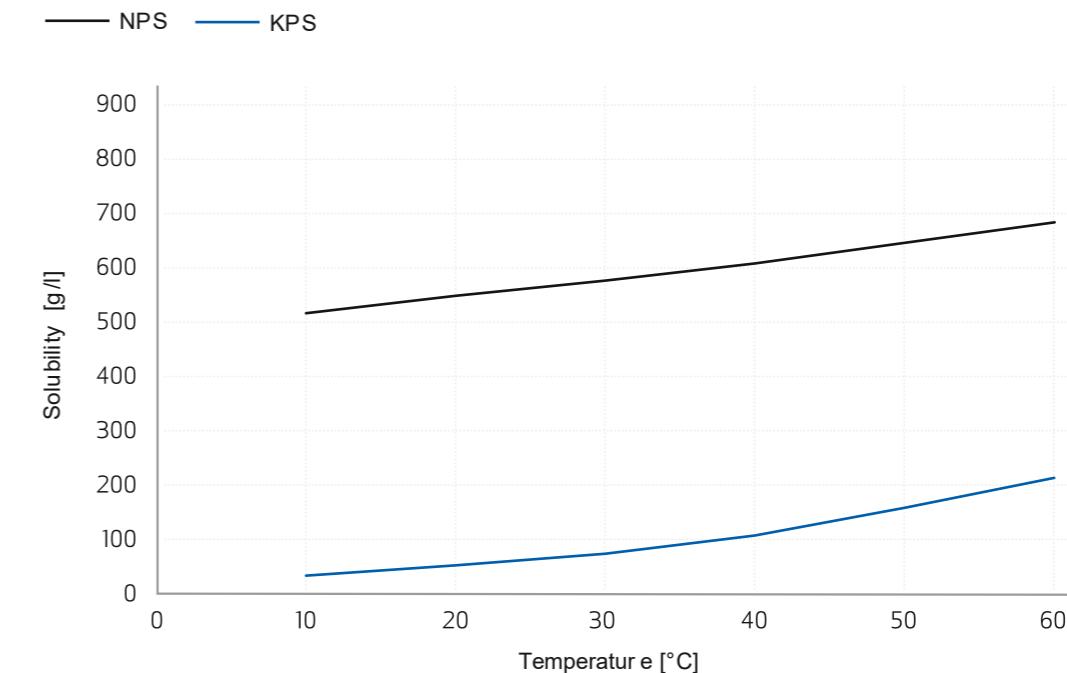
Persulfates - Typical Analytical Data				
	Unit	NPS Sodium Persulfate	KPS Potassium Persulfate	Comment ¹
Active Oxygen	%	≥ 6.65 / 6.70	≥ 6.94 / 7.00	S / T
Purity	%	≥ 99.0 / 99.9	≥ 99.0 / 99.6	S / T
Sulfuric Acid	%	≤ 0.1 / 0.01	≤ 0.15 / 0.08	S / T
Moisture	%	- / < 0.03	< 0.03	T
Bulk Density	g/cm ³	1.25	1.10	T
Insolubles	ppm	< 10	< 10	T
pH (1 % in water, 20 °C) ²		5.0	4.4	T
pH (10 % in water, 20 °C) ²		4.0	3.6	T
Ammonium (NH ₄ ⁺)	ppm	< 10	< 10	T
Platin (Pt)	ppm	< 0.2	< 0.2	T
Copper (Cu)	ppm	< 0.2	< 0.2	T
Chloride (Cl)	ppm	< 3.0	< 3.0	T
Chromium (Cr)	ppm	< 0.1	< 0.1	T
Iron (Fe)	ppm	< 5 / 0.5	< 5 / 1	S / T
Manganese (Mn)	ppm	< 0.2	< 0.2	T
Zink (Zn)	ppm	< 2.5	< 2.5	T



¹ S = technically specified; T = typical value (European production)

² The initial pH value depends on the sulfuric acid content.

Solubility of Persulfates as Function of Temperature
(Aqueous solutions)



Particle Size				
Sieve Aperture		NPS ¹	KPS ¹	
µm	mesh			
2360	8	100	100	
710	24	90	100	
500	32	76	100	
355	40	58	100	
250	60	44	100	
180	80	28	100	
125	115	16	98	
90	170	10	93	

Physical and Chemical Properties			
UI Product Name	Sodium Persulfate NPS	Potassium Persulfate KPS	
Chemical Name	Sodium peroxodisulfate	Potassium peroxodisulfate	
Chemical Formula	Na ₂ S ₂ O ₈	K ₂ S ₂ O ₈	
Molecular Weight [g/mol]	238.1	270.1	
Enthalpy Change of Solution [kJ/mol]	40.9	79.1	
Crystal Density [g/cm ³]	2.48	2.59	
Color	white	white	
Odor	odorless	odorless	

¹ Typical results of light scattering test. Data applies for material from our Pullach site.



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