Determination of absorption capacity of chemicals by SORB®XT

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Client	SORB®XT – Allegro Capital, Logistics, Services & More GmbH Mr. Thorsten Narawitz Klosterhofweg 64 41199 Mönchengladbach
Contractor	ifn Forschungs- und Technologiezentrum GmbH Dr.-Bergius-Straße 19 06729 Elsteraue Tel. 03441/53 88 45 Fax 03441/53 88 40 e-Mail: info@ifn-ftz.de website: www.ifn-ftz.de
Project editor	Dr. rer. nat. Peter Hahn
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Dipl.-Chem. Thomas Glaubauf
CEO

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Project Manager
Dr. rer. nat. Peter Hahn

Task

The aim was to determine the absorption capacity and the absorption time of chemicals by the absorbent material SORB®XT.

Experimental procedure

The tests on the absorption capacity of SORB®XT was carried out in accordance with the regulations of the DWA-A 716-9 worksheet using the Westinghouse method. The test set-up comprises a sieve into which the absorber material was placed in a defined quantity. The loaded sieve was then immersed in the substance to be investigated without bubbles and left for 20 minutes. After saturation of the absorbent material SORB®XT, the sieve was carefully pulled out and allowed to drip off for 30 minutes. Finally, a weighing was carried out. The difference between the weight of the sieve, the dry amount of absorbent material used and the final weight (sieve, Sorb®XT and absorbed chemical) was used to determine the absorption capacity of SORB®XT towards selected chemicals. Three measurements were carried out per chemical. Due to the low density - and the associated large volume of SORB®XT - the tests were each carried out with approx. 4g - 5g of the material.

Evaluation

substance	m SORB®XT [g]	m (absorbed substance) [g]	absorbed substance per g SORB®XT [g]	Ø absorbed amount per g SORB®XT [g]
iso-Propanol	4,12	13,23	3,21	3,04
	4,48	13,47	3,01	
	4,84	14,01	2,89	
Hexane	4,24	9,94	2,34	2,37
	4,03	9,91	2,46	
	4,40	10,21	2,32	
Chlorobenzene	4,13	15,89	3,85	4,07
	4,02	17,06	4,24	
	4,33	17,86	4,12	
Acetonitril	4,14	11,99	2,90	3,10
	4,62	13,30	2,88	
	4,75	16,70	3,52	
Acetone	4,51	12,61	2,80	2,97
	4,11	12,53	3,05	
	4,40	13,45	3,06	
Butanol	4,08	14,51	3,56	3,10
	4,53	12,83	2,83	
	4,82	14,01	2,91	
Dichlormethane	4,53	17,42	3,85	3,79
	4,06	15,70	3,87	
	4,23	15,50	3,66	
Chloroform	4,84	19,11	3,95	3,94
	4,66	18,83	4,04	
	4,84	18,47	3,82	
Ethanol	4,39	11,63	2,65	3,07
	4,08	11,99	2,94	
	4,46	16,12	3,61	

substance	m SORB®XT [g]	m (absorbed substance) [g]	absorbed substance per g SORB®XT [g]	Ø absorbed amount per g SORB®XT [g]
Acetic acid 96 %	4,06	15,68	3,86	3,92
	4,09	16,56	4,05	
	4,08	15,76	3,86	
Butyric acid	4,72	15,70	3,33	3,64
	4,14	16,27	3,93	
	4,71	17,32	3,68	
Vinylacetat	4,12	13,22	3,21	3,51
	4,03	13,96	3,46	
	4,14	16,00	3,86	
Toluol-2,4-diisocyanat	4,50	23,00	5,11	5,37
	4,28	24,24	5,66	
	4,30	22,92	5,33	
Polyol (1,3-Propandiol)	4,27	19,38	4,54	4,72
	4,11	20,36	4,95	
	4,08	19,05	4,67	
Phenolsolution (Acetone, 50 g/l)	4,03	11,35	2,82	3,01
	4,15	11,90	2,87	
	4,13	13,79	3,34	
Methylphenol	4,40	16,79	3,82	4,06
	3,99	16,62	4,17	
	4,00	16,78	4,20	
Tetrahydro-thiophene	4,25	14,12	3,32	3,49
	4,18	14,77	3,53	
	4,40	15,95	3,63	
Acrylic acid	4,22	14,22	3,37	3,65
	4,30	16,33	3,80	
	4,25	16,06	3,78	

All organic chemicals or solvents that were tested are bound by SORB®XT. The absorption capacity is between 2.37 (hexane) and 5.37 (toluene-2,4-diisocyanate) grams per gram of SORB®XT.

For the determination of the absorption capacity of water-based chemicals, the absorbent material SORB®XT had to be lightly incorporated into the substance to be tested in order to avoid floating or only superficial wetting. The following table shows the minimum values of the absorption capacity of SORB®XT for aqueous chemicals determined in this way.

substance	m SORB®XT [g]	m (absorbed substance) [g]	absorbed substance per g SORB®XT [g]	Ø absorbed amount per g SORB®XT [g]
Sodium hydroxide solution 5 %	4,38	32,81	7,49	7,39
	4,04	32,81	8,12	
	4,51	29,51	6,54	
Sodium hydroxide solution 15 %	4,21	27,29	6,48	6,78
	4,23	28,14	6,65	
	4,14	29,87	7,21	
Ammonia water 5 %	4,44	27,95	6,30	5,89
	4,52	30,27	6,70	
	4,15	19,38	4,67	
Ammonia water 15 %	4,49	27,83	6,20	6,46
	4,73	34,20	7,23	
	4,09	24,40	5,97	
Hydrogen peroxide solution	4,01	11,88	2,96	2,77
	4,22	8,59	2,04	
	4,12	13,65	3,31	
Lead acetate solution 10 %	4,40	6,58	1,50	1,32
	4,06	5,14	1,27	
	4,18	5,03	1,20	
Sulfuric acid 30 %	4,64	13,68	2,95	3,42
	4,36	18,55	4,25	
	4,20	12,91	3,07	
Sulfuric acid 10 %	4,21	9,88	2,35	2,20
	4,27	7,22	1,69	
	4,33	11,07	2,56	
Hydrochloric acid 37 %	4,22	26,04	6,17	6,32
	4,19	23,42	5,59	
	4,37	29,19	6,68	
Hydrochloric acid 18,5 %	4,02	20,02	4,98	4,40
	4,18	16,49	3,94	
	4,14	17,65	4,26	
Nitric acid 53 %	4,36	35,63	8,17	8,20
	4,47	34,99	7,83	
	4,21	36,17	8,59	
Phosphoric acid 85 %	4,31	25,65	5,95	6,53
	4,37	29,30	6,70	
	4,18	28,96	6,93	
Hydrofluoric acid 40 %	2,02	12,01	5,95	5,46
	2,08	10,29	4,95	
	1,95	10,72	5,50	

Due to the poorer miscibility of water-based chemicals with SORB®XT, the average values determined here for the absorbed amount of chemical per gram of absorber material are to be understood as a minimum amount. It was very difficult to achieve a homogeneous distribution of SORB®XT in the water-based chemicals in the test set-up used, so that some areas of the material used were not wetted with the chemicals. For an application of SORB®XT to absorb the chemicals from surfaces, a better mixing of both is easier to realise (for example by sweeping).

During the absorption tests of SORB®XT with nitric acid (53 %) or phosphoric acid (85 %), a change in the starting material occurred, so that a chemical reaction between the absorber material and the acids cannot be excluded. After the absorption tests with nitric or phosphoric acid, the loaded SORB®XT is present as an easily deformable, cohesive mass with a very dark colour. In absorption tests with the other chemicals tested, the saturated absorbent material shows a (lighter) brown colouring and a friable, brittle habit.

Due to the acute toxicity as well as the difficult handling of hydrofluoric acid (40 %), the tests were carried out with approx. 2 grams of SORB®XT in PE vessels.

Determination of the absorption time of chemicals

An exact determination of the absorption time is not possible experimentally. As soon as the absorber material comes into contact with the chemicals, absorption of the chemicals occurs. The absorption time associated with this is fractions of a second. A complete absorption of the chemicals depends exclusively on the quantity ratio of SORB®XT to absorbing substance. This behaviour can be clearly seen in the attached videos. If an excess of absorbent material SORB®XT meets chemicals, they are completely bound within a few seconds. In the experiments carried out for this purpose, all chemicals were absorbed after a short rearrangement of the SORB®XT. The total time for this process was about 10 seconds.