

TÜV Pfalz Test Report Green Stuff® Absorbent Concentrate



Universal Binding Agent

Green Stuff® is characterized by its huge absorption capacity and the particularly fast absorbing performance. It is very well suited for being used when pasty substances such as paints, resins, varnishes or adhesives leak onto industrial surfaces or factory floors. Thanks to its low weight and the residual content of ashes of 0,2 % , the disposal costs are also kept down.

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Technical Report

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on examinations to determine the compatibility
and absorbing performance of binding agents

Executed on behalf of
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by
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Environmental Protection

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Date: 19th November 1998
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1 CONTENTS OF INSTRUCTIONS

1.1 The Technische Überwachungs-Verein Pfalz e. V., Kaiserslautern, was instructed by Mr. Schwientek from Green Stuff Absorbent, Grünstadt in his letter dated 12 / 11 / 1996 and over telephone on 16 / 11 / 1998 to carry out examinations on binding agents. The instructions included the following examinations:

- a) Examinations to ascertain the compatibility / chemical tolerance of "Green Stuff" binding agent with 60 liquid chemicals and preparations which are usually available on the market.
- b) Comparative examinations to ascertain the absorbing performance of the five following binding agents:
 - Green Stuff
 - Sawdust
 - Mineral binder type I (calcium hydrosilicate)
 - Mineral binder type II (calcined diatom product)
 - Polyurethane granulate

The examinations were carried out using the five substances specified below:

- Alkyd resin / diluting agent
- Fuel oil EL
- Soda lye (33 %)
- Battery acid (sulphuric acid 37 %)

- c) Comparative examinations to ascertain absorbing speed:

The examinations were effected using Xylene as a solvent with the five binding agents specified in item 1.2.

- d) Examination of the calorific value and ash content of Green Stuff binding agent.

1.2 In the course of the year 1998, the original product “Green Stuff” was subjected to modifications to increase its absorbing performance. In the process it was managed to shift the pH value in the eluate of the binding agent to a slightly acidically range. Yet the basic chemical composition remained unaffected.

In order to characterise this new product (“Green Stuff MG”), additional tests for determining the absorbing performance and the pH value in the eluate were carried out. As a result, the submitted report is based on our initial report US / 96/4/0539/01 and was supplemented by the results of the recently implemented tests (chapter 3.2 and 3.6).

Since the chemical structure of the binding agent was not subjected to any relevant changes, especially the results from chapter 3.1 (compatibility / chemical tolerance) may be easily transferred to the modified binding agent.

2 EXECUTION OF EXAMINATIONS

2.1 Determination of the compatibility / chemical tolerance of Green Stuff binding agent

The substance to be assessed (approx. 20 ml) and the weighed-in binding agent "Green Stuff" were mixed at a volume ratio of 20 : 1, homogenised for two hours in an ultrasonic bath and left to stand at room temperature for 24 hours. Subsequently, the mixture was filtered. The resulting residue of the binding agent was washed, dried and weighed back. The residual share of the binding agent was specified in weight percent. Furthermore, notes were made about unusual incidents (development of gas, decomposition, discolouration, etc.).

2.2 Determination of absorbing performance

The examinations were carried out following the test standard "Requirements to oil binding agents, state as of: 28 / 02 / 1990, announcement of BMU dated 12 / 03 / 1990 – WA 13 – 20374 / 18".

For determining the absorbing performance, reference was made to the test of type III oil binding agents ("Oil binding agents for special industrial incidents, in particular in trade and industry") according to section 4.5 of the above-mentioned test standard.

The experimental set-up from interconnected containers has been designed for highly viscous media (oil) and, as a result, could not be used in the arrangement described in this standard.

The following method was chosen:

- Approx. 25 mg of binding agent was put in a separating funnel fitted with an insert made of quartz wool.
- A layer of 0.5 litre of the substance to be examined was added to binding agent.
- The mixture was allowed to react for two hours.
- The substance to be examined was discharged until reaching the volume constancy (max. 24 h).
- The amount of the absorbed substance was determined from the difference between the absorbed and the discharged volume.

The absorbing performance of the product was also ascertained in the system "alkyd resin (blue) / diluting agent". On the basis of the very high viscosity the described method could not be applied. As a result, alkyd resin / diluting agent was added to a prepared amount of binding agent and stirred until the absorbing power of the binding agent was exhausted.

2.3 Experiments to ascertain pourability

In various viscous oils, paints, and sewage sludges we tested both their compatibility and ascertained the amount of binding agent necessary to maintain the pouring characteristics of the substance absorbed.

For that, Green Stuff binding agent was added to the substance placed in a container until the mass thus generated was dry and able to be poured.

2.4 Comparative experiments to ascertain the absorbing speed

The experimental set-up consist of the two interconnected containers A and B. Xylene was put into the vertically movable container A (with a capacity of 100 ml) and then shifted so that the Xylene level in container B (with a diameter of 6.5 cm) just covered the lower calibration mark E_u . Subsequently, half of container B was filled with approx. 200 ml of binding agent (calibration mark E_u). The amount of liquid absorbed by the binding agent (reading off the scale graduations on container A) was ascertained after five, ten, and thirty minutes after adding the respective binding agent.

Sketch of the experimental set-up (schematic)

Gefäß B (Bindemittel) – container B (binding agent)

Flüssigkeitsspiegel Xylol vor Aufgabe des Bindemittels – liquid level of xylene bevor adding the binding agent

Gefäß A (Xylol) – container A (xylene)

Verbindung Gefäß A / B – connection of container A / B

2.5 Determining the calorific value and ash content

Calorific value: in accordance with DIN 51900

Ash content: in accordance with DIN 51719

2.6 Determining the pH value in the eluate

Method: DEV C 5 (slightly modified according to specification of Green Stuff)

3 RESULTS

3.1 Compatibility / chemical tolerance

Applied binding agent: "Green Stuff"

Substance group 1: Aliphatic hydrocarbons

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|-------------|------------------------------|------------|
| Hexane | >99 % | 99.4 % | no reaction | yes | 3.3b |
| Cyclohexane? | >99 % | 99.9 % | no reaction | yes | 3.3b |
| Cyclohexene? | >99 % | 99.9 % | no reaction | yes | 3.3b |
| 2-methyl-pentane | >99 % | 100 % | no reaction | yes | 3.3b |

Substance group 2: Aromatic hydrocarbons

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|--------------------------------|------------------------------|------------|
| Xylene | >99 % | 100 % | Remaining solution light green | yes | 3.31c |
| Toluene | >99 % | 100 % | no reaction | yes | 3.3b |
| Aniline | >99 % | 100 % | Remaining solution brownish | yes | 6.1, 12b |

Substance group 3: Alcohols

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|--------------------------------|------------------------------|--------------------------|
| Ethanol | >98 % | 92.8 % | Remaining solution light green | yes | 3.3b |
| Isopropanol | >99 % | 96.5 % | Remaining solution light green | yes | 3.3b |
| Ethylene glycol | >99 % | 100 % | Remaining solution brownish | yes | no information available |

Substance group 4: ?Catones / aldehydes

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|-----------------------|---------------|--------------------------|--------------------------------|------------------------------|--------------------------|
| Formaldehyde | >36 % | 96.9 % | intense gas evolution | yes | 8.63c |
| Acetaldehyde | >99 % | 100 % | Remaining solution light green | yes | 3.1a |
| Benzaldehyde | >99 % | 95.8 % | no reaction | yes | no information available |
| Acetone | >99 % | 95.8 % | Remaining solution dark green | yes | 3.3b |
| Methyl ethyl ketone | > 99 % | 99.3 % | Remaining solution dark green | yes | 3.3b |
| Methylisobutyl-cetone | >99 % | 99.3 % | no reaction | yes | 3.3b |

Substance group 5: Ester / ether

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|--------------------------------|------------------------------|------------|
| Ethyl acetate | > 99 % | 96.5 % | no reaction | yes | 3.3b |
| Diethyl ether | >99 % | 98.2 % | no reaction | yes | 3.2 a |
| ?2-butoxy ethanol | >99 % | 98.5 % | Remaining solution light green | yes | 6.1, 14c |
| n-butyl acetate? | >99 % | 98.5 % | Remaining solution light green | yes | 3.31c |
| Methyl acetate | > 99 % | 98.8 % | no reaction | yes | 3.3b |

Substance group 6: Solvents usual in commercial practice

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|-------------------------------|------------------------------|--------------------------|
| Dimethyl-sulfoxide | >99 % | 100 % | no reaction | yes | no information available |
| Tetrahydro-furane | >99 % | 99.7 % | no reaction | yes | 3.3b |
| Pyridine | >99 % | 100 % | Remaining solution dark green | yes | 3.3b |
| Dioxan | >99 % | 98.3 % | Remaining solution turquoise | yes | 3.3b |

Substance group 7: Chlorinated hydrocarbons

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|----------------------|---------------|--------------------------|--------------------------|------------------------------|------------|
| Carbon tetrachloride | > 99 % | 99.7 % | no reaction | yes | 6.1, 15b |
| Tetrachloro-ethylen | >99 % | 99.8 % | no reaction | yes | 6.1, 15c |
| Chloroform | >99 % | 99.7 % | no reaction | yes | 6.1, 15c |
| Methylene chloride | >99 % | 100 % | binding agent springs up | yes | 6.1, 15c |

Substance group 8: Organic acids

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|--------------------------|---------------|--------------------------|---------------------------------------|------------------------------|------------|
| Formic acid | > 99 % | 91.4 % | slight decomposition of binding agent | no | 8.32b |
| Ethanoic acid | >99 % | 96.7 % | remaining solution slightly cloudy | yes | 8.32b |
| Trichloro-ethanoic acid? | 30 % | 96.4 % | remaining solution green | yes | 8.31b |
| Propionic acid | >99 % | 99.2 % | remaining solution green | yes | 8.32c |

Substance group 9: Consumable substances? usual in commercial practice

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|-----------------------|--------------------------|--------------------------|-----------------------------|------------------------------|------------|
| Engine oil | >99 % | 100 % | no reaction | yes | - |
| Remover | no information available | without back weighing | no reaction | yes | - |
| Fuel (petrol) | >99 % | 99.6 % | no reaction | yes | 3.3b |
| Diesel fuel | >99 % | 100 % | no reaction | yes | 3.31c |
| Antifreeze | no information available | 98.6 % | no reaction | yes | - |
| Rust remover | no information available | 100 % | remaining solution green | yes | - |
| Developer | sodium thiosulfate 10 % | 98.9 % | remaining solution green | yes | - |
| Accumulator acid | sulphuric acid 37 % | 97.3 % | no reaction | yes | 8.1b |
| Brake fluid | no information available | 100 % | remaining solution brownish | yes | - |
| Engine cleaning agent | no information available | 99.2 % | remaining solution cloudy | yes | - |

Substance group 10: Inorganic acids

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|-------------------------------|----------------------|--------------------------|--|------------------------------|------------|
| Hydrochloric acid | 30 % | without back weighing | binding agent springs up | yes | 8.5b |
| Fuming sulphuric acid (oleum) | 65 % SO ₃ | without back weighing | binding agent decomposes immediately, intense gas evolution | no | 8.1a |
| Sulphuric acid | 98 % | without back weighing | binding agent strongly attacked | no | 8.1b |
| Nitric acid | 65 % | without back weighing | binding agent decomposed, intense evolution of nitrous fumes | no | 8.2b |
| Hydrofluoric acid | 40 % | without back weighing | binding agent is decomposed | no | 8.7b |
| Phosphoric acid | 85 % | 100 % | remaining solution yellowish | yes | 8.17c |
| Perchloric acid | 70 % | without back weighing | binding agent attacked, gas evolution | no | 5.1, 3a |

Substance group 11: Lye

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|-------------------------|---------------|--------------------------|---------------------------------|-------------------------------|------------|
| Soda lye | 33 % | without back weighing | binding agent springs up | yes | 8.42b |
| Caustic potash solution | 35 % | without back weighing | binding agent springs up | yes | 8.42b |
| Ammonia | 25 % | without back weighing | binding agent slightly attacked | to be examined in single case | 8.43c |

Substance group 12: Special compounds

| Individual substance | Concentration | Residue of binding agent | Note | Suitability of binding agent | GGVS class |
|-------------------------|---------------|--------------------------|-----------------------------|-------------------------------|--------------------------|
| Hydrogen peroxide | 30 % | 100 % | remaining solution greenish | to be examined in single case | 5.1, 1b |
| Di-tert-butyl peroxide? | >99 % | 98.7 % | no reaction | yes | 5.2, 7b |
| Diethyl methylamine? | >99 % | 100 % | no reaction | yes | no information available |
| Amyl nitrite | > 99 % | 100 % | solution yellow-green | yes | 3, 3b |
| Sodium nitrite | 30 % | 100 % | binding agent springs up | yes | 5.1, 23c |
| Propionitrite? | > 99 % | 100 % | solution light green | yes | 3, 11b |

3.2 Determination of absorbing rates?

Applied binding agents: “Green Stuff MG”

3.2.1 Results related to one kg of absorbed substance per kg of binding agent [kg/kg]

| Substance | Binding agent | | | | |
|--|----------------|---------|------------------------|-------------------------|------------------------|
| | Green Stuff MG | Sawdust | Mineral binder type I* | Mineral binder type II* | Polyurethane granulate |
| Alkyd resin (blue) / diluting agent | 4.0 *** | 2.2 | 0.7 | 0.6 | 0.8 |
| Fuel oil EL | 8.4 | 1.6 | 0.8 | 1.0 | 0.8 |
| Soda lye 33 % | 14.0 | 4.2 | 2.2 | 2.4 | 1.1 |
| Xylene | 9.1 | 1.8 | 1.0 | 1.0 | 0.7 |
| Sulphuric acid 37 % (accumulator acid) | 9.7 | 6.6 | 1.6 | 1.4 | 2.3 |

*Mineral binder type I: calcium hydrosilicate

Mineral binder type II: calcined diatom product

** See note in chapter 2.2

*** System no longer reproducible, information taken from original binding agent “Green Stuff”

3.2.2 Results related to one litre of absorbed substance per litre of binding agent [l/l]*

| Substance | Binding agent | | | | |
|--|----------------|---------|------------------------|--------------------------|------------------------|
| | Green Stuff MG | Sawdust | Mineral binder type I* | Mineral binder type II** | Polyurethane granulate |
| Alkyd resin (blue) / diluting agent | 0.4 *** | 0.4 | 0.2 | 0.3 | 0.3 |
| Fuel oil EL | 1.2 | 0.3 | 0.4 | 0.6 | 0.4 |
| Soda lye 33 % | 1.2 | 0.6 | 0.6 | 0.9 | 0.3 |
| Xylene | 1.3 | 0.4 | 0.5 | 0.6 | 0.3 |
| Sulphuric acid 37 % (accumulator acid) | 0.9 | 0.9 | 0.5 | 0.6 | 0.8 |

*Calculated using the results in table 3.2.1 including apparent densities of binding agents and specified weights of applied substance, not ascertained separately.

Apparent densities:

| | |
|------------------------|-------------|
| Green Stuff | 0.12 kg / l |
| Sawdust | 0.18 kg / l |
| Mineral binder type I | 0.40 kg / l |
| Mineral binder type II | 0.51 kg / l |
| Polyurethane granulate | 0.43 kg / l |

**Mineral binder type I: calcium hydrosilicate

Mineral binder type II: calcined diatom product

*** System no longer reproducible, information taken from original binding agent “Green Stuff”

3.2 Experiments for determining the pouring characteristics (oils, varnishes / enamels, sludges)

Applied binding agents: "Green Stuff"
Final state: dry mixture capable of being poured

Data specified in kg of absorbed substance per kg of binding agent "Green Stuff"

| Individual substance | Concentration in % | Note | Pouring consistence |
|----------------------|--------------------------|-------------|---------------------|
| Sewage sludge no. 1 | 22.5 % H ₂ O | no reaction | 6.7 |
| Sewage sludge no. 2 | <20 % H ₂ O | no reaction | 10.0 |
| Paint V1 | no information available | no reaction | 5.0 |
| Paint V9 | no information available | no reaction | 4.8 |
| Bee's wax varnish | no information available | no reaction | 3.3 |
| Fuel oil | >99 % | no reaction | 3.1 |

3.3 Determining the absorbing rate

Applied binding agent: "Green Stuff"

The specified amounts of xylene include those which were absorbed by the respective binding agent after five, ten, and thirty minutes (under the marginal conditions described in chapter 2.4).

| Substance | Binding agent | | |
|---|---------------|------------|------------|
| | 5 minutes | 10 minutes | 30 minutes |
| Green Stuff | 24 ml | 28 ml | 34 ml |
| Sawdust | 12 ml | 17 ml | 21 ml |
| Mineral binding agent type I (calcium hydrosilicate) | 6 ml | 7 ml | 10 ml |
| Mineral binding agent type II (calcined diatom product) | 10ml | 12 ml | 17 ml |
| Polyurethane granulate | 8 ml | 10 ml | 12 ml |

3.4 Calorific value and ash content

Applied binding agent: "Green Stuff"

3.5.1 Calorific value

Calorific value H_u = 20.28 MJ/kg (water contents of sample: 9.7 %)

3.5.2 Ash content

Ash content = 0.2 %

3.5 pH value in eluate

Applied binding agent: "Green Stuff MG"

pH value / eluate: 5.68

4 BRIEF ASSESSMENT CONCERNING THE DETERMINATION OF COMPATIBILITY / CHEMICAL TOLERANCE

The above-specified examinations on the binding agent Green Stuff were carried out on approx. 60 liquid chemicals and preparations which are usually available in commerce.

This selection is not necessarily applicable to all handled substances and mixtures. The statements made below, therefore, refer to the examined substances with the specified concentrations.

The examined aliphatic and aromatic hydrocarbons, alcohols, ?cetone /aldehydes (with the exception of formaldehyde), ester / ether, solvents usual in commercial practice, chlorinated hydrocarbons, organic acids (with the exception of formic acid), consumable substances? usual in commercial practice, diluted ($\leq 30\%$ - 40%) inorganic acids (with the exception of hydrofluoric acid), lyes (with the exception of ammonia) in addition to special compounds proved to be unproblematic. Although the binding agent sprung up and / or the remaining solution changed in colour (without significant loss of binding agent) once in a while, the usability of the binding agent was not restricted in the event.

The binding agent was definitively attacked and / or decomposed (partly with intense gas evolution) by the substances specified below.

As a result, the binding agent cannot be used in combination with these substances (substance groups, respectively):

- Formaldehyde (36 %)
- Formic acid (99 %)
- Oleum (fuming sulphuric acid 65 %)
- Sulphuric acid (98 %)
- Nitric acid (65 %)
- Hydrofluoric acid (40 %)
- Perchloric acid (70 %)
- Ammonia (25 %), yet with only weak reactions to be observed.

Unexpectedly, the examined organic peroxide (di-tert-butyl-peroxide?) reacted neutrally. However, this will surely not apply to all compounds belonging to this class. The same applies for strong solutions of hydrogen peroxide.

Therefore, it is not recommended to use Green Stuff in combination with strong oxidants, reductives, chemically unstable substances and strong mineral acids.

Kaiserslautern, 19th November 1998
US/Dr. Ka/kie

Special unit for engineering chemistry
The expert:
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[Stamp: TÜV Pfalz]



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