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## LASTFIRE Firefighting Foam Summit

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### Treatment of PFAS Contaminated Firefighting Waters

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### Research Projects on Optimal Treatment of PFAS Contaminated Groundwater

- In cooperation with **Fraunhofer Research Institute UMSICHT** and within the scope of the **German Federal Ministry of Economic** sponsored R&D projects, Cornelsen has developed „cost-optimized“ processes for the purification of PFAS-contaminated waters“.
- In cooperation with the **AAV Association for the Brownfield Recycling and Remediation** and within the scope of semi-technical trials, Cornelsen is testing the PFAS-purification of groundwaters.

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### Completed and Ongoing Scientific Studies on the Treatment of PFAS Contaminated Fire Extinguishing Waters

- In cooperation with Cornelsen, the **BP Fire Brigade** (Mr. M. Neuhaus & Mr. A. Terbeck, BP Refinery Gelsenkirchen/Germany) carried out scientific studies for the treatment of fire fighting water (2016)
- In cooperation with the **Fraunhofer Research Institute UMSICHT** and with funding from the **German Federal Ministry of Education and Research**, Cornelsen carries out scientific studies on the cost-optimized and ecologically compatible treatment of PFAS contaminated fire extinguishing water (2016-2018)

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### Completed and Ongoing Scientific Studies on the Treatment of PFAS Contaminated Fire Extinguishing Waters

Implementation of Fire Test with Crude Oil

Crude Oil contaminated Extinguishing Water Residue

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### Completed and Ongoing Scientific Studies on the Treatment of PFAS Contaminated Fire Extinguishing Waters

Amount of activated carbon used (g/L)	Elimination rate with pretreatment (%)	Elimination rate without pretreatment (%)
0.2	99.2	98.8
0.3	99.5	98.9
0.4	99.6	99.0
0.5	99.8	99.1
0.6	99.9	99.2

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### Disposal of PFAS Contaminated Firefighting Water (1)

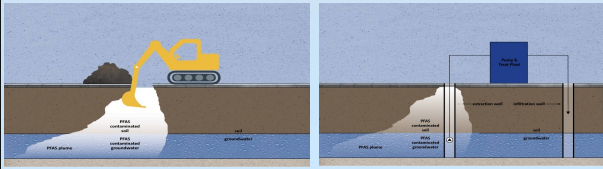
- Extinguishing water cannot be collected**
  - Infiltration of the firefighting water into the ground and possibly also into the groundwater

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### Disposal of PFAS Contaminated Firefighting Water (1)

- **Extinguishing water cannot be collected**
  - Consequence: excavation of the soil with subsequent disposal at an landfill + many years of remediation of groundwater contaminated with PFAS using pump and treatment methods



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### Disposal of PFAS Contaminated Firefighting Water (2)

- **Discharge of the extinguishing water into the sewer system and from there into the biological wastewater treatment plant**
  - German wastewater treatment plants normally only have biological treatment steps.
  - Note: Harmful PFAS substances are not biodegradable !
  - Biological treatment stages are absolutely ineffective.

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### Disposal of PFAS Contaminated Firefighting Water (3)

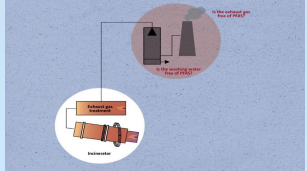
- **Transportation of the collected firefighting water by silo vehicles to „Off-Site-Water-Treatment-Plants“**
  - In Germany, such systems usually consist only a physical treatment, i. e. a neutralisation stage.
  - There are also no process steps for PFAS removal.

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### Disposal of PFAS Contaminated Firefighting Water (4)

- **Combustion of water in conventional incinerators (approx. 850 °C) or in high-temperature incinerators (>1,100 °C)**
  - Note: scientific studies show that a complete and residue-free destruction of PFAS is only possible above 1,100 °C.



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### Disposal of PFAS Contaminated Firefighting Water (5)

- **Firefighting water treatment with activated carbon systems (GAC) at the fire site**
  - PFAS are extremely poorly adsorbed on activated carbon. Especially if the water also has a high organic load.
  - When using activated carbon, therefore there is a risk that the treatment targets will not be achieved.
  - Extremely large amounts of activated carbon are required, which leads to high treatment costs.

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### Disposal of PFAS Contaminated Firefighting Water (5)



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### Disposal of PFAS Contaminated Firefighting Water (6)

- **Treatment of firefighting water at the fire site using PerfluorAd process from Cornelsen**
  - Water purification technology specialized on PFAS.
  - High efficiency and safety in achieving target values.
  - Low quantities of active ingredients and therefore optimized operating costs.
  - PerfluorAd active ingredient is biodegradable.
  - Activated carbon is used only for post-treatment; the required amount of activated carbon is significantly reduced.

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### PerfluorAd Process for the Optimised Treatment of PFAS Contaminated Waters

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### PerfluorAd Process for the Optimised Treatment of PFAS Contaminated Waters

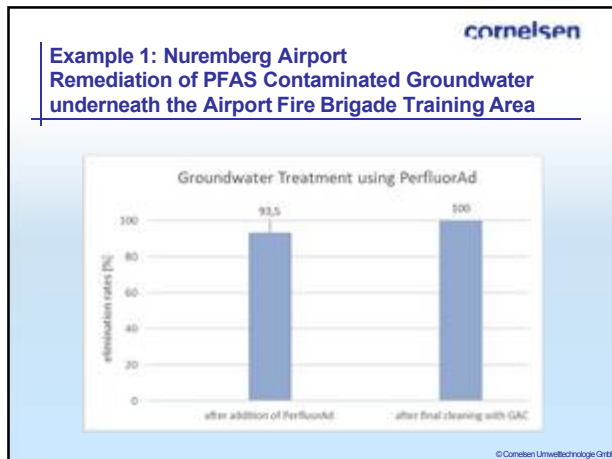
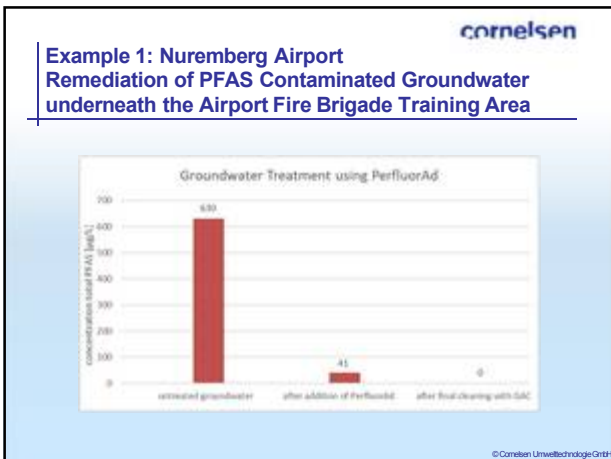
Conventional Activated Carbon (GAC) Plant
Activated Carbon Plant (GAC) with PerfluorAd Pretreatment Stage

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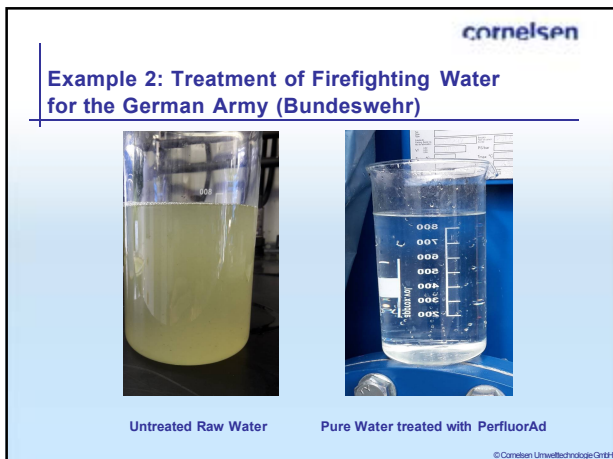
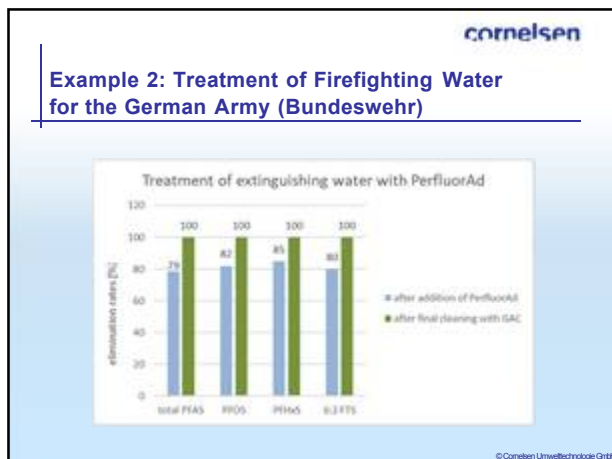
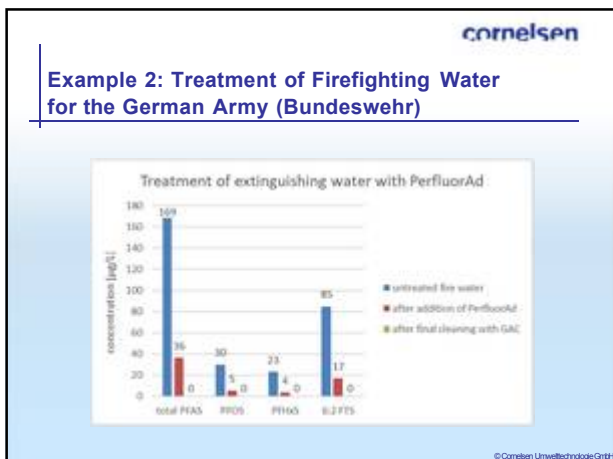
### Example 1: Nuremberg Airport Remediation of PFAS Contaminated Groundwater underneath the Airport Fire Brigade Training Area

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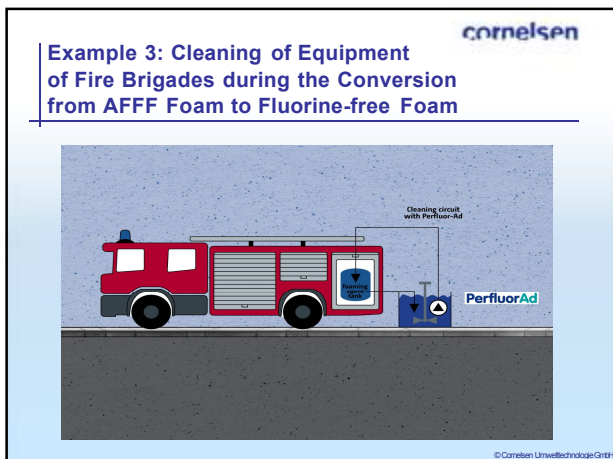


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- Example 1: Nuremberg Airport  
Remediation of PFAS Contaminated Groundwater  
underneath the Airport Fire Brigade Training Area**
- Reduction of raw water load by 589 µg total PFAS/L (elimination rate of 93.5%) only by adding the liquid active ingredient PerfluorAd.
  - This is equivalent to a PFAS-PerfluorAd ratio of **1.18%**. Achievable PFAS-Activated carbon ratios (means GAC loads) are generally to be found in the range between **0.01 up to max. 0.1%**.
  - The effective PerfluorAd treatment leads to a significant extension of the lifetime of the activated carbon filter and thus to a reduction in treatment costs.
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- ### Example 2: Treatment of Firefighting Water for the German Army (Bundeswehr)
- Further Treatment Results: besides the almost complete elimination of PFAS the extinguishing water sample after the application of PerfluorAd:
    - was decolorized
    - suspended particles were separated (by simultaneous flocculation)
    - foam formation was suppressed (through a significant lowering of the content of fluorinated as well as non-fluorinated surfactants)
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**Example 3: Cleaning of Equipment of Fire Brigades during the Conversion from AFFF Foam to Fluorine-free Foam**



PerfluorAd Cleaning Circuit with initial Foam Formation

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**Example 3: Cleaning of Equipment of Fire Brigades during the Conversion from AFFF Foam to Fluorine-free Foam**

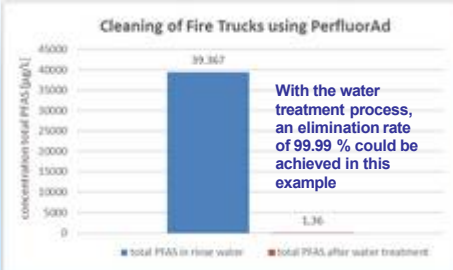


View into the AFFF Foaming Agent Tank after Cleaning with PerfluorAd

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**Example 3: Cleaning of Equipment of Fire Brigades during the Conversion from AFFF Foam to Fluorine-free Foam**



**Cleaning of Fire Trucks using PerfluorAd**

Measurement	Concentration total PFAS (µg/L)
total PFAS in rinse water	39.347
total PFAS after water treatment	1.36

With the water treatment process, an elimination rate of 99.99 % could be achieved in this example

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**Conclusion (1)**

- If PFAS contaminated firefighting water is not retained before entering the environment, it represents a burden on the environment and causes high costs by the elimination of environmental damage.
- Conventional water treatment systems, such as waste water treatment plants, off site treatment plants, activated carbon filters, as well as incinerators, are either not suitable to meet the strict target values, cause high costs and can also pollute the environment.

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**Conclusion (2)**

- Especially firefighting water contaminated with PFAS, which also has a high organic load, can hardly be cleaned with conventional activated carbon filters.
- On the other hand, firefighting water could be purified using the liquid active ingredient PerfluorAd.
- Even for extremely contaminated firefighting waters through the application of PerfluorAd **elimination rates up to 99%** were reached for quantifiable PFAS substances.

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**Conclusion (3)**

- The PerfluorAd liquid active substances are classified as biodegradable. The technology fulfills the principles of sustainability.
- The PerfluorAd technology does not represent a competition to the adsorption process, but rather should optimize its use.
- The technical equipment required for the PerfluorAd-technology is simple and robust.

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**Conclusion (4)**

- The use of PerfluorAd technology is particularly recommended for complex contaminated water with a high organic background load, high PFAS concentrations and demanding treatment targets, such as for
  - firefighting water,
  - cleaning and washing water (which may be produced during cleaning and servicing of fire engines),
  - contaminated groundwater, etc.

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**Conclusion (5)**

- The PerfluorAd technology is portable due to its container design and can therefore be quickly mobilized.
- The PerfluorAd technology is available at Cornelsen and can also be used as part of a full service package (i. e. incl. rent, operating engineers, delivery of active ingredients, disposal of residual materials, etc.)..
- Low yearly license fees ensure that potential users have access to the PerfluorAd technology as well as the use of mobile treatment plants.

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**Technical possibilities for the treatment of PFAS contaminated groundwater, extinguishing water etc.**

Mobile PerfluorAd Treatment Plant  
(Constructed in 20' Container)

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**Thank you for your attention !**

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