Reactivation of PFAS loaded spent GAC

from drinking water applications in Jacobi's german facility

1. Jacobi Premnitz site; Health and safety

Jacobi Carbons is on a journey to become the most sustainable carbon company in the world. Sustainability starts with safety. When working with spent activated carbon loaded with PFAS compounds, process security and the safety of plant personnel is our primary consideration. The Jacobi site at Premnitz in Germany, is accredited to ISO 9001, ISO14001 and ISO50001 (manufacturing process, Environment and energy). This site is certified to ISO45001. To have achieved this certification, the site must ensure that safe working procedures, good manufacturing practices and health management systems are in place. The Premnitz location is regularly audited by external assessors on the ISO accreditation standards that it has obtained.

The following paragraphs focus on the processing of PFAS loaded activated carbon:

2. Reactivation Procedure

Product acceptance and preparation

The spent carbon arrives in big bags or bulk trucks and is tested against the agreed acceptance criteria to ensure material handling is performed in accordance with the permit to operate. Upon acceptance the material is planned for reactivation in the kilns. Prior to processing the key reactivation parameters are agreed and these are used to define operating conditions.

Reactivation

The spent carbon is fed to the rotary kiln. The kiln is operates in a countercurrent direction, meaning the temperature in the kiln increases in the zones through which the material progresses from feed to discharge. The reactivated material produced is analysed for a range of parameters, such as physico-chemical properties, but also residual PFAS content and other contaminants. The reactivated material is then categorised depending on these characteristics. The product can be reused directly by the customer providing the spent material (ReSorb™ Solo) or moved to the carbon inventory (ReSorb™ Pool).

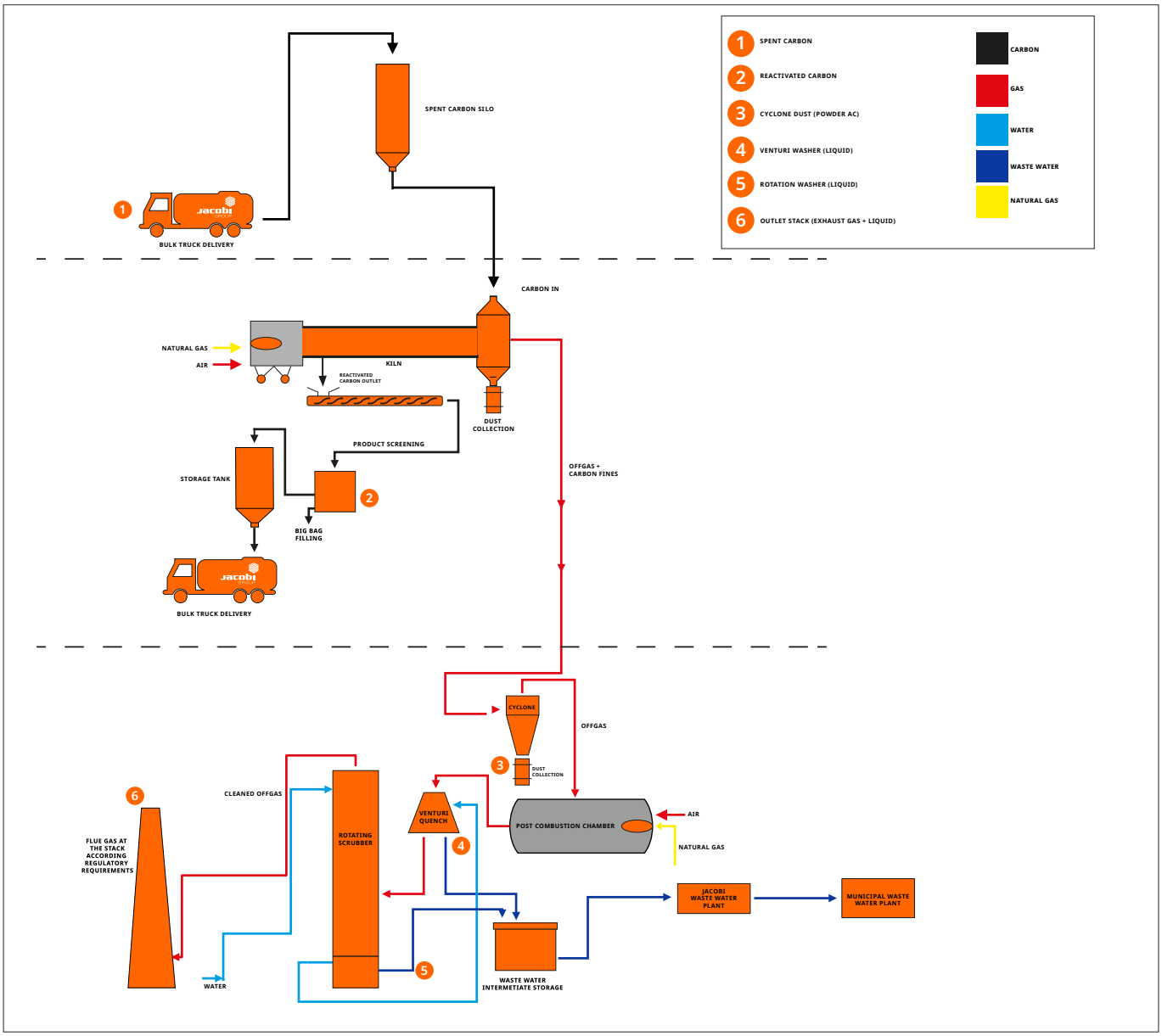
The high temperatures used during reactivation dissociate the PFAS molecule, liberating the inorganic part (mainly fluorine) and splitting the hydrocarbon portion into CO and H_2 that are then burned in the kiln as 'fuel'. Residual inorganics pass into the off-gas from the kiln.

Off-gas treatment, solid residue and waste water treatment

Dust generated from agitation of the spent product during reactivation is collected from the kiln in a cyclone. Although a relatively minor quantity of dust is generated (typically less than 1 % of the batch volume), it is collected and packed into steel drums. It is then consigned for destruction by incineration at a company licenced to handle this type of waste product.

Off-gasses from the reactivation kiln are burned at high temperatures in a post combustion chamber and then fed to a wet scrubber. Residual inorganic compounds (e.g. fluorine) are removed in the scrubber. The cleaned off gas is then discharged to atmosphere through an exhaust stack.

The rich scrubber liquid is treated in an on-site wastewater treatment system, before discharging to the municipal wastewater plant. Any water used to convey the spent activated carbon from the received packages or the feed silos is similarly sent to the on-site waste water treatment system.



3. PFAS reactivation tests and permit

To ensure safe and pollution-free PFAS reactivation, Jacobi committed to a strict and detailed approval process between March and June 2023. The approval is based on an independent reactivation test performed and controlled by TüV (operating under ISO certification DIN EN ISO/IEC 17025) Analysis of the triplicate samples recovered during the trial were performed by two independent certified laboratories.

The extensive and detailed test report was submitted to, and studied by the regional authorities. **Upon evaluation the authorities have granted Jacobi with a permit to reactivate PFAS loaded activated carbon.**

4. Test details

The tests were performed in March 2023, with a >4000 µg/kg loaded spent carbon returned from a drinking water site and a very highly loaded industrial carbon.

Sample points:

- Activated carbon:
- Spent carbon inlet
- Reactivated carbon
- Dust from the cyclone.
- Air stream:
- Gas from post combustion to scrubber
- Exhaust stack outlet
- Waste water: Scrubber outlet.

Test methods: carbon and liquid samples were taken every 30 minutes by TüV during the test period. Samples are taken in triplicate. Gas sampling was done via online monitoring devices.

PFAS analytics were performed on all samples. Direct analytics were employed when possible.

On the activated carbon measurements were undertaken after solvent extraction. Fluorine measurements were conducted at all sampling points to derive a mass balance ensuring all residuals are captured. Test methods used include:

- PFAS in solution: DIN 38407-42:2011 (HPLC-MS/MS); 32 substances (PFAS32); measured in external lab, TÜV Rheinland /TZW
- PFAS in activated carbon: proprietary lab test method for extraction (boiling in methanol) in combination with DIN 38407-42:2011; 32 substances (PFAS32); measured at TÜV Rheinland
- Total fluorine (AOF and inorganic fluorides): proprietary lab test method for use in combination with CIC (combustion ion chromatography); TÜV Rheinland and TZW
- AOF in solution: DIN EN ISO 10304-1:2009; measured in the external lab at TZW
- HF in gas stream: proprietary lab test method in accordance with DIN EN 1911:2010; measured at TÜV Rheinland
- PFAS and AOF in gas stream: DIN CEN/TS 13649*DIN SPEC 33969:2015 for adsorption and release and DIN 38407-42:2011 for analysis of PFAS and CIC for analysis of total fluorine; measured in external lab, TÜV Rheinland.

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