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Test report no. 134981: AEP54 adsorption capacity experiments
Your reference: Signed quotation 142698 / COLPRO 150/200 filter
Contact person: M. de Jonge

Date 11-10-2024
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Ref.no.: 142698

Dear Mr. Houda,

At the request of VzduchoTechnik s.r.o. (your reference signed quotation 142698 / COLPRO 150/200 filter) ProQares performed adsorption capacity experiments on an activated carbon sample according to AEP-54 (Ed. B, Ver. 1, 2014) NATO Standard for colpro (collective protection) in a CBRN (chemical, biological, radiological and nuclear) environment. The tests were performed between 26-07-2024 and 03-10-2024.

Samples

The details of the received samples are presented in Table 1.

Table 1: Received samples

Sample code ProQares	Description by customer*	Received
24PQA1820	Activated carbon (Pleisch) Product 30171-100; PL MC 12x20 C-CBRN; Lot 096079; code: 420240030	24-07-2024

Test Method

The adsorption capacity tests were performed according to AEP-54 following chemical agent vapour for single attack, combined with Toxic Industrial Chemical (TIC) challenge, as agreed with VzduchoTechnik. The detailed description of the test procedure is presented in Annex 1.

Results

The test results are presented in Table 2a and 2b. Note that the test results are only applicable to the received and tested materials, mentioned in Table 1 and do not necessarily hold for other samples of the same type. Table 2a shows the results of the "dry" condition Table 2b shows the results of the "wet" condition. In the tables is stated whether the carbon meets the essential level and/or desired level. The experiments are performed in duplicate (one dry and one wet, HCl and PCl₃ are tested in duplicate in dry condition).

It was agreed to continue until the breakthrough criterion is reached or up to 140% of the desired Ct level for single chemical vapour attack and the desired level for Toxic Industrial Chemicals. If breakthrough occurred and the critical Ct level in the effluent air is reached, it is displayed at what percentage of the required capacity, the Ct level is reached. So if it is reached between 100% and 140% of the required capacity, it would be stated "Pass". If it is reached before 100% of the required Ct level, it would state "Fail".

* ProQares is not responsible for the correct description of the received samples.

Table 2a: Test results "dry" condition

Component	Essential level	Desired level	Critical Ct level reached at (%) of desired Ct level
Sarin	Pass	Pass	>140
Soman	Pass	Pass	>140
Hydrogen cyanide	Pass	Pass	>140
Chloro cyanide	Pass	Pass	>140
Mustard gas	Pass	Pass	>140
Chloropicrin	Pass	Pass	>140
Bromine	Pass	Pass	>140
Chlorine	Pass	Pass	>140
Hydrogen chloride	Pass	Pass	>140
Hydrogen fluoride	Pass	Pass	>140
Hydrogen sulphide	Pass	Pass	>140
Phosgene	Pass	Pass	>140
Phosphorus trichloride	Pass	Pass	>140
Sulphur dioxide	Pass	Pass	>140

For all challenge agents the capacity of the carbon, tested in the "dry" condition meets the requirements for the essential and desired Ct level.

Table 2b: Test results "wet" condition

Component	Essential level	Desired level	Critical Ct level reached at (%) of desired Ct level
Sarin	Pass	Pass	>140
Soman	Pass	Pass	>140
Hydrogen cyanide	Pass	Pass	>140
Chloro cyanide	Pass	Pass	>140
Mustard gas	Pass	Pass	>140
Chloropicrin	Pass	Pass	>140
Bromine	Pass	Pass	>140
Chlorine	Pass	Pass	>140
Hydrogen chloride	N.A.	N.A.	N.A.
Hydrogen fluoride	Pass	Pass	>140
Hydrogen sulphide	Pass	Pass	>140
Phosgene	Pass	Pass	>140
Phosphorus trichloride	N.A.	N.A.	N.A.
Sulphur dioxide	Pass	Pass	>140

For all challenge agents the capacity of the carbon, tested in the "wet" condition meets the requirements for the essential and desired Ct level.

It should be noted that the accuracy has not been taken into account on the above values.

We trust all things are clear to you. In case of any questions, please do not hesitate to contact us.

Kind regards,



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ANNEX 1 DESCRIPTION OF TEST METHODS

The aim of the investigation was to establish whether the carbon, when used in a colpro filter, will meet the stated requirements for the list of chemical warfare agents (CWA) for a single chemical warfare agent attack and for the list of toxic industrial chemicals (TIC`s). The requirements with respect to the various adsorption tests are stated in document AEP 54: collective protection (colpro) in a chemical, biological, radiological and nuclear (CBRN) environment, Edition B, Version. 1 (2014). These requirements are classified as NATO-confidential. Therefore the actual requirements cannot be stated in this report. In general it can be stated that the AEP 54 prescribes tests with various components; the components should be adsorbed by the carbon at a given dose, expressed as a Ct-value (mg.min/m³). For each component, two Ct-values are stated, an essential Ct-value and a desired Ct-value. The essential Ct-value is the minimum value that must be adsorbed by the carbon. The desired levels are higher.

It was agreed with Vzduchotechnik to perform the experiments up to the point that a specific amount breaks through or when the challenge dose has reached the desired level without breakthrough plus at least 40%. In practice, this means that the experiments are performed by loading the carbon for a period of at least 50 minutes (some agents require different number of minutes) and continued until maximum of 70 minutes. The influent concentrations are calculated by dividing the desired Ct-levels by a factor of 50. Should breakthrough occur, then the Ct-value can be calculated to investigate whether the essential Ct-value is met.

The carbon will be used in a radial colpro filter, coded by Vzduchotechnik as COLPRO 150 / 200 filter. At ProQares it is impossible to perform experiments with toxic substances on complete filters. Therefore a model is made of the filter; the model has a diameter of 5.0 cm. In the model experiments the linear velocity of the air, the residence time of the air etc. are exactly the same as in the actual filter. This method is generally accepted within NATO. From the data of the filter, provided by Vzduchotechnik, the flow through the model was calculated. The results of this calculation are presented in Table 3. According to the specifications of Vzduchotechnik, it is a radial filter with a bed depth of 34 mm, the flow through the filter is 200 m³/h, dimensions of the filter are as follows: Outside diameter 458.5 mm; inside diameter 390.5 mm and height of 391 mm.

Table 3 calculation of the flows

Commercial name filter	Filter type	Flow through model (L/min)	Bed depth (mm)
COLPRO 150/200	Filter 200 m ³ /h	12.55	34

From several discussions within the NATO PPP panel, the carbon should be tested at the 2 extremes referred to in the document, the “wet” condition; in this condition the carbons had to be tested after equilibration with air of 23 °C and 80% RH. During the actual experiment, the conditions of the airflow are 23 °C and 80% RH as well. Also the “dry” condition is used for the experiments, which means that the carbon is tested as received, without any pre-conditioning and the conditions of the airflow are 23 °C and RH lower than 15%. Some agents cannot be tested at high RH, due to reaction with water; as well safety as incorrect measurement caused by low generation as result (HCl clusters together with water and causes condensation of HCl solution in the test-equipment; PCl₃ can form an explosive mixture together with water due to the extreme reactivity with water.