

TÜV Anlagentechnik GmbH
Regionalbereich Berlin

TÜV Rheinland/Berlin-Brandenburg
Magirusstraße 5
12103 Berlin

Tel.: +49 30 7562-0



Investigations concerning the performance capacity of the "NFP 2,0" or "NFP Premium" filter cartridge

produced by

CARBONIT Filtertechnik GmbH

Summary Evaluation / February 2003

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Client:	CARBONIT Filtertechnik GmbH Dorfstraße 24c 29416 Dambeck
Order date:	February 2002
Project management:	TÜV Rheinland/Berlin-Brandenburg Regionalbereich Berlin TÜV Anlagentechnik GmbH Magirusstraße 5 12103 Berlin
Project head:	Dipl.-Ing. Ralf Herrmann
Responsible official:	Dipl.-Met. André Förster
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1 Summary

CARBONIT Filtertechnik GmbH, Dorfstraße 24c, 29416 Dambeck, is a manufacturer of filter installations for the purification of waters obtained from a variety of sources. Within the framework of investigations accompanying product development, CARBONIT charged TÜV Anlagentechnik GmbH, Geschäftsfeld Druckgeräte und Werkstofftechnik, Magirusstraße 5, 12103 Berlin with the task of performing a summary evaluation of investigations already carried out from the point of view of the product characteristics contained in the manufacturer's descriptions.

In the case of the NFP 2,0" (later renamed "NFP Premium"), the product under consideration is a standard filter cartridge (activated carbon), which is built into corresponding filter holders and installed in parallel fashion with private service water pipelines in order to provide separately filtered drinking water.

Investigations have been commissioned and carried out within the framework of quality management measures accompanying product development (see Chapter 2.1) which characterize the effectiveness of the filter system in reference to selected microbiological, organic and inorganic retention capability. The goal of the investigations was to achieve sufficiently representative model approaches which would reproduce implementation in practice and existing pollution burdens.

In the year 2000, CARBONIT Filtertechnik altered the designation of the filter cartridge, changing it from "NFP 2,0" to "NFP Premium". The type of construction was not modified, which means that all of the expert appraisal certificates concerning the "NFP 2,0" filter cartridge can thus be transferred without limitation to the "NFP Premium" filter cartridge.

Result

The expert appraisal certificates considered in the context of this evaluation concerning 6 test series concerned with the "NFP 2,0" and/or "NFP Premium" filter cartridge can be characterized as follows:

- the experimental setups, the performances and the analyses, respectively, are each appropriate for confirming the statements contained in the product information concerning retention capabilities,
- experimental setups were selected which adequately reproduced the conditions obtaining with real-life utilization of the filter system,
- the investigations were carried out in accordance with methodologies which either corresponded to the current state of technology or which were on a scientific level of sophistication,
- the detection limits applied within the framework of the analyses are sufficiently precise to be able to justify the manufacturer's specifications,
- the selection of the investigated components was made on the basis of real-life problem situations, which included everyday components on the one hand and relevant exotic ones on the other.



Conclusion

The results achieved by the investigations commissioned by CARBONIT, taking into account the respective methods used, allow for the statements made by the manufacturer concerning the respective product characteristics of the "NFP 2,0" and/or "NFP Premium" filter cartridge manufactured by the CARBONIT Company. It is to be assumed that the results mentioned above are reliable and sufficiently capable of being applied to real-life utilization of the filter cartridge (see Chapter 3 and Chapter 4).

2 General Information and Terms of Reference

CARBONIT Filtertechnik GmbH, Dorfstraße 24c, 29416 Dambeck, is a manufacturer of filter installations for the purification of waters obtained from a variety of sources. Within the framework of investigations accompanying product development, CARBONIT charged TÜV Anlagentechnik GmbH, Geschäftsfeld Druckgeräte und Werkstofftechnik, Magirusstraße 5, 12103 Berlin with the evaluation of investigations already carried out (see Chapter 2.1) from the point of view of the product characteristics contained in the manufacturer's descriptions (retention capacity and throughput).

In the case of the "NFP 2,0" (later renamed "NFP Premium"), the product under consideration is a standard filter cartridge (activated carbon), which is built into corresponding filter holders and installed in parallel fashion for private service water pipelines in order to provide separately filtered drinking water.

Investigations have been commissioned and carried out within the framework of quality management measures accompanying product development (see Chapter 2.1) which characterize the effectiveness of the filter system in reference to selected microbiological, organic and inorganic retention capability. The goal of the respective investigation was to achieve sufficiently representative model approaches which would reproduce both implementation in practice and existing pollution burdens.

2.1 List of the Investigations Performed

Within the framework of quality assurance measures accompanying product development, the investigations were commissioned and carried out at the client's behest which were to characterize the retention capacity of the filter cartridge designated "NFP 2,0" or "NFP Premium". The following expert appraisal certificates, reports and investigations were submitted for the present summary evaluation:

- 1. Hygienic-microbiological investigations with the CARBONIT Monoblock NFP 2,0 filter element (April 1999)**
Gesellschaft zur Förderung des Forschungs- und Technologietransfers in der
Universität Bielefeld e. V.
Produktbereich Wasser/Abwasser-Analytik, Prof. Dr. Rolf Mannesmann
Universität Bielefeld, Fakultät für Biologie
Universitätsstraße 25
33615 Bielefeld
- 2. Report No.: 6-99/053 - Reduction of copper concentrations in drinking water systems through the utilization of CARBONIT filters of the "CARBONIT Monoblock" type (October 1999)**
TÜV Umwelt Berlin-Brandenburg GmbH, Niederlassung Berlin
Schmalenbachstraße 11
12057 Berlin
- 3. Report No.: 6-00/180 - Reduction of lead concentrations in drinking water systems through the use of CARBONIT filters of the "CARBONIT Monoblock" type (August 2000)**
TÜV Umwelt Berlin-Brandenburg GmbH, Niederlassung Berlin
Schmalenbachstraße 11
12057 Berlin

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4. Expert appraisal certificate – Experiments concerning the removal of pharmaceutical residues, steroid hormones and polar pesticide residues from doped drinking water using CARBONIT® water filters (November 2000)

Technische Universität Berlin
Institut für Lebensmittelchemie
Arbeitsgruppe Wasseranalytik
Gustav-Meyer Allee 25
13355 Berlin

5. Investigation of the adsorption capacity of the CARBONIT Monoblock NFP Premium filter system against atrazine, lindane, p,p'-DDT, chloroform and free chlorine as individual substances (July 2001)

Hochschule Magdeburg-Stendal (FH)
Fachbereich Chemie/Pharmazie
Dr. Feuerstein
Postfach 3680
39011 Magdeburg

6. Final report and advisory comment concerning retention of selected organisms (January 2002)

Universität Bielefeld, Fakultät für Biologie
Prof. Dr. Rolf Mannesmann
Universitätsstraße 25
33615 Bielefeld

3 Evaluation of the studies previously carried out

3.1 Hygienic-microbiological Investigations

Reporting institution: Universität Bielefeld
Gesellschaft zur Förderung des Forschungs- und
Technologietransfers in der Universität Bielefeld
e. V., Produktbereich Wasser/Abwasser-Analytik,
Prof. Dr. Rolf Mannesmann
Address: Universität Bielefeld, Fakultät für Biologie
Universitätsstraße 25
33615 Bielefeld
Time period: April 1999

Scope of the investigation

Performance and assessment of a series of experiments for determination of the hygienic-microbiological behavior of the filter cartridge in a drinking water system. The series of experiments was intended to monitor the behavior of the filter in reference to the reduction of live pathogenic bacteria in the presence of unfavorable albeit realistic conditions. Utilization was made of *Escherichia coli* and *Enterococcus faecalis* bacteria, ones which can also play a role in real-life drinking water systems and/or are recognized as control agents and indicator organisms.

Evaluation of experimental setup and of performance

The experimental setup was implemented in the laboratory and simulates the discharge area at the end of a drinking water system which includes a filter housing containing a filter cartridge of the NFP 2,0 type. The test track includes the water pipe as well as devices for the generation of bacteria-free water in order to establish neutral conditions for the subsequent injection track (injection for bacterial contamination).

Sampling frequency and flow rates were selected in such a way as to simulate a consumption mode which is high in terms of the bacterial load on a filter system. To accomplish this, the bacterial loads were renewed at two-week intervals with a water flow rate of circa 130 l. A water flow rate corresponding to average domestic usage was introduced every three days. Samples of the filtrate were removed and tested at two-week intervals. This ensured that the bacteria had sufficient growth conditions. The test duration of 6 months is to be deemed sufficient in view of the question formulation, considering the fact that filters should in principle be replaced every 6 months, in accordance with manufacturer's specifications and in terms of DIN 1988.

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Evaluation of the methods of analysis

The microbiological Investigations were carried out in accordance with the standard procedures of the DEV (Deutsches Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchungen, Teil K - German Uniform Procedures for Investigations of Water, Sewage and Sludge, Part K). As a result of the recognized competency of the Institute, one can assume the presence of good scientific oversight at a level which at a minimum corresponds to the current state of technology.

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

3.2 Report concerning reduction of copper concentration

Reporting institution: TÜV Umwelt Berlin-Brandenburg GmbH,
Niederlassung Berlin, accredited testing laboratory
in accordance with DAP and GOST Standards
Address: Schmalenbachstraße 11
12057 Berlin
Time period: August 2000

Scope of the investigation

Performance and assessment of a series of experiments for the determination of the reduction behavior of the NFP 2,0 filter cartridge in a drinking water system in terms of copper as a water component. The series of experiments was intended to monitor of the behavior of the filter in reference to copper reduction under realistic albeit unfavorable conditions.

Evaluation of experimental setup and of performance

A positioning place was selected for carrying out the planned experiment in a drinking water system which met the following requirements:

- the entire drinking water pipe system consisted mainly of copper tubing.
- the water sample extraction point was located at the end of a long train of drinking water pipes.
- the drinking water intake from the public water supply network was to be in its usual location in the basement of the building.
- either only very little or no water at all was drawn at night from the drinking water system train of pipes to be sampled (stagnant water).
- copper concentration following stagnation was to be above 3 mg/l (the standard value of the Drinking Water Regulations - see below).
- as little water as possible to be drawn from the pipe system during the day throughout the entire building.

A positioning place on the 5th floor of a commercial building with a high level of non-occupancy was found. The requirements for the sampling site listed above were met and the filter was subjected to real-life utilization under difficult operating conditions. The sampling method in terms of idle and flow times was appropriate for reproducing consumer behavior under unfavorable conditions. The quantities of water allowed to pass through were adjusted to match the predicted service life of a filter (10,000 liters), so that the statements made here can also be applied to real-life utilization of the filter cartridges.

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Evaluation of the methods of analysis

The analytical methods were applied in accordance with conventional VDI guidelines, i.e. validated methods for which respective accreditation was also available.

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

3.3 Report concerning reduction of lead concentration

Reporting institution: TÜV Umwelt Berlin-Brandenburg GmbH,
Niederlassung Berlin
accredited testing laboratory in accordance with
DAP and GOST Standards
Address: Schmalenbachstraße 11
12057 Berlin
Time period: October 1999

Scope of the investigation

Performance and assessment of a series of experiments for the determination of the reduction behavior of the NFP 2,0 filter cartridge in a drinking water system in terms of lead as a water component.

Evaluation of experimental setup and of performance

The experimental setup included the construction of a train of pipes in imitation of the old drinking water pipelines made of lead often to be found in pre-World War I apartment buildings in Berlin. Thanks to the incorporation of used pieces of pipe obtained from buildings undergoing renovation, it was possible to simulate realistic worst-case conditions. The sampling method in terms of idle and flow times was appropriate for reproducing consumer behavior under unfavorable conditions. The quantities of water allowed to pass through were adjusted to match the predicted service life of a filter (10,000 liters), so that the statements made here can also be applied to real-life utilization of the filter cartridges.

Evaluation of the methods of analysis

The analytical methods were applied in accordance with conventional VDI guidelines, i.e. validated methods for which respective accreditation was also available.

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

3.4 Report concerning the removal of pharmaceutical residues, steroid hormones and polar pesticide residues

Reporting institution: Technische Universität Berlin
Institut für Lebensmittelchemie
Arbeitsgruppe Wasseranalytik
Address: Gustav-Meyer Allee 25
13355 Berlin
Time period: November 2000

Scope of the investigation

Performance and assessment of a series of experiments for the determination of the reduction behavior of the NFP 2,0 filter cartridge in a drinking water system in terms of polar pharmaceutical residues, steroid hormones and polar pesticide residues as water components. The series of experiments was intended to monitor reduction behavior under unfavorable albeit realistic conditions. Selected components relevant to water purification were utilized.

Evaluation of experimental setup and of performance

A storage tank which contained prefiltered tap water was used to simulate a real-life drinking water system within the framework of the investigations in order to exclude the influence of other materials contained in local tap water on the test object. During the course of the experiment, samplings were taken following each doping and a subsequent 500 l of water flow which were then analyzed for the components listed above. This made it possible to monitor a continuous loading of the filter which in terms of the quantity of its flow accounted for the projected service life of a filter (10,000 liters). Dopings were carried out at the levels of the residues present in the drinking water and/or at those of the limit values contained in the Drinking Water Regulations as well as at the concentration levels which were observed in surface water. Conditions were thus created in terms of the quality of the water used and of filter load which permit application of the conclusions reached to real-life utilization in terms of the question formulation.

Evaluation of the methods of analysis

The methods of analysis were carried out to some extent in accordance with conventional standards, although fundamentally at a high scientific level bearing relation to research areas in the field. For that reason, as a result of the recognized competency of the Institute, one can assume the presence of good scientific oversight in combination with an array of technical equipment at a level which corresponds at a minimum to the current state of technology .

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

3.5 Adsorption capacity in reference to atrazine, lindane, p,p'-DDT, chloroform and free chlorine as individual substances

Reporting institution: Hochschule Magdeburg-Stendal (FH)
Fachbereich Chemie/Pharmazie
Dr. Feuerstein
Address: Postfach 3680
39011 Magdeburg
Time period: July 2001

Scope of the investigation

Performance and assessment of a series of experiments for the determination of the adsorption behavior of the NFP 2,0 filter cartridge in a drinking water system when exposed to atrazine, lindane, p,p'-DDT, chloroform and free chlorine as water components. The series of experiments monitored reduction behavior under unfavorable realistic conditions. Selected components relevant to water purification were utilized.

Evaluation of experimental setup and performance

Because of the toxic potential, a real-life drinking water system was simulated using two tanks in rotation, each of which alternately serving to charge the filter cartridge while the other received the filtered water. This made it possible to monitor a continuous loading of the filter which in terms of flow quantities was equivalent to the projected service life of a filter. Dopings were carried out in dimensions 50 and/or 100 times greater than the residues present in drinking water and/or than the limit values contained in the Drinking Water Regulations. Conditions were thus created in terms of the quality of the water used and of the filter load which permit application of the conclusions reached to real-life utilization in terms of the question formulation, even in connection with critical situations.

Evaluation of the methods of analysis

The methods of analysis were carried out in accordance with conventional standards and guidelines, i.e. validated methods. In view of the recognized competency of the Institute, one can assume the presence of good scientific oversight at a level which corresponds at a minimum to the current state of technology, and that this standard will also have applied to the array of technical equipment utilized.

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

3.6 Retention of Selected Organisms

Reporting institution: Universität Bielefeld, Fakultät für Biologie
Prof. Dr. Rolf Mannesmann
Address: Universitätsstraße 25
33615 Bielefeld
Time period: January 2002

Scope of the investigation

Performance and assessment of a series of experiments for determination of the hygienic-microbiological behavior of the NFP 2,0 filter cartridge in a drinking water system. The series of experiments was intended to monitor the behavior of the filter in reference to the reduction of pathogenic bacteria in the presence of unfavorable albeit realistic conditions. The viruses, bacteria, lower yeast forms and eucaryotic parasites of internationally hygienic relevance were tested.

Evaluation of experimental setup and of performance

The experimental setup was implemented in the laboratory and simulates the discharge area at the end of a drinking water system which includes a filter housing containing a filter cartridge of the NFP 2,0 type. The test track included the water pipe as well as devices for the generation of bacteria-free water in order to establish neutral conditions for the subsequent injection track (injection for bacterial contamination). The injection was carried out with hygienically-relevant organisms.

Sampling frequency and flow rates were selected in such a way as to simulate a consumption mode which is high in terms of the bacterial load of a filter system. An investigation time period of 2 weeks with 4 injections and samplings was established for this purpose, with a daily water flow rate of approximately 130 l. This ensured that the bacteria had sufficient growth conditions in order to provide sufficient filter load. As a whole, the methodology is comparable with the investigations of April 1999 and to be termed sufficient in terms of the question formulation.

Evaluation of the methods of analysis

The microbiological Investigations were carried out in accordance with the standard procedures of the DEV (Deutsches Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchungen, Teil K - German Uniform Procedures for Investigations of Water, Sewage and Sludge, Part K). In view of the recognized competency of the Institute, one can assume the presence of good scientific oversight at a level which corresponds at a minimum to the current state of technology, and that this standard will also have applied to the array of technical equipment utilized.

Conclusion of the investigation

No objections are to be found from the point of view of reliability and applicability of the results within the framework of the scope of the investigation in terms of the selection and precision of the methodology applied.

4 Summary Evaluation

The expert appraisal certificates considered in the context of this evaluation concerning 6 test series concerned with the "NFP 2,0" (renamed "NFP Premium") filter cartridge can be characterized as follows:

- the experimental setups, the performances and the analyses are respectively appropriate for confirming the statements contained in the product information concerning retention capabilities,
- experimental setups were selected which adequately reproduce the conditions obtaining with real-life utilization of the filter system,
- the investigations were carried out in accordance with methods which either corresponded to the current state of technology or which were on a level of scientific sophistication,
- the detection limits applied within the framework of the analyses are sufficiently precise to be able to justify the manufacturer's specifications,
- the selection of the investigated components was made to recreate real-life problem situations, which included everyday components on the one hand and appropriate exotic ones on the other.

The following table summarizes the results of the investigations which are also included in the manufacturer's product information:

Parameters	Reduction	Expert Appraiser
Bacteria	> 99.9%	Universität Bielefeld / GFT (see Chapters 3.1 and 3.6)
Selected micro-organisms	> 99.9%	
Fungi / yeasts / viruses	> 99.9%	
Escheria coli	> 99.9%	
Enterococcus faecalis	> 99.9%	
Lead	> 90%	TÜV Umwelt (see Chapters 3.2 and 3.3)
Copper	> 90%	
Chlorine	> 99%	Fachhochschule Magdeburg (see Chapter 3.5)
Chloroform	> 99.9%	
Lindane	> 99.8%	
DDT	> 99.8%	
Atrazine	> 99.8%	
Pharmaceutical residues		Technische Universität Berlin (see Chapter 3.4)
Clofibric acid	> 99.9%	
Carbamazepine	> 99.9%	
Diclofenac	> 99.5%	
Ibuprofen	> 99.9%	
Ketoprofen	> 99.9%	
Propiphenazone	> 99.9%	
Polar pesticides		
Bentazone	> 99.9%	
2,4-D	> 99.9%	
Dichlorprop	> 99.9%	
MCPA	> 99.9%	
Mecoprop	> 99.9%	
p,p'-DDA	> 99.5%	

Conclusion

The results achieved by the investigations commissioned by CARBONIT, taking into account the respective methods used, allow for the statements made by the manufacturer concerning the respective product characteristics of the "NFP 2,034" and/or "NFP Premium" filter cartridge manufactured by the CARBONIT Company (see Chapters 3 and 4). It is to be assumed that the results mentioned above are reliable and sufficiently capable of being applied to real-life utilization of the filter cartridge. 34

Detailed descriptions of the experiments, assessments and results can be obtained from the respective investigation reports.

5 Other

The results relate exclusively to the scope of testing. This report may not be disseminated in the form of partial extracts without our prior authorization.

Berlin, 27 February 2003

A handwritten signature in blue ink, appearing to be 'RH', with a long horizontal line extending to the right.

Dipl.-Ing. Ralf Herrmann

A handwritten signature in blue ink, appearing to be 'A. Förster', with a large, stylized loop at the top.

Dipl.-Met. André Förster