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Abstract of the Ph.D. thesis

Physical and chemical features of tarpaulin fabrics with special regard to materials being injurious to health

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4. Publications published in subject of the dissertation

1. Ahmad Khuder: Korszerű ponyvák (Up-to-date tarpaulins).
   Magyar Textiltechnika 2007/4, p.104-106

2. Ahmad Khuder, Oroszlány Gabriella: Ponyvaszövetek előállítása, szerkezeti felépítése (Manufacture and structure of tarpaulin fabrics).
   Magyar Textiltechnika 2007/5, p. 141-142

3. Ahmad Khuder, Oroszlány Gabriella: A perfluoroktánsav tulajdonságai (Properties of perfluorooctanoic acid).
   Textil Fórum, Vol. XVIII. No. 352., p. 16.

4. Ahmad Khuder, Gyovai Ágnes, Oroszlány Gabriella: A ponyvák története és történelmi fejlődése (History and growth of tarpaulins).
   Textil Fórum, Vol. XVIII. No. 357., p. 18-20.

5. Ahmad Khuder, Gyovai Ágnes, Oroszlány Gabriella: A Sátor (The tent).
   Magyar Textiltechnika 2008/3-4, (accepted for publication)

5. Publication not related to the subject of the dissertation

1. Ahmad Khuder: INCOTERMS 2000. CÉLiránytű, 2004/288, p. 5-7.

In the peak in question of the chromatogram of the tested samples the sign of 131 (m/z) fragment can be found, this refers expressly to the presence of PFOA. (The ion of specific mass 131 does not appear anywhere in the chromatogram.)

Using selective ion follow-up the 131 (m/z) specific mass molecule can be found in the chromatograms of the tested samples.

With this method, on basis of the value of area under the peaks connecting with specific mass 131 fragment, it could be established that with increasing the welding temperature quantity of evolved PFOA is also increasing. Comparing with 300 °C welding temperature near 300 % increasing was observed when the temperature was raised by 80 °C.

3. Summary of the new scientific results

During my research work, put down in my dissertation, with testing of natural and man-made fibres I achieved the following scientific results:

1. I established that in manufacture of the pure cotton woven tarpaulin fabric made from 2-ply warp (50 tex x 2 S 334) and 5-ply weft yarn (37 tex x 5 S 185) produces better and more durable fabric with greater strength and higher waterproofness than that made from 2-ply warp (29,5 tex x 2 S 412) and single-ply 37 tex S 720 weft yarn.

2. I established that in manufacture of a cotton-jute woven tarpaulin fabric made from 2-ply cotton warp yarn (50 tex x 2 S 334) and single-ply jute weft yarn (278 tex S 120) produces better and more durable fabric with greater strength and higher waterproofness than that made from 2-ply warp (29,5 tex x 2 S 412) and single-ply 120 tex S 235 weft yarn.

3. I was the first who proved the presence of perfluorooctanoic acid in a textile fabric made of glass fibres and covered by Teflon, while most research works concentrate to examine Teflon-covered pots.

4. I established that at making-up of woven fabrics made of glass fibres and covered by Teflon does evolve perfluorooctanoic acid, even if the lowest necessary welding temperature is used.

5. I established during my experimental work that the quantity of perfluorooctanoic acid depends on the temperature: at higher temperature more PFOA evolves.

1. Introduction and objective

Tarpaulin fabrics are usually strong and heavy woven fabrics manufactured in plain or rep weave and are suitable to protect objects or areas from harmful effects of adverse weather conditions, mainly from rain and solar radiation.

Various kinds of tarpaulins made of natural fibres have been known and used long. However, these have some unfavourable features: their resistant to light as well as to chemical and biological effects is poor. This is why lifetime of these products is relatively short. Various technological processes have been developed to improve these disadvantageous features and the result of these works is the large variety of synthetic tarpaulin fabrics. They are able to prevent their original properties for long and can be manufactured economically with mass-production methods.
Mechanical properties of synthetic tarpaulin fabrics are determined first of all by the structure of their textile ground. The rest of physical and chemical features depends from the quality and thickness of the covering film layer.

Use of tarpaulin structures in architecture has come to the fore in recent decades since the form imagined by the architect can be transferred to implementing plan only by using considerable theoretical work and adequate computer software. However, application of these tarpaulin structures is advantageous in several respects: because of their great variety of forms they can be easily adapted to their environment, they are mobile, transformable and, if necessary, easily disposable. Up-to-date tarpaulin materials are strong, durable, flame retardant, can be dyed, resistant to chemicals, their translucence can be regulated – all of these mean that tent constructions can be made for many various functions. Technical tarpaulins have come to the fore in architecture in the recent 30 years because they enable to span large distances with relatively low costs of metal structures. Simple technical tarpaulins (polyester fabrics covered by PVC) offer at least 10-year lifetime while for glass fibre fabrics covered by Teflon 50 years lifetime can be guaranteed.

Textile products made of natural and man-made fibres have been parts of Arab architecture since many centuries. Main application fields of tarpaulin woven fabrics in our country are, in addition to constructions for shading and protection, communal buildings and halls combined by tarpaulins with glass fibre reinforcement and covered by Teflon which are even more popular.

Teflon was invented by Dr. Roy Plunket, a young chemist at DuPont, in 1938, while he was carrying on experiments with cooling gases. He found a slippery material, poly(tetrafluoro-ethylene) (PTFE), which did not stick to anything and which was called later Teflon by DuPont.

Its basic material is chloridfluoromethane which rises from the reaction of chloroform and hydrogen-fluoride. By its pyrolizing at 800 to 1000 °C tetrafluoro-ethylene (TFE) develops which will be cleaned and polymerized in water emulsion or suspension.

General use of Teflon is the consequence of its excellent properties. Its friction coefficient is the lowest among synthetic materials (0,05 to 0,5) and it has excellent resistance to cold and warmth: can be used durably in the range of –269 and +260 °C.

Teflon-coated surfaces are hydrophobic and oleophobic, they do not get wet thus they are easy to clean, in many cases they are self-cleaning. Teflon coating remains neutral, it does not react to its chemical environment, it is sensitive only to melted alkali metals and chemicals containing much fluorine. While tested in wide frequency range very high dielectric strength, low loss factor and very high surface resistance were found.

Depending on field of application, Teflon-coated woven fabrics made of glass fibres could be theoretically sewn with special thread and sewing machine but this seam would not be waterproof. Thus, usually welding at 240 to 380 °C temperature is used instead of sewing.

Teflon coat contains perfluorooctanoic acid (PFOA) which is used by producers as additive to prepare the coating but, according to their statement, the final product does not contain it. PFOA is said to be probably carcinogenic. Many disquieting scientific works have been published about the disadvantageous effects of PFOA to the environment and health.

This is the reason why it is declared as persistent organic pollutant (POP). Degradation period of POP materials is very long, their half-life period may be many years, they easily accumulate in adipose tissue of living creatures and enrich in their organism.

Objective of my research work is, in addition to introduce the manufacture and properties of tarpaulins made of natural and man-made fibres, examination of unsanitary materials originating during further processing, mainly verification of presence of PFOA in synthetic, glass-fibre containing, Teflon-covered tarpaulin fabrics in the making-up phase.

Technological modifications of tarpaulin fabrics made of natural fibres were necessary because weaving parameters had been changed in order to reduce production costs. Consequence of these changes were lower quality and less stability: lower strength both in warp and weft direction and also lower waterproofness.

The result of using 29,5 tex x 2 S 412 warp and 37 tex S 720 weft yarns in making pure cotton woven tarpaulin fabric was looser structure. Similarly, when making a tarpaulin fabric from 29,5 tex x 2 S 412 cotton warp and 120 tex S 235 jute weft yarns quality parameters became worse.

In my experimental work I wanted to find solution to approach customers' requirements by application of new parameters.

2. Experimental methods used

First step of my research work was to examine woven tarpaulin fabrics made of natural fibres before and after change of technology parameters. I tested the tensile strength both in warp and weft direction and the value of waterproofness.

Use of 50 tex x 2 S 334 warp and 37 tex x 5 S 185 weft cotton yarns resulted in higher strength and better waterproofness. When making cotton-jute tarpaulin fabric from 50 tex x 2 S 334 cotton warp and 278 tex S 125 jute weft yarns the fabric structure was more durable.

Second part of my research work was to examine woven tarpaulin fabrics made of glass fibres and covered by Teflon, to prove the presence of PFOA in made-up tarpaulins. These fabrics were made of EC 3/4 type glass fibres, yarn count 204 tex in both warp and weft, area density: 450 g/m2 (without coating). I prepared welded seam with 60 s pressing time and using 300, 340 and 380 °C temperatures. From the welded side of the fabric I cut out with sharp blade specimens for instrumental analysis. I sought PFOA traces in them in a gas-chromatograph equipped with mass spectrometer (type QP 2010 by Shimadzu).

Mass spectrometry is an examination method in which ionic particles are separated on pressures which are decreasing in relation with their mass (mass per unit charge, m/z), with help of electric or magnetic fields. Intensity of separated ions are continuously measured, this leads to an ion-current intensity vs. specific mass function – this is the so called mass spectrum.

This mass spectrum is basis of the information on quality since do not exist two organic compounds the same characteristic mass spectrum of which or, more precisely, their so called characteristic mass spectrum normed to the most intensive ion, would be the same.

Plotting the detector sign in function versus time a series of peaks can be seen which is called chromatogram. From the chromatogram the most important date, the retention time relating to the chromatographic peaks can be read out. This retention time is characteristic of the material while the area under the peak is in relation with the quantity of the specific component.

The retention time for a standard PFOA compound (Sigma Aldrich standard compound) was 2,8 minutes. Evaluating the chromatograms of the three samples, a peak at 2,8 minutes could be really observed in each cases, but on basis of the mass spectrum the software could not establish from its library PFOA connecting with this peak. The reason of this was that the separation was not satisfactory, the peak was created by more than one components.

On basis of this the specific mass of the basic ion of PFOA in the mass spectrum of the standard sample is 131 (m/z).