Integration of ergonomic and comfort aspects in new standards – a challenge for standardisation

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THE WORK IN CONTEXT

Ergonomics and comfort aspects are important for the industry to develop and optimize products e.g. car seats, sleeping bags, protective clothing. A lot of effort is necessary of scientific world and industry to develop methods for the determination of the ergonomic and comfort aspects of products. Companies e.g. in the automotive industry use often their own standards to define the quality and the requirement for their products. In the field of textiles there are often standards, which were developed in national and international standardisation organisation with stakeholders from the material industry, manufacturer, brands and end user. The aim of the standardisation is to improve the quality of the product and give the possibility to compare different products from different manufacturers. E.g., the standard for sleeping bag was developed as national standard with focus on the cold protection of sleeping bags and the practical methods to determine the comfort. Over the years, the standard was developed further to an ISO standard. Now, this sleeping bag standard is used all over the world to guarantee the quality and comfort parameters. Comfort and ergonomics aspects of protective clothing are coming more and more in the focus of the protective clothing producers. A lot of effort is necessary to develop standards in this field from manufactures, scientist and end users. In this talk, different examples fare presented for developing new standards concerning comfort and ergonomics aspects.

KEYWORDS

International standardisation (CEN/ISO), product standard, test standard, standards for protective clothing

Introduction

Standardization is important and organized nationally and internationally. The International Organization for Standardization (ISO) is the independent, non-governmental, international organization with membership of 165 national standards bodies and started the work in 1946. Today, 23921 standards cover almost all aspects of technology and manufacturing. The work is done by experts from 165 national standard bodies in 796 technical committees and subcommittees. Examples for national standards body are e.g., DIN is the German Standard Institute for Standardization, BSI is the British Standard Institute for Standardization, AFNOR is the French Standard Institute for Standardization. The work of national standard bodies is explained at DIN. DIN, the German Institute for Standardization, is the independent platform for standardization in Germany and worldwide. More than 36.000 experts from industry, research, consumer protection and the public sector bring their expertise in the developing process of German standards. Standards help to ensure the free movement of goods. Standards support efficiency and quality assurance in industry, technology, science, and the public sector and serve to safeguard people and property and improve quality in all areas of life. The use of DIN standards is voluntary. They only become mandatory if they are referred to in contracts, laws or regulations (e.g., EU PPE regulation).

But as generally accepted rules of technology, standards make it easier to demonstrate that one has followed best practices. DIN represents German interests in international organizations such as CEN, the European standards body, and ISO, the International Standards Organization. Today, roughly 85% of all national standards projects are European or international in origin. International Standards provide a common language for the technical world, supporting global trade.
CEN's national members are the national standard bodies (NSBs) of the 27 European Union Countries, United Kingdom, the Republic of North Macedonia, Serbia, Turkey, and the three countries of the European Free Trade Association Iceland, Norway, and Switzerland.
Standardisation uses the knowledge of the industry and scientific world. However, to develop a standard is often time-consuming. Every five years, a check is carried out to determine whether the standard developed can exist for further five years, must be changed or whether it will be withdrawn. For the revison of standards, the knowledge of new scientific methods and results are necessary and exchanges between industry and scientist are necessary- However, the long period of the standardisation process is not good compatible with the fast scientific world. The next chapters give some examples of standard with comfort and ergonomic aspects and problems to involve and improve comfort and ergonomic aspects.

Standardisation of sleeping bags

Sleeping bags are often used worldwide. The sleeping bags standards ISO 23437-1:2018 and ISO 23537-2:2018 were developed by the technical committee ISO/TC 83 "Sports and other recreational facilities and equipment" in cooperation with the technical committee CEN/TC 136 "Sports, playground and recreational equipment" in the working group 11 "sleeping bags". Part 1 deals the thermal properties of sleeping bags and the part 2 with the material and product properties. Part 1 specifies the requirements and test methods as well as provisions for labelling of adult sized sleeping bags for use in sports and leisure time activities regarding thermal characteristics, dimensions, and mass. ISO 23537 based of the EN 13527:2002 and the DIN 7943-1 and -2:1995. The standards give consumer the possibility to easily compare the quality of sleeping bags. The thermal properties of sleeping bags can be determined with thermal manikins. The test conditions the test equipment, the test procedure is descripted in detail in the standard. Basis of the sleeping bag tests are the correlation of the data of the thermal manikin and the data of subjects' trials. Part 1 of ISO 23537 does not apply to sleeping bags intended for specific purpose such as military use and extreme climate zone expedition. But more and more people wish to make expedition in extreme climate zones (e.g., cruises in Arctic, and Antarctic region, mountaineers in high mountain region (e.g., Himalaya). In this case, the data of subject trials in controlled condition are missing and no prognosis is possible. The ISO 23537 does not apply to sleeping bags for children or babies. However, the industry and the consumer need the possibility to compare sleeping bags for children. The problem is known since years. There are children manikin available in a few research institutes, however not often in test houses. The correlation of the data of the children manikin with subjects' trials with children in realistic scenarios are missing. These investigations are very expensive and so the financial support is necessary for universities and research institutes to generate such data. Effort of scientist and industry is needed to get such data. Sleeping bags without homogeneous fillings designed to provide local extra insulation in certain parts are coming into the market and that pose issues with the calibration and/or test procedure. Ongoing work continues to provide suitable means of establishing temperature ratings. This can be only done with the help of the scientific world and the industry.

Standardisation of personal protective clothing – protective clothing against cold and cool environments

Protective clothing must protect the user before health risks and at the same time, there must provide a high level of comfort and ergonomics to avoid discomfort. Protective clothing is often

heavy and hinders free movement by working because of the protection function. New technologies and materials are now available to improve the protective clothing and leads to problems with the existing standards. In Europe, the product standards for personal protective clothing are mandatory and must applied. Protective clothing against cold environments can be proofed according the EN 342 developed in the working group CEN/TC 162 WG 4. With the EN 342, a common basis in Europe is achieved for requirements and test methods for protective clothing ensembles and garments against cold in the interest of manufacturers, test institutes and end-users. The measured properties and their subsequent classification are intended to ensure an adequate protection level under different user conditions. Thermal insulation and the air permeability of the ensemble or garment are the essential properties of this kind of PPE. Thermal insulation is the most important property, and it is measured by using a full-sized thermal manikin with the ensemble or garment and accompanying reference clothing in order to account for the effect of layers, fit, drape, coverage and shape. In some conditions with intermittent exposures (e.g., cold store work) or in conditions close to and above 0 °C the water vapor resistance value of fabrics become increasingly important and fabrics with a low value can contribute to improved heat balance and thermal comfort.

With the EN 14058 Protective clothing— Garments for protection against cool environments, a common basis is achieved for requirements and test methods for protective clothing ensembles and garments against cool environments for manufacturers, test institutes and end-users. Cool environments mean the moderate low temperatures above -5 °C garments against local body cooling. This can be used for outdoor activities e. g. in construction industry but can be used for indoor activities e. g. in food processing industry. The thermal insulation is measured with material test methods e.g., the sweating guarded hotplate and not with a thermal manikin. The material test is not so expensive as the product test with the manikin. But new materials and new constructions are coming in the market. Inhomogeneous distribution of the insulation material in garment can be observed. However, inhomogeneous distribution leads to problems in the testing because an appropriate specimen number should be used for testing. Also pockets and other design properties leads to additional test specimens. Inhomogeneous distribution of the insulation material in garments leads to additional effort for testing and the question is: What will be the best test methods? What is the best way to calculate an average value for the insulation of the whole garment? There are more scientific investigations necessary. There is also the question if the test with the manikin could solve this problem. Test houses can make services testing and sometimes they develop new methods. The development of new methods is time consuming and need a deep scientific understanding of the materials, test methods and the analysis of huge data and here the support of research institutes is needed.

Standardisation of immersion suits

Immersion suits are another example of PPE which should show certain insulation that allow people to survive in water in an accident. One important property for immersion suit is the insulation which is necessary for this kind of PPE. In the Standard ISO 15027-3:2012, which is developed in the ISO 188 SC 1 and CEN/TC 162 WG 6, two methods are described. The first is the measurement of the insulation with thermal manikin the second one is wearer trials.
The overall thermal protection provided by a suit system shall be assessed by measurement of the effective insulation of the whole suit system and associated underclothing placed on a thermal manikin and immersed in calm but circulated water. The tests with human test subjects are time-consuming but often used for products. There are not so many laboratories worldwide which over the manikin test in water. Because of the different size, shape, and construction of the manikins the results of the insulation received from different laboratories differ. For the revision of the standard,

the manikin test should approve and the problems with differences in the results should be solved. This need a lot of effort for the industry and test houses because a lot of investigation are necessary.

Standardisation of ergonomic aspects of personal protective equipment

The implementation of comfort and ergonomics aspects are more and more in the focus. One example is the new standard “Ergonomics of PPE ensembles” (prEN 17558:2021), developed in the working group CEN/TC 122 WG 14. This standard can be used to compare the performance of different ensembles as part of any PPE selection process and can assist employers in evaluating PPE Ensembles in standardised conditions. Ergonomics of PPE can be tested by use of either test persons, use of manikins and/or use of (computer) models as benchmark or comparative testing. Laboratory as well as field test are incorporated. This standard does not replace the product standards for the certification of individual items of PPE. It specifies the testing of individual items of PPE as an ensemble, so that the interactions between the individual items of PPE can be evaluated and any adverse interactions between the individual items of PPE, the user and the environment can be identified. This work in only possible by networking of the industry, the user and scientist. There are a lot of product standards for PPE available e.g., fire fighter clothing, fire fighter shoes, ear protection or eye protection. The interaction of the different items of PPE during the use is not in the scope of product standard. But a fire fighter must wear a lot of items of PPE in the immersion case for best protection and therefore the ergonomic aspects of all items together which the persons are wearing during immersion case are important and should be investigated. In the industry, often filed test are made for testing the products. But the knowledge about the number of test persons which are necessary for testing, the analysis of the results and the knowledge about significant differences between test result is not sufficient and needs the support from the scientific world. This standard is the first approach and was initiated by a fire fighter association. The next years will show how the standard is used in real life and how the standard can be improved in the next years because this first draft cannot answer and solve all questions.

Standardisation of a methods to measure the cooling function of fabrics

Clothing with additional functions is more and more important in the field of sports but also in protective clothing. The cooling textiles should support the efficiency of athletes and workers. The cooling effect should improve the comfort and the wellbeing. During high activity and/or in warm environments the body core temperature can increase and human starts sweating to prevent an overheating of the body. The evaporation of liquid sweat is the most effective process to cool the body. Cooling textile should support the body to keep the body temperature constant. The cooling effect of textile material in not limited to the use of clothing textiles; the cooling effect is also interesting in the field of bedding, seats, and technical textiles.
The cooling of a textile cannot be determined with the conventional test methods of the clothing physiology. To determine the cooling power of fabrics, the new heat release tester WATson was developed in Hohenstein (Classen). With WATson, the cooling power of cooling materials can be determined and compared. However, the measured cooling power is only a physical value. Without the correlation of these values with data of subject trials, the cooling power do not give any information about the perception of the human body and the achieved cooling effect.
A clothing physiological device for testing the cooling function of textiles was developed. The test method was the basis of the new standard, the DIN SPEC 60015 (English). A DIN Specification, or DIN SPEC, is a document that specifies requirements for products, services and/or processes. However, in contrast to standards, DIN SPECs do not require full consensus and the involvement of all stakeholders. A DIN SPEC is the fastest way for turning research into a marketable product. DIN SPECs are effective marketing instruments that are widely accepted by customer and potential partners alike. Any DIN SPEC can be used as a basis for developing a full standard.

Conclusion

Standardisation is one instrument to develop and optimize products, technology and with a high-quality level. Companies need standards to be able to guarantee quality of products under comparable and comprehensive conditions. Comfort properties are coming more and more in the focus of the industry. The industry needs methods to determine the comfort properties. Scientists can support the implementation of comfort and ergonomic aspects with their research results and their knowledge. This support is very important to improve comfort and ergonomics in products. Standardisation needs the results of actual scientific work and the networking of all stakeholders. Standards are revised every five years to be up to date. In the revision state, the implementation of new research results, new test methods or improved technology is possible and necessary for improvement of standards.

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