Particle penetration in firefighter clothing – a pilot study

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Introduction

Firefighters are exposed to a wide range of gases and particles from fire smoke. Research shows that firefighters are more prone to develop a variety of cancer diseases than the general population (Pukkala *et al*, 2014). Fire protection features related to restricting intrusion of hazardous gases and particles into clothing are essential for limiting unfortunate health effects from firefighting.

Objective: To establish new knowledge and methods for testing the penetration of hazardous soot and smoke particles into fire clothing and further, to provide the basis for the development of new firefighter clothing with better protection against particle penetration.

Figure 1. Firefighters are exposed to a wide range of gases and particles from fire smoke.

Experimental

The process involved the stages of
1) Establish insights of user needs and context of use
2) Specify design objectives
3) Develop and evaluate a small-scale method for textile evaluation and a medium-scale method for evaluating whole garments and clothing design features.

Figure 2. Workshop at Wenaas Workwear AS, input on experiences, challenges and requirements from end-users

Two test methods were developed;
1) Particle transmission propensity through fabric layers were studied in a small-scale test.
2) Particle transmission propensity through fabric layers and garment openings while wearing protective clothes in actual fire smoke were studied in a medium-scale test.

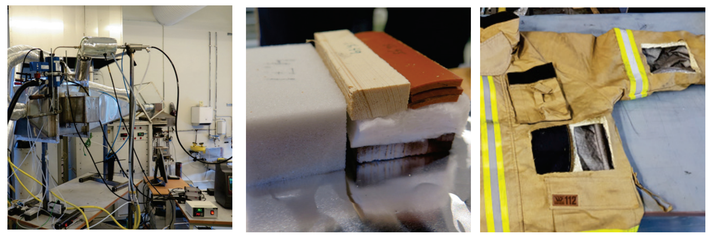

Figure 3. Small-scale test set-up with smoke generator and textile holder (left). Foam, PVC and wood used as fuel (centre). Firefighter jacket sampling after medium scale test (right).

Results

The mapping of the end-users needs indicates that a good balance between the following characteristics should be targeted in the development of a new firefighter clothing (non-priority order):

- Facilitate simple and effective (correct) dressing
- Provide good freedom of movement and comfort
- Reduce harmful particle penetration
- Not increase thermal stress during work
- Ensure good overall protection
- Ensure good compatibility with relevant technical equipment and other PPE
- Ensure garments are adapted for relevant exposures, activity level and response times
- Ensure garments are complementary to established routines and procedures.

The small-scale tests give indications of the textiles' ability to block gases and particles from penetrating into the clothing. **The medium-scale tests** indicate how the total garment assembly (layering) and garment design performs in terms of preventing intrusion of gases and particles (Storesund and Mikalsen, 2019). Both tests showed that the set of developed methods is a good starting point for further development, as they indicate decent repeatability between tests and between scales.

Conclusions

Findings from the project are now addressed by
- FRIC: Fire Research and Innovation Centre in Norway
- HERO: Health risks and health effects of firefighter work

- Further development of the method developed in PartiKle
- The dual challenge of penetration of toxic smoke particles vs. heat dissipation
- Findings from these projects will be used to further improve personal protecting clothing for firefighters.

References

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