IFP Interview the International Water Mist Association's Young Talent Award Winner Martin Thielens

Martin Thielens graduated from Ghent University in October 2022. In early 2023, he applied for the IWMA Young Talent Award, a prize which the International Water Mist Association awards annually. As the winner of the award, he will present his thesis entitled *Advanced Computational Fluid Dynamics Modelling of Water Sprays in Fire-Driven Flowsat* at the 22nd International Water Mist Conference in Copenhagen in October.

1. From where does your interest in fire-safety engineering derive?

When I was 5 years old, I visited a fire station with my parents and since then, I have always been fascinated by the 'fire world' and the firefighters. It was therefore natural for me to attend firefighter courses (adapted to teenagers) besides the 'classical college'. These classes – given by firefighters – convinced me that I wanted to work in the fire field and do something that could help and protect people. Besides, I also loved mathematics and sciences. This is the reason why I chose engineering studies in order to put the knowledge of the sciences into application in the 'fire world'.

2. On your first day at university, did you know that you would be writing your PhD. thesis about watermist?

No, not at all. Firstly, I never thought I would get the opportunity to do a PhD When my professors at Ghent University invited me to discuss the possibility of doing a PhD in their team, I remember that the first thought was that I would never be able to do it. Prof. Beji had two subjects in mind: one about soot modelling and the other one about water sprays. Given my interest in the firefighting world, I thought the one related to water sprays could be the most useful for my future. Thus, I applied, with the aid of Prof. Beji and Prof. Merci, for a FWO funding which I was granted.

3. Have you been to other universities before you graduated from Ghent University?

Yes. I have been to the University of Liège which is my hometown. I was lucky because the faculty of engineering there is very good. This is also the reason why – when I was 18 – I had not looked at other universities. It was logical for me to study at 'ULiège' as their Faculty of Engineering is well known. I did my bachelor's in civil engineering and was also supposed to do my master's in civil engineering there. I just wanted to do an Erasmus for one semester during my master's. Therefore, during the last year of my bachelor's, I did some research and decided to look for a university where I could follow a course in fire-safety engineering. Then, I realized that in some universities, it is not only one course that is dedicated to fire-safety engineering but an entire master's! This is how I suddenly changed my plans and decided to go to the University of Ghent.

◀ Martin at the University of Ghent / Martin Thielens at Ghent University.

4. How was your interest in watermist aroused?

My first contact with water spray happened during my 'fire cadet school' (firefighter courses for teenagers) where I could use and test a real water hose. This was a more practical approach. Then, during my master's degree at the University of Ghent, I learned more about water spray and I discovered watermist technology. I continued to discover this technology during my PhD and I must confess that the more I read about watermist, the more my interest increased!

5. What do you think are the great advantages of the watermist technology?

To me, there are three main advantages. First, with its thermal properties, water has incredible suppression performance and, in contrast to some chemical inhibitors, water is not harmful for human beings and is environmentally friendly. Then, for a similar total volume of water, watermist will present a better surface-to-volume ratio than conventional sprinkler systems. Knowing that one of the main effects of water spray is the cooling by (convective) heat-up and evaporation, this means that the heat absorbed by watermist is substantially higher. Finally, it also allows for smaller storage space for the water tank and the retention of the water used during the extinguishment procedure is also smaller.

6. How was the time during which you wrote your thesis? How will you look back at it in years to come?

I really loved the international aspect of research. The Combustion, Fire and Fire Safety Group from the University of Ghent is an amazing group and I have met incredible people. I thought that during my PhD I would be able to travel a lot and discover other cultures. For instance, I was supposed to stay for several weeks at the University of Fukui in Japan to run some experimental tests but then Covid decided otherwise… this stay was cancelled and the conferences were online. Still, I was lucky because there were a lot of different nationalities in my group in Ghent. So, by talking with them, I've learned a lot and discovered some parts of their cultures.

▲ Martin (Thielens) together with Prof. Tarek Beji, one of his supervisors.

Regarding the workload, doing a PhD is very intense. Even when you are not at work, it always stays in your head and you constantly think about your thesis and try to find solutions to the problems you encounter. Regarding your time and personal investment, your PhD is really a part of you. I was also lucky because my supervisors were very involved in my thesis and supported me a lot. I could really count on them. Also, my family was a big support. You forget very soon the more difficult periods when you were stuck or under pressure with the writing of the thesis. I know I will only keep the good memories and the good moments I spent with my team. There are plenty of them!

7. What do you think the future of watermist will look like?

Regarding the environmental challenges we are confronted with, I think its future is great. I also hope that my thesis will help to foster the confidence we have in the Computational Fluid Dynamics (CFD) capabilities and therefore the use of this system.

8. What are your personal plans for the future regarding your career?

I am currently working for Jensen Hughes, a very famous consultancy company in fire-safety engineering. I like working for this company because I can put into practice some of the knowledge I have gained and apply it to real projects. And being such a famous company, we also have challenging projects which is very interesting as I can learn a lot. There is a difference between fundamental research and the professional world. I think it is very worthwhile to see both sides and I hope this will make me a better engineer and scientist. As I have already said, I hope that one day I will be able to join a fire service as a volunteer or as a professional. Something that I also miss from my PhD is the teaching part. I really loved to be challenged by the students as it forces you to master your subject very well and transfer part of your knowledge. This is something that I discovered while writing my thesis: actually the more you learn about a subject, the more you realize you do not know anything!

9. Will watermist be a part of your future?

Yes, of course. I do not know if it will be from a more theoretical point of view (in research), from an application point of view (in a consultancy company), from a practical point of view (with firefighters) or a mix of the three, but water sprays and watermist will definitely be part of my future.

▲ **Martin having a but of fun together with his supervisor Prof. Bart Merci (left pic) and: Thesis finished! Martin standing between his two supervisors Prof. Merci and Prof. Beji.**

Summary

It is well-known that water-based fire-suppression systems are an efficient means of mitigating the hazardous effects of a fire. However, there is no universal design of such systems. There is indeed a variety of systems (e.g. conventional sprinkler systems and watermist) and design parameters (e.g. water flow rate and nozzle positioning) which could depend on the specific application and the desired mechanisms to be put in place (e.g. smoke cooling, suppression and/or fuel surface wetting).

Although a lot of knowledge has been gained by experimental testing, there is still a need for a deeper understanding of the complex underlying physics behind the interaction of water sprays with fire-driven flows. This would allow the development of numerical tools with reliable predictive capabilities, thus supporting the design of water-based fire-suppression systems in the framework of a performance-based approach or to illustrate equivalent safety level in case of deviations from the prescriptive rules.

The long-term objective of my thesis was to improve the current level of CFD capabilities by following a fundamental approach based on the analysis of 'simple' test cases. This approach allowed to focus on two specific sub-models.

The first sub-model is the heat-up of a single water droplet. The most common approach is to apply a uniform temperature distribution within the droplet. Whilst this approach is very well-suited (and justified) for small droplets, as typically encountered in a watermist, it might generate substantial uncertainties for large droplets. Therefore, a novel two-zone model has been implemented in an in-house code as well as in the Fire Dynamics Simulator (FDS). The analysis carried out shows that – for large droplets that can be found in conventional sprinklers – the distribution of the energy absorbed by the droplet, either by heat-up or by evaporation is affected by the choice of the heat-transfer model. The latter also affects the amount of water vapour production and the amount of liquid water that reaches the floor.[1]

However, the second sub-model that has been investigated in my work is clearly connected to watermist systems as it is related to drag reduction in a dense spray. The uncertainty associated with the approach currently in FDS has been first identified in a former work carried out Dr Liu[2] where she has shown that the 'deficiency' in droplet drag reduction leads to a very narrow spray envelope in comparison to the experimental measurements. The approach adopted by Liu et al.[3] for purely diagnostic purposes is to set the drag coefficient to a constant value for all the droplets in the spray in order to reach a good agreement with the experimental data. In my thesis, a more physical model, i.e. a Novel Drag Reduction (NDR) model has been implemented in FDS and assessed against the Wuhan spray data. It has shown to expand the spray envelope of the Wuhan spray by substantially reducing the drag force in dense regions (typically, near the nozzle) of the spray. The simulation results were closer to the experimental observations when the NDR model is implemented than when the default FDS code is used. However, the results with the NDR model have shown to be sensitive to the mesh size. The newly proposed drag reduction model has been assessed against more sprays (in cold conditions) in order to examine its ability to cope with different levels of density. The NDR model does not really affect or deteriorate the simulation results for more dilute sprays. Besides, the configuration of spray penetration in a hot air jet, which has been examined experimentally[4] and extensively simulated at Ghent University, has been revisited in this PhD. It is argued that the difficulties to correctly predict the position of the stagnation plane in the previous numerical studies can be attributed to some (if not a large) extent to a deficiency in drag reduction modelling (which has not been considered before). The current results show a better prediction of the interface height between the air jet and the watermist. The preliminary results are very promising but should be deepened in a future work.

Finally, a clear strategy has been set up during my PhD thesis in order to ensure a good dissemination as well as an easy access to the models and the codes developed during this work. More detailed information on how to access the different codes can be found in my thesis.[5]

For more information, go to www.iwma.net

Reference

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