Efficient methods for radiative heat transfer analysis in fires and water sprays for fire suppression

Sprawozdania

Informacje na temat projektu

RAD-FIRE

Identyfikator umowy o grant: 749220

Strona internetowa projektu

DOI
10.3030/749220

Projekt został zamknięty

Data podpisania przez KE
23 Marca 2017

Data rozpoczęcia
1 Września 2017

Data zakończenia
28 Lutego 2019

Finansowanie w ramach
EXCELLENT SCIENCE - Marie Skłodowska-Curie Actions

Koszt całkowity
€ 146 591,10

Wkład UE
€ 146 591,10

Koordynowany przez
KINGSTON UNIVERSITY HIGHER EDUCATION CORPORATION
United Kingdom

Ten projekt został przedstawiony w...

Periodic Reporting for period 1 - RAD-FIRE (Efficient methods for radiative heat transfer analysis in fires and water sprays for fire suppression)

Okres sprawozdawczy: 2017-09-01 do 2019-02-28

Podsumowanie kontekstu i ogólnych celów projektu

Fire statistics show that every year in Europe, there are 4000 deaths due to fires, with annual cost of losses at €126bn. To address these fire safety challenges, the development of efficient fire safety engineering models and computing codes are needed. Thermal radiation is the dominant mode of heat transfer in fires and its rigorous and efficient modelling is important in fire safety engineering. RAD-FIRE aims to develop reliable and efficient radiative heat transfer models for fires and fire suppression by water sprays.

Four main objectives were assigned to the RAD-FIRE project:

1. Develop and validate efficient and improved radiative transfer models
2. To develop the Experienced Researcher (ER)’s career by training him in acquiring new knowledge in fire safety engineering
3. To foster a two-way transfer of knowledge between the ER and participating organisations
4. To disseminate and communicate the results of the project.

The action run for 18 months and has broadly met its main objectives. Its main conclusions can be summarised as follows.

1. A rigorous and simplified radiative heat transfer model based on the P1 spherical harmonics to solve the RTE (radiative transfer equation) was developed and applied to some real fire configurations. In addition, a box gas radiation model, based on the exponential wide band approach to handle gas radiation was implemented during the action.

2. The Experienced Researcher (ER), Dr Dombrovsky was provided training in fire modelling by the

supervisors of the projects. These trainings have consisted in one to one sessions covering CFD approaches in fire models, turbulence and combustion modelling. Dr Dombrovsky also has attended the International Water Mist Conference in London in September 2018 to interact with researchers and industry members.

3. During the RAD-FIRE action, seminar and workshop presentations were given by the ER to share his radiation experience with staff and students.

4. A website was created to provide some update information on the RAD-FIRE project. The results of the project were disseminated in four scientific publications (two journals and two conferences). Contacts were made with industry during the International Water Mist Conference in London.

Prace wykonane od początku projektu do końca okresu sprawozdawczego oraz najważniejsze dotychczasowe rezultaty

The action was divided into the four following work packages as described in the DoA :
• WP1: Development & validation of efficient radiation models,
• WP2: Implementation into fire CFD code
• WP3: Training the Experienced Researcher
• WP4: Dissemination and Communication

1. Work done in WP1 & WP2 (modelling studies)

The modelling part of the work has consisted in developing (1) a two-step radiation modelling approach based on P1 method and (2) implementation of a Box gas radiation model.

For fire studies, a model was developed during RAD-FIRE by the ER based on a two-step method to simplify time-consuming spectral radiative transfer calculations in fires. Firstly the P1 approximation is used to calculate the divergence of radiative flux, and the research in RAD-FIRE found that this approach is sufficient to determine the flame parameters. Secondly a ray-tracing procedure is used to obtain the radiation field outside the flame. The real pool fires test cases investigated in RAD-FIRE demonstrate that the two-step method based on P1 and box model is sufficiently accurate for fire applications. This is one of the main contributions of the project. At the same time, typically the computational time decreases in more than two orders of magnitude compared with advanced methods used in many CFD codes. This will lead to a much faster radiation calculations in CFD codes.

The second stage of the modelling task consisted in implementing a gas radiation model that is sufficiently accurate but more computationally efficiency. The real spectrum of thermal radiation was divided into few bands. The box model is based on two key parameters: the averaged band width and absorption coefficients. The preliminary benchmark test cases in RAD-FIRE have shown that the box model provides a good compromise accuracy and computing times for fire simulations.

For fire simulations, the open source LES (large eddy simulation) CFD code FireFoam was used in RAD-FIRE. The radiation models were coupled with FireFoam for real case fire simulations. The results demonstrate that the radiation approach based on P1 and box gas radiation model, is a good way forward in fire simulations, this is another key contribution of the study.

2. Work done in WP3: Training the Experienced Researcher (ER)

The Experience Researcher (ER), Dr Dombrovsky is experienced in radiation heat transfer but not in fire safety. During RAD-FIRE, three academics (Dr Dembele, Dr Volkov and Prof Wen) have held meetings with the ER to discuss turbulence modelling strategies in fires, combustion modelling, Computational Fluid Dynamics (CFD), and the use of the fire computer code FireFoam. PhD students at Kingston University were also involved in two-way transfer of knowledge with the ER. Dr Dombrovsky has attended the International Water Mist Conference to interact with scientists and industry involved in water mist research in fire protection.

3. Work done in WP4: Dissemination and Communication

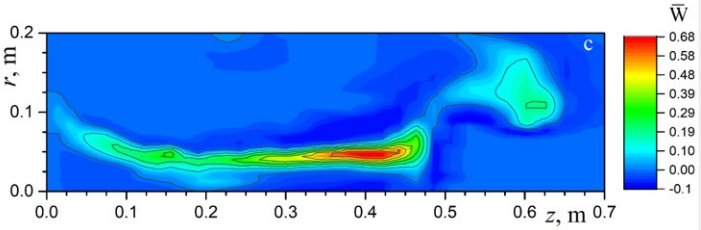
At the beginning of the project, a RAD-FIRE Website was created to to communicate with the outside world on the project. The project results were disseminated mainly in four open accessible publications: two conferences and two journal publications. Also the ER and Lead supervisor attended the International Water Mist Conference in London (19-20 September 2018) where Dr Dembele has highlighted and communicated the main findings of RAD-FIRE.

During RAD-FIRE four research seminars and workshops were held on 7th February 2018, 11th May 2018, 12th September 2018 and 20th February, to share the ER's heat transfer experience and disseminate and communicate on the results of the project. The seminars were well attended by the academic community and has led to some useful potential collaboration between the ER and some other academics. As part of the outreach beyond the academic community, Dr Dembele has spoken to some primary school children about fires on 10 July 2018 in London. Also during the Grenfell Tower fire disaster in London, Dr Dembele has spoken to ITN News TV channel journalist Russell Patrick, about fire safety.

Innowacyjność oraz oczekiwany potencjalny wpływ (w tym dotychczasowe znaczenie społeczno-gospodarcze i szersze implikacje społeczne projektu)

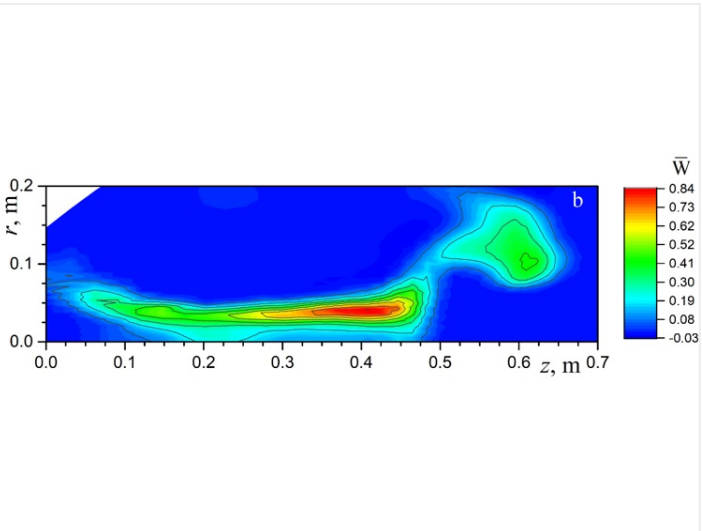
The modelling approach developed in RAD-FIRE, combining a two-step radiative transfer solver and a box gas radiation model applied to fire scenario, is beyond the current state of the art. Fire modellers, academics, industry scientists who could openly have access to the scientific publications and the radiative computer code, could employ it for their own CFD simulations. One of the clear obstacles nowadays in the use of CFD (computational fluid dynamics) for fire simulations is due to the very high computing costs and times. The efficient approach proposed in RAD-FIRE shows that the approach proposed dramatically reduces the computing costs while losing little in accuracy. It will take

few years for the impact to be felt across the community and fire regulators. The Kingston University team will continue to raise the awareness and communicate on the results of RAD-FIRE at other upcoming fire events.

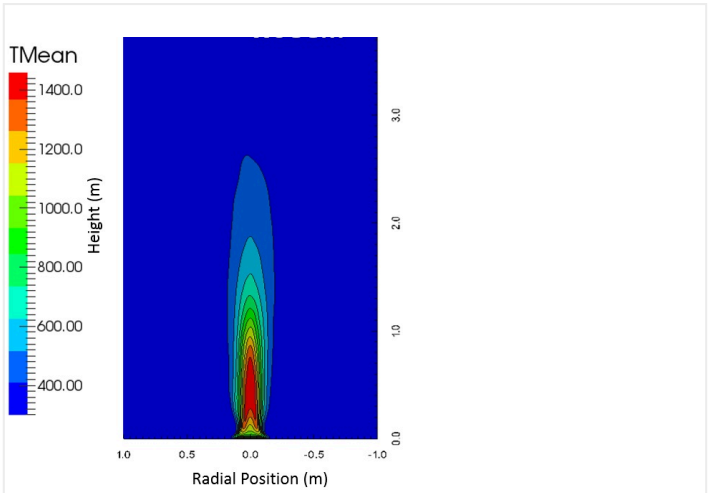


Radiative source term in flame with advanced and time-consuming FVM

Dr Dembele, principal investigator RAD-FIRE (left), and Dr Dombrovsky, Experience Researcher (right)



Similar Radiative source term in flame with time reduced efficient model developed in RAD-FIRE



Computational Fluid Dynamics (CFD) simulation of a pool fire in RAD-FIRE to compare models

Ostatnia aktualizacja: 3 Maja 2024

Permalink: https://cordis.europa.eu/project/id/749220/reporting/pl

European Union, 2025