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Recommendations on how to calculate of fire between industrial buildings

Fire Protection and Risks in Industrial settings

It is important to estimate the risk of fire spread between industrial buildings. In the Swedish guidelines, a requirement for a maximum radiation level during a given period is used to determine the risk of fire spread. The uncertainty in the input parameters used in calculation models is often large. Therefore, a research project which gives overview of the methods available to calculate the fire spread and validation tests for radiation and flame height has been carried out.

An overview of the available knowledge indicates that the single largest problem in the calculation of the risk of fire is to determine the input parameters to the models. The problem is knowing which fire size to be used in the model and what other assumptions to be made. When a building is burning, flames penetrate out from the roof structure, windows or doors. The parts of the flames that penetrate and become visible outside the building generates the radiation flux to nearby buildings. Depending on the building size, design, heat release rate, smoke generation and wind conditions, the risk of fire spread is calculated.

Since there are no data on heat release rates from industrial fires available, we have made estimates by studying photos of various fires. The estimated heat release rate is in the order of 6 GW to 22 GW in the cases studied. This is a very high heat release rates so that flame heights becomes in the order of 15 m to 50 m, and occasionally 150 m. The flame height is not solely dependent on heat release rate, but also the diameter of the fire area. We have found that the ratio between diameter and the flame height is an important parameter. In most major industrial fires the ratio is between 0.1 to 0.4, that is, the flame diameter is 2.5 to 10 times higher than flame height. The effects of crosswind on flame heights and how they lean has also been discussed and analyzed. We estimated the heat release rates that can be generated per fire area, when the flames have penetrated through the roof. We found that the heat release rate varies between 0.5 to 1.3 MW/m^2 MW/m^2. We recommend to use Heskestad flame height correlations which take into account the fire area and heat release rate. The report also provide an equation that can be used when the wind blows. A comparison with full-scale pool fire tests were carried out to validate the models. The results show that when we regards the fire source as point source, as good or better results compared to view factor method are obtained. This is also confirmed in the 1:10 model tests conducted.

The main objective of the 1:10 model tests was to study flame heights and measure radiation from the flames, and to evaluate the computational models used to estimate the risk of fire spreading. The model had dimensions 6 m × 3 m × 0.7 m and simulated an industrial building in full scale measuring 60 m by 30 m by 7 m. The fire source used large wood cribs, which was lit with the help of heptane. These fire sources were designed to get a fire as even as possible over a relatively long period of time. We also aimed at a fire that would cover a large enough surface area to simulate a widespread fire in an industrial building.

A total of ten tests were carried out. The number of openings and their area was varied to simulate the doors and openings in ceilings and walls. The results obtained show that the size of the opening and placement in a significant way affect the radiation and the risk of fire. Figure 1 shows the flame that erupts through the hole in the roof of the model. By collecting the combustion gases in a large hood, the heat release rate could be measured. Together with the measured radiation, flame height and various models for incident radiation to neighboring structures were validated. Something that was very evident during the experimental series was that not only the openings in the roof, but also the openings in the walls and open ports had large effects on the heat release rate.

Report

The project is described in two SP Reports 2010: 17 Industrial Fires — An Overview and SP Report 2010:18 Fire Spread Between Industry Premises. The report can be downloaded from www.brandforsk.nu, project number 601-071.

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