Stabile Systems for Fire Protection - Sprinkler Type Systems

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Stabile systems for fire protection have a great contribution in fire protection and fire elimination. These systems can be realized on different ways and with different fire extinguisher, such as water, CO_2, dust, foam, inergen, halon or some other. Statistically, the number of fires in object with fire detection systems and without fire detection systems is equal. Systems with fire detection in early stage can't stop the occurrence of fire. But, with installed extinguishing systems at the existent systems, the potentials in sense of safety, detection and extinguishing are much bigger. This paper has written to present the stabile systems for fire protection of sprinkler type and FDS computer simulation of extinguishing with this kind of stabile fire protection system.

Key words: *fire, extinguishing, sprinkler, simulation*

1. INTRODUCTION

The main purpose of every fire protection system is right timed reaction, fire detection at early stage and, as much as possible, protection of human lives and material properties. Some of fire protection systems are systems of fire detection, systems that can only detect fire consequences such as smoke, flame or heat, without proper extinguishing action. Anyway, these systems much faster detect fire and, according to that fact, the time needed for start of extinguishing is shorter and results much better than systems without fire detection. These systems are very complex and for the proper and correct functioning they should have next parts-elements: automatic and manual fire detectors, fire detection central device, devices for sound and light alarming, electrical installations for connecting noted elements, devices for additional power supply, parallel indicators, devices for realization functions management and other additional devices and subsystems.

Stabile systems for fire protection present systems that can detect fire and start to extinguish the same with proper fire extinguisher. According to the fact that stabile systems use different fire extinguishers, they can be divided on stabile systems that use water as fire extinguisher (sprinkler and drencher types), stabile systems that use CO_2, stabile systems that use halons (the derivatives of halogen elements and carbon), stabile systems that use inergen (the mixture of three nature gasses: nitrogen (52 %), argon (40%) and carbon dioxide (8%)), stabile systems that use dust, stabile systems that use foam, stabile systems that use pyrotechnic generated aerosol and other [1-4].

2. STABILE INSTALATIONS OF SPRINKLER TYPE

Stabile installation of sprinkler type presents automatic stabile installation for fire protection that uses water spray as fire extinguisher, with proper number of nozzles. In stand by position, nozzles are closed. Fire extinguishing is realized with determined number of nozzles, in dependence of fire spreading speed. This type of stabile installation is used everywhere where water can be used as effective fire extinguisher and where ambient and other conditions allow that (for example, in technical processes with high fire load). In this system, every sprinkler nozzle presents thermo maximal fire detector, which means that this system realizes fire detection and fire extinguishing at the same time.

The principle of activation is in the fact that higher temperature melts ampule in the closest nozzle and releases nozzle opening. That action causes that water or air pressure in pipe line decreases, what leads to open of sprinkler vent in sprinkler station. After that,

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water from the water tank goes through pipe line and sprinkler vent and supply nozzles, while the smaller volume of water goes through electrical signal device that activates mechanical ring by water pressure. System is design that in case that the first nozzle does not extinguish the fire and it expands, next sprinkler nozzles are opening in the direction of fire spreading. Basic elements of wet and dry sprinkler system (sprinkler nozzles, pipe lines, pumps, vents, tank with water and other) are presented on figure 1, while the sprinkler system in action is presented on figure 2.

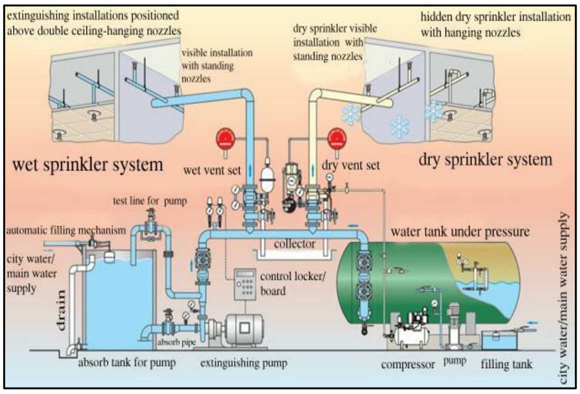

Figure 1 - Scheme of sprinkler installation (figure source: http://www.virsistem.co.rs/gasenje-pozara/ sprinkler/)

Figure 2 - Sprinkler system in action (figure source: http://allsafefiresprinkler.com/)

Sprinkler installations, according to ambient conditions can be realized as wet sprinkler installation, dry sprinkler installation, combined sprinkler installation, dry fast reacting installation and dry sprinkler installation with previous management.

Wet sprinkler installation is used for fire protection of objects where doesn't exist danger from freezing all over the year. Minimal temperature in object should be 5 ° C. The main characteristic of this type of sprinkler installation is that all pipelines are filled with water under pressure permanently and it has very short time for activation.

In opposition to wet sprinkler installation, dry sprinkler installation has a net of pipelines filled with air under pressure, from the point of sprinkler vent to the points of sprinkler nozzles. The main characteristic of this type of sprinkler installation is that it must be installed in objects endangered with low and high temperatures.

Combined sprinkler installation implies one wet installation connected with one or more dry installations. The main characteristic of this type of sprinkler installation is that it must be installed in objects that have permanent heating with several zones endangered with low temperatures or with high temperatures. Usually, in summer months, this installation is filled with water, while in the winter months this installation is filled with air.

Dry fast reacting installation presents simple dry sprinkler installation where the opening of sprinkler vent is controlled by main central device for automatic fire detection. The main characteristic of this type of sprinkler installation is the curtailment of the time needed for its reaction.

Dry sprinkler installation with previous management presents an installation where water was leaded to the sprinkler vent by previous reaction of automatic fire detection system. Activation of sprinkler vent is regulated by activation of sprinkler nozzle. This type of sprinkler installation is applied wherever water can do great damages due to false alarming.

The important parts of every sprinkler system are sprinkler vent and sprinkler nozzle.

Sprinkler vent presents very important part of every sprinkler system. It has several tasks with crucial importance for functioning of complete sprinkler system. It must to control signal system, to control pressure in pipelines and sprinklers net ant to enable again restoration of sprinkler system. The sprinkler vent can be wet vent, combined wet dry vent or sprinkler vent with previous action, in accordance of system that they have designed for.

Sprinkler nozzles also present very important parts of every sprinkler system. They practically present activation element of the sprinkler system. The main purposes of every nozzle are to open itself at the determined temperature and to sprinkle protected area. Sprinkler nozzles can be differ by different criteria: reaction temperature, the way of opening of water exit, spray shape deflector, the way of hanging etc.

Sprinkler nozzles are mounted only vertically on that way that for wet sprinkler installation nozzles are mounted with deflector turned down while for dry and combined sprinkler installations, nozzles are mounted with deflector turned up. Every sprinkler nozzle should provide at least 60 l of water per minute. Nozzles must be mounted on that way that one nozzle mustn't overlap other nozzles. The selection of sprinkler nozzles demands many different factors, such as geometry shape of the room, geometry space relationships, sprinkler net pressure, needed volume of water, temperature, corrosion danger and similar. It is very important to note that the number of sprinkler nozzles in protected area demands from fire hazard degree, size and height of protected area and the way of material storage. According to that, vertical distance deflectors from the ceiling must be from 12 cm to 15 cm and mustn't be less than 7 cm and bigger than 250 cm. Especially important fact is that sprinkler nozzles mustn't have any obstacles below their Some of sprinklers nozzles are presented on figure 3.

Figure 3 - Different types of sprinkler nozzles (figure source: Tošić A, Stabilni sistemi za gašenje, skripta za pripremu stručnog ispita iz oblasti Zaštite od požara, slide 32)

The special cases of sprinkler installations are high pressure sprinkler installations- sprinkler installations that use water fog. These systems demand lot of corrections related to the classical sprinkler systems. These corrections imply usage of proper devices and equipment for water fog. Water fog has great advantages as fire extinguisher. Water drops have very small dimensions (from 0.3 mm to 0.6 mm) and it enables very big surface between water drops and burning material. Water fog has about 125 times bigger cooling effect than full water spray.

Also, water fog has significant choked effect. The usage of water fog in sprinklers systems demands special room supplied with bottles that, in the most common cases, contain inert gasses. These systems also demand work pressure bigger then 20-30 bars (sometimes pressure can reach up to 100 bars), so it implies that pipe nets must be resistance on high pressure. Water fog also demands special kind of sprinkler nozzles. The difference between classic sprinkler nozzle and nozzle for water fog is presented on figure 4, a and b.

a)

b)

Figure 4 - The difference between classic sprinkler nozzle (a) and nozzle for water for (b) (figure source: Tošić A, Stabilni sistemi za gašenje, skripta za pripremu stručnog ispita iz oblasti Zaštite od požara, slide 32)

All devices that provide power supply, management, alarming, water supply and other needed devices needed for system functioning are located in the sprinkler station. This part of the object must be designed according to special conditions and it must provide special demands, such as reserve power supply, determined temperature (between 5 ° C to 40 ° C), high fire safety (at the first place, built from fireproof material) and others.

Realization, design, installation, maintaining and control of sprinkler systems are allowed by proper competent and certified persons with proper documents, certificates and licenses [5-15].

3. SIMULATION MODEL

Simulation model for this paper was realized in FDS software (version 6.6). This software was developed for investigation and prediction of fire and smoke and has a great usage in calculations and investigations related to fire and smoke.

Simulated object has dimensions 24.5 m x 24.5 m x 3.2 m with six separated rooms (rooms dimensions were 8 m x 3 m x 3.2 m). Whole object was built from concrete. The fire source was located in the upper part of the middle hallway and it was modelled as burner in form of rectangle with dimensions of 7.9 m x 0.95 m and HRR (Heat release rate per area) of burner 2500 kW/m^2. The sprinkler vents were set to 65 l/minute under 1 bar pressure and their reaction temperatures were set to 70 ° C. Simulated object with sprinklers and burner positions is presented on figure 5.

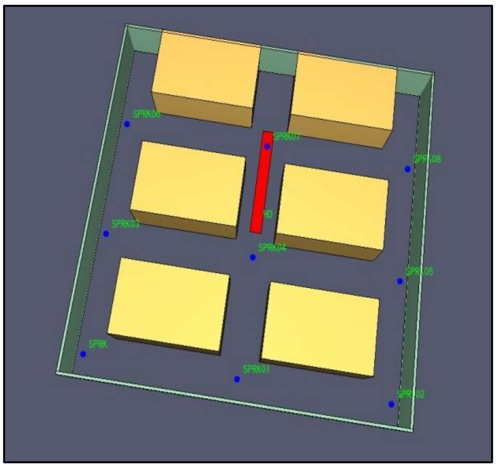

Figure 5 - Simulated object with sprinklers arrangement and burner`s position

4. SIMULATION RESULTS

The computer used for simulation for this paper was Laptop ACER Aspire 3 A315-31-C5UX – NOT-11988 Intel® Celeron® N3350 at 2.20GHz, 128GB SSD, 4GB RAM. The complete simulation time was set to 240 seconds. Simulation realized results were divided into two groups. The first group were results that showed fire and smoke spreading and reaction of determined sprinkler`s vents, presented from figures 6 to 11, while the second group were results that showed thermal presentation during fire extinguishing, presented from figures 12 to17.

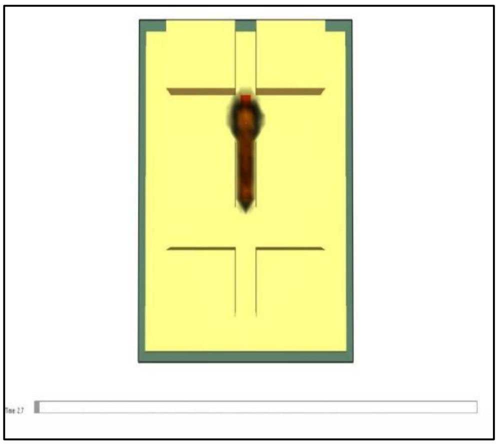

Figure 6 - Smoke and flame spreading with sprinkler reaction after 2.7 seconds from fire start

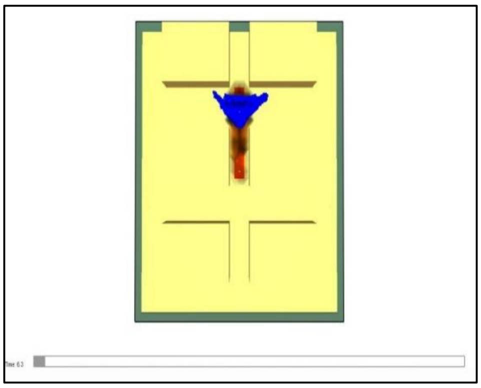

Figure 7 - Smoke and flame spreading with sprinkler reaction after 6.3 seconds from fire start

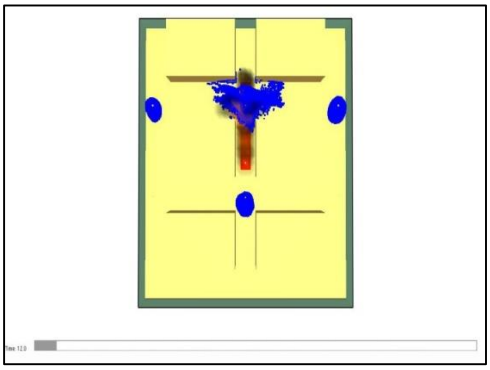

Figure 8 - Smoke and flame spreading with sprinkler reaction after 12 seconds from fire start

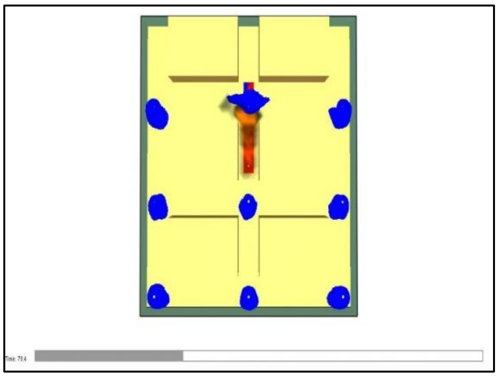

Figure 9 - Smoke and flame spreading with sprinkler reaction after 79.4 seconds from fire start

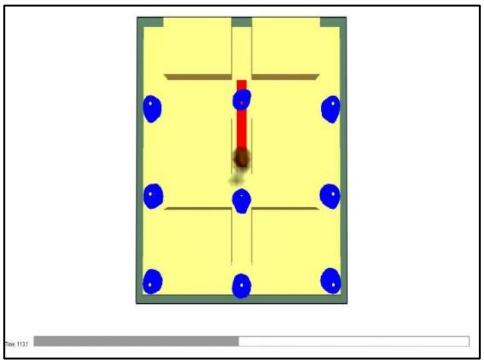

Figure 10 - Smoke and flame spreading with sprinkler reaction after 113.1 seconds from fire start

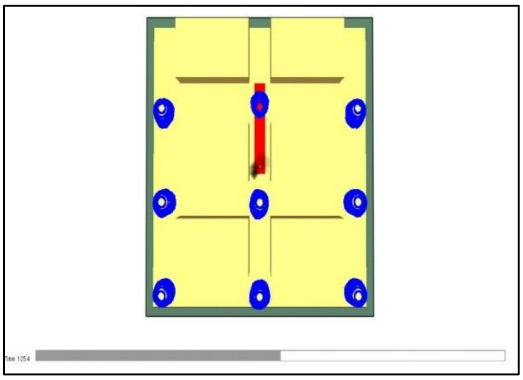

Figure 11 - Smoke and flame spreading with sprinkler reaction after 125.4 seconds from fire start

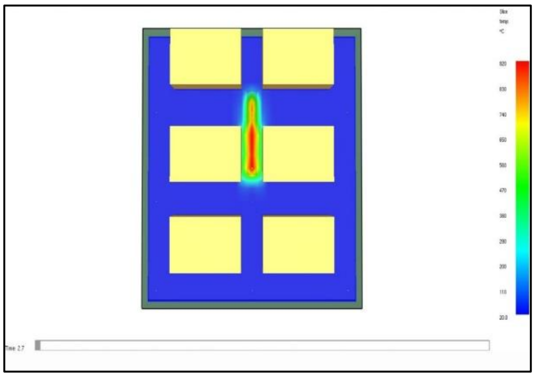

Figure 12 - Thermal presentation of sprinkler reaction after 2.7 seconds from fire start

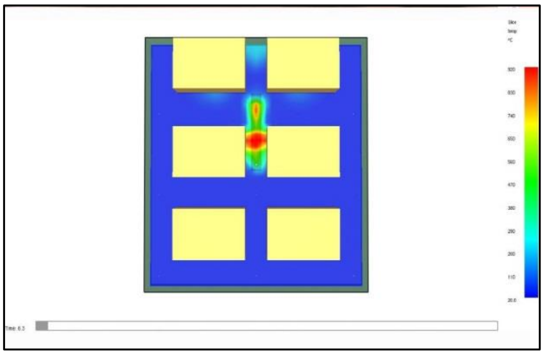

Figure 13 - Thermal presentation of sprinkler reaction after 6.3 seconds from fire start

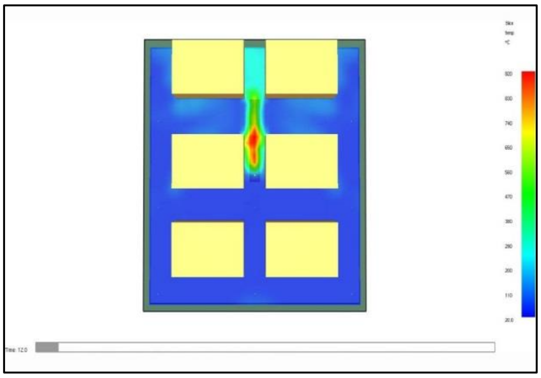

Figure 14 - Thermal presentation of sprinkler reaction after 12 seconds from fire start

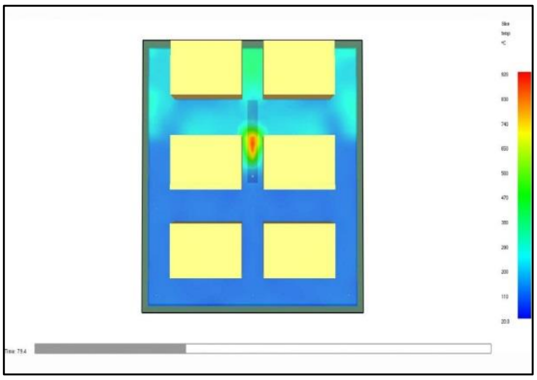

Figure 15 - Thermal presentation of sprinkler reaction after 79.4 seconds from fire start

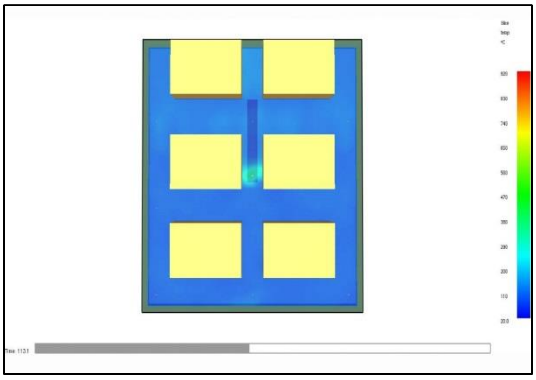

Figure 16 - Thermal presentation of sprinkler reaction after 113.1 seconds from fire start

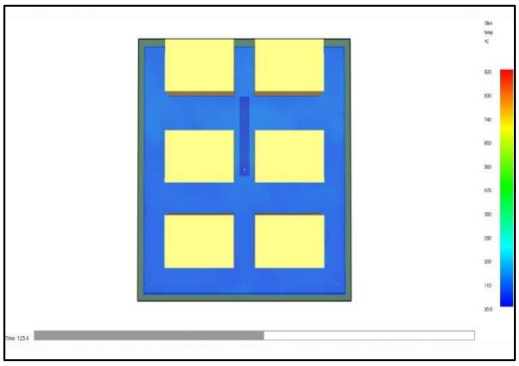

Figure 17 - Thermal presentation of sprinkler reaction after 125.4 seconds from fire start

5. ANALYSIS OF RESULTS

Simulation results showed that sprinkler installation reacted very fast (figure 7) and extinguish fire after 100-120 seconds. At the start moment, the closest sprinklers reacted, after some time, other sprinkler reacted. It is important to note that in this simulation, fire started directly at burning phase where the temperature at the floor, where the burner was located, reached up to 900 °C (figures 13 and 14).

After sprinkler reactions, temperature fell at room`s temperature, around 20 ° C (figures 16 and 17). It was obvious according to the realized results that fire extinguishing time could be even shorter, if the pressure in nozzles was higher (higher than 1 bar) and related to that, volume of water through nozzles was bigger (bigger than 65 l/minute).

6. CONCLUSION

Sprinkler installations are used wherever water can be used as fast fire extinguisher and have a great usage as stabile fire protection systems. Design of these systems implies many different and demanded tasks, such as: needed water volume for extinguishing, types of water sources, limited and unlimited water sources, selection and types of sprinklers, water tanks under pressure, pumps, minimal pressure on sprinkler`s nozzle, water pipeline, pressure fall in installation, power supply by two electric nets, arrangement of sprinklers, power supply by electric net and alternative diesel engine and many other.

Testing of sprinkler system implies testing partial elements, parts and devices. Testing results are written into protocol. Usage of simulation software can be very useful in automatic stabile fire protection systems design and calculations. These calculations can significantly improve the complete systems efficiency and significantly decrease testing costs [16, 17].

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REZIME

STABILNI SISTEMI ZA ZAŠTITU OD POŽARA - SISTEMI SPRIKLER TIPA

Stabilni sistemi za zaštitu od požara imaju veliki doprinos u zaštiti od požara i eliminisanju požara. Ovi sistemi mogu biti realizovani na različite načine i sa različitim sredstvom za gašenje, kao što su voda, , CO_2, prah, pena, inergen, halon ili neki drugi. Statistički, broj požara u objektim sa sistemima za dojavu požara i bez sistema za dojavu požara je isti. Sistemi sa dojavom požara u ranoj fazi ne mogu zaustaviti pojavu požara. Ali, sa instaliranim sistemima za gašenje požara u postojećim sistemima, mogućnosti u smislu sigurnosti, detekcije i gašenja su mnogo veće. Ovaj rad je napisan sa ciljem da predstavi stabilni system zaštite od poara tipa sprinkler i FDS računarsku simulaciju gašenja ovim sistemom za zaštitu od požara.

Ključne reči: *požar, gašenje, sprinkler, simulacija*