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(54) **FIRE SPRINKLER SYSTEM**

BRANDSPRINKLERSYSTEM

SYSTÈME D'EXTINCTEURS AUTOMATIQUES

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to sprinklers used in automatic fire protection systems for storage buildings, warehouses and the like.

BACKGROUND OF THE INVENTION

[0002] Automatic sprinklers have long been used in automatic fire protection systems for buildings in order to disburse a fluid to control a fire. Typically, the fluid utilized in such systems is water, although systems have also been developed to disburse foam and other materials. Historically, sprinkler heads include a solid metal base connected to a pressurized supply of water, and some type of deflector used to alter the trajectory of the water flow. Alteration of the water flow by the deflector generates a defined spray distribution pattern over the protected area. The deflector is typically spaced from the outlet of the base by a frame, and a fusible trigger assembly secures a seal over the central orifice. When the temperature surrounding the sprinkler head is elevated to a pre-selected value indicative of a fire, the fusible trigger assembly releases the seal and water flow is initiated through the sprinkler head.

[0003] Originally, automatic sprinkler systems have been designed to achieve what is referred to as "fire control" about a protected area. In the fire control method of combating fires, the automatic sprinkler system is designed and installed such that a relatively large number of individual sprinklers will activate upon detection of a fire. That is, in response to a fire, not only will the sprinklers closest to the fire be actuated, but also sprinklers, which protect the areas surrounding the fire, so as to define a controlled area. While it is anticipated that the sprinklers immediately above the fire may not be able to extinguish the fire, the goal of the fire control method is to actuate the sprinklers about the fire to pre-wet the combustible materials in the fire's general vicinity to prohibit the fire's growth. Thus, the fire control method seeks to confine the fire within a predetermined area until additional fire fighting methods are deployed, such as response by a fire department, in order to extinguish the fire.

[0004] Beginning in the 1970's, industries began more widely using relatively large warehouses for the storage of products. To effectively utilize space within these warehouses, products are normally stacked on racks in a vertical arrangement. These warehouses may reach approximately 10 meters in height and contain storage racks offering a storage height exceeding 7 meters. However, as the storage height extends to higher levels, fire protection becomes more difficult to achieve.

[0005] An alternative to traditional ceiling sprinklers that allows for high rise storage racks is a system combining ceiling sprinklers with in-rack or aisle sprinklers. In such systems, sprinklers are thus installed within the storage array defined by the rack. These sprinklers typically oppose vertical fire growth up as well as horizontal fire spread within the rack.

[0006] A further measure to limit fire spread is provision of so-called "flue spaces", both longitudinally and transversally, as well as horizontal barriers. Flue spaces are open spaces between rows of storage. In rack storage, the longitudinal flue spaces are perpendicular to the direction of loading, and transverse flue spaces are parallel to the direction of loading. Horizontal barriers are solid sheets on a horizontal plane within a rack, beneath which in rack sprinklers are installed. They extend to both ends and aisle faces of the rack. Their purpose is to impede vertical fire spread by blocking off normally open flue spaces, while also helping to achieve prompt in-rack sprinkler operation by banking heat down to the in-rack sprinklers that must be installed under each barrier.

[0007] It may also be noted that, in the 1970s, Factory Mutual Research Corporation's research lead to the development of the so-called "large drop sprinkler", designed to control high-challenge storage fires of moderate height. In the new engineering bulletin for FM Global (dated 22.06.2006) the storage height for uncartoned expanded plastis is limited to 3 m (10 ft) height in 7,5 m (25 ft) high buildings. The bigger diameter of the orifice of the large-drop sprinkler produces significantly larger water droplets to more effectively penetrate a fire plume.

[0008] As a further alternative to the inadequacies of traditional ceiling-level sprinkler systems, the sprinkler industry began the design and installation of "Early Suppression Fast Response" (hereinafter referred to as "ESFR") sprinkler heads. As the name indicates, the theory behind ESFR is to deliver a sufficient quantity of water during the early stages of fire development in order to suppress and extinguish the fire and deny the opportunity for fire growth. In order to achieve the goal of early suppression, ESFR sprinklers must quickly generate a sufficient quantity of water capable of penetrating the fire plume and thus be delivered to the core of the fire, often referred to in the industry as the "fuel package." To deliver a sufficient quantity of water to the "fuel package", ESFR sprinklers are equipped with a thermally sensitive fusible trigger assembly capable of actuating the sprinkler head shortly after ignition of the fuel package. US 7,036,603, e.g., describes an ESFR sprinkler systems.

[0009] Hence, over the years, sprinkler technology has evolved and various fire combating strategies with sprinklers have been developed. Today, different organizations, inter alia the European insurance and reinsurance federation (CEA, *Comité Européen des Assurances),* the National Fire Protection Association (NFPA) and the Factory Mutual Research Corporation (FMRC), provide guidelines and regulations concerning the design and installation of automatic fire sprinkler systems. Typically such regulations and guidelines are based on data gained over decades of experience, and are updated in light of advances in technology. Compliance with these

regulations is frequently required by state agencies and insurance companies. Consequently, as a commercial practicality, sprinkler designs and the installation of sprinkler systems must be able to perform successfully within the accepted guidelines e.g. set by the NFPA. Failure to conform or operate successfully within regulations and guidelines effectively prohibits the commercial viability of a particular sprinkler design or its installation.

[0010] In addition to providing guidelines concerning the design and installation of sprinklers, the FMRC, in conjunction with the NFPA, have established "commodity" classifications which categorizes materials commonly found in warehouses or storage facilities. A European classification also exists, but is less detailed. Each commodity classification segregates materials according to their degree of combustibility and the operating requirements necessary to extinguish them. For each of these commodities, a particular sprinkler head must meet certain water properties (supply and discharge requirements) in order to provide adequate protection. Currently, materials are classified in the following commodity classifications: class 1 through 4 and Plastics, the latter being further detailed as: carton unexpanded plastic, cartoned expanded plastic, uncartoned unexpanded plastic and uncartoned expanded plastic. Of these commodities, uncartoned unexpanded and expanded plastic commodities represent the two most challenging fire hazards, with uncartoned expanded plastic carton commodities representing the most challenging fire scenario. Expanded plastic is classified in the highest hazard class HHS4 of the European classification.

[0011] The NFPA and FMRC regulations/guidelines are thus extremely precise and detailed in terms of commodity class, sprinkler type, storage arrangement, packaging, storage height, building height, etc. As it appears from these documents, protection options for rack storage arrangements are based on either ceiling-only sprinkler systems or a combination of both ceiling-level and in-rack sprinklers. The FMRC guidelines indicates the number of in-rack sprinklers depending on the commodity class, storage height, rack type (simple, double or multiple row), etc.

[0012] While various sprinkler systems have been developed, one attracting solution remains the ESFR sprinkler system or more generally ceiling-level sprinklers. Indeed, being able to control or suppress a fire in a warehouse using ceiling-level sprinklers only greatly simplifies the installation of the fire protection system. It must be said that employing in-rack sprinklers has several drawbacks:

- a minimum distance is required between the sprinkler head and the top of the stored products, whereby storage space is lost;
- changing or modifying the rack requires in most cases a modification of the sprinkler system;
- moving a rack always needs modifying the sprinkler system;
- there is always a risk of damaging a sprinkler head when loading or unloading a storage bay, in particular when employing a fork lift.

[0013] As mentioned before, the theory behind ESFR is to deliver a sufficient quantity of water during the early stages of fire development in order to suppress and extinguish the fire and deny the opportunity for fire growth. Therefore, ESFR sprinklers have a large discharge coefficient, K-Factor, and are designed for a rapid activation, as indicated by their low Response Time Index (RTI).

[0014] As it is known in the art, the K-factor is defined as $K = Q \cdot P^{1/2}$, where Q represents the flow rate (in L/min) of water from the outlet of the internal passage through the sprinkler body and P represents the pressure (in bars) of water fed into the inlet end of the internal passageway though the sprinkler body.

[0015] The RTI value is essentially a measure of the thermal sensitivity of the fusible trigger assembly, which actuates the sprinkler head. Consequently, the lower the RTI value of a particular sprinkler, the faster the actuation time of the sprinkler head in response to a fire.

[0016] As it appears from the above, the art of fire sprinklers is highly empirical. The regulations and guidelines are based on data from tests or real fires collected over decades. Fire sprinkler installations are required to conform to these guidelines to meet the approval of insurances companies and it is not advisable to derive therefrom.

[0017] For example, in accordance with FMRC guidelines of May 2005 (see .e.g. data sheet 8-9, table 2.3.7.5 (d) *"Suppression Mode Sprinklers for Rack Storage of Uncartoned Expanded Plastic with Open Shelves*") protection concepts for Uncartoned Expanded Plastic with ceiling-level sprinklers only is limited to a storage height of 7.5 m with a ceiling height of 12 m and using rack storage with open shelves. According to this standard, the ESFR sprinklers (called "Suppression Mode" sprinklers in FMRC documents) have a K-factor of 200 L/(min·bar$^{1/2}$) (14 gpm/(psi)$^{1/2}$) at 6.9 bars (100 psi), i.e. providing a density of 58.4 mm/min (1,43 gpm/ft^2) with a sprinkler spacing of 3 m (10 ft).

[0018] In the more recent FMRC guidelines of January 2008, (see data sheet 8-9, table 2.3.7.5(a) Suppression Mode Sprinklers Installed on a Wet System for Rack Storage with Open Shelves) a new protection concept for Uncartoned Expanded Plastic with ceiling-level sprinklers only is presented, which needs a high amount of water of about 88 L/(min·m^2) for a ceiling height of more than 9 m. As a minimum total flow more than 16 000 L/min are needed. According to the FM Global data sheet 2-2 "Installation rules for suppression mode automatic sprinklers", 2.3.2.5 "Flue Spaces in Racks", continuous longitudinal and transverse flue spaces are required for a rack storage above 7.6 m.

[0019] WO 98/56510 describes a sprinkler arrangement for an enclosure with storage racks with a low pressure water supply using very extra large orifice sprinklers arranged in arrays in which the sprinklers are spaced by ten feet in two orthogonal directions or by ten feet in one direction and by eight feet in an orthogonal direction. The commodities to be protected are stored in racks extending parallel to one of the orthogonal directions.

OBJECT OF THE INVENTION

[0020] The object of the present invention is to provide an alternative type of fire sprinkler system that is suitable for high-rise storage heights and that does not require in-rack sprinklers.

[0021] This object is achieved by a sprinkler system as claimed in claim 1.

SUMMARY OF THE INVENTION

[0022] The present inventors have considered that the ESFR sprinkler concept, while being very satisfactory from the logistical point of view, relied on a philosophy that was not optimal. Indeed, quick activation of the sprinklers, in particular when backed-up with fast in-rack sprinklers, causes a significant decrease in the water pressure delivered to each individual sprinkler head. Less water is thus available for delivery to the fire and provides an opportunity for the fire to spread. Furthermore, actuation of remotely located sprinkler heads results in water damage to the products protected by such sprinklers. Also, early activation of sprinklers leads to a quicker consumption of water resources, which may thus compromise the water feed over time.

[0023] Furthermore, fire tests with ESFR ceiling protection only have shown that there are limitations in the protection of exposed expanded plastics and candles with ESFR sprinklers.

[0024] To avoid theses problems, the present inventors have developed a fire sprinkler system that can be used for high storage heights and does not require in rack sprinklers. It permits controlling the fire and limiting the fire damage to a given area. Accordingly, the present invention concerns a fire sprinkler system for an enclosure, namely a warehouse or the like, which has a ceiling and a floor, and has a storage area comprising one or more racks for the storage of goods, namely flammable goods. The racks offer a storage height that may be up to 8.5 m (27.89 ft) and comprise vertical solid barriers extending over the rack's depth and storage height, the maximum distance between two successive solid barriers being about 5.8 m (19.03 ft). The sprinkler system comprises ceiling-level sprinklers having a standard thermal sensitivity, i.e. having a RTI of 80 or greater.

[0025] It has been surprisingly found that the present sprinkler system, associating standard response sprinklers with the passive protection provided by vertical barriers, permits controlling a fire of very hazardous products in high-rise storage racks. By contrast to the popular ESFR sprinkler technology that uses quick- or fast-response sprinklers and requires both longitudinal and transverse flues, the present sprinkler system has proved efficient while using standard-response sprinklers. The use of slower response sprinklers results in the triggering of a fewer amount of sprinklers; this is favourable in terms of water pressure and autonomy. In particular, the present sprinkler requires less water than the very water-demanding ESFR concept described in above-mentioned FM data sheet 8-9.

[0026] Another surprising and appreciable aspect of the invention, in particular over the ESFR concept, is that transverse flues are no longer needed, which facilitates the storage of pallets with varying sizes in the racks.

[0027] While this system has been designed to operate with ceiling-level sprinklers only, one may of course add other types of sprinklers.

[0028] Preferably, the K-factor is of at least 115 L/(min $bar^{½}$) (8 gpm/$(psi)^{½}$), more preferably above 160 L/(min·$bar^{½}$) (11 gpm/$(psi)^{½}$) and even above 260 L/(min·$bar^{½}$) (18.1 gpm/$(psi)^{½}$). In particular, the K-factor may be in the range of 160 L/(min·$bar^{½}$) to 290 L/(min·$bar^{½}$) (11 gpm/$(psi)^{½}$ to 20.1 gpm/$(psi)^{½}$), or more preferably between 260 L/(min·$bar^{½}$) and 290 L/(min·$bar^{½}$) (18.1 gpm/$(psi)^{½}$ to 20.1 gpm/$(psi)^{½}$).

[0029] The values of RTI and K-factor mentioned herein are to be interpreted in accordance with European standard EN 12259-1 for fixed firefighting systems (components for sprinkler and water spray systems - Part 1: Sprinklers).

[0030] As it will be understood by those skilled in the art, when a lower K-factor is used the sprinkler spacing shall be reduced as well. Typically, in the sprinkler spacing may be between 2 and 3 m (6.56 to 9.84 ft).

[0031] In one embodiment, the sprinkler spacing, K-factor and supply pressure are determined so as to provide a density of minimum 45 mm/min (1.10 gpm/ft^2), preferably minimum 50 mm/min (1.23 gpm/ft^2). Typically the design density may be less than 70 mm/min (or 70 L/(min·m^2). The density values given herein are also expressed in accordance with EN 12845, "Fixed firefighting systems - Automatic sprinkler systems - Design, installation and maintenance" or CEA 4001, "Sprinkler Systems, Planning and Installation".

[0032] In the present system, the ceiling height may be as high as 12 m (39.37 ft), and the storage height may reach 8.5 m (27.89 ft). The present system is thus especially designed for rack storage in warehouses having a ceiling height of between 10 and 12 m (32.80 to 39.37 ft), and where the storage height is between 6.5 and 8.5 m (21.33 to 27.89 ft) and especially between 7.5 and 8.5 m (24.61 and 27.89 ft). In the latter cases, the vertical barrier has a height of up to 8.5 m, or between 6.5 and 8.5 and specifically between 7.5 and 8.5 m. The present system may however also be used for lower ceiling and storage heights.

[0033] Preferably the racks are of the double row rack

type, but single row racks and multiple row racks can also be used provided that the solid vertical barriers properly span over the entire width and storage height. More preferably, double row racks are used in the storage area, which are designed to offer a max. storage height of 8.5 m (27.89 ft) and a max. storage depth (width) of 4.6 m, (15.09 ft) including a longitudinal flue space of min. 0.2 m (7.87 in). The rack shelves may be open (or slatted) or full shelves (without openings). The distance between two consecutive shelves may typically be between 0.75 and 1.5 m. The rack structure is preferably of metal.

[0034] The solid vertical barriers preferably consist of non-combustible material such as sheet metal. For example a 1 to 2 mm (0.04" to 0.08") thick (or even greater) metal sheet may be used as vertical barrier. However, combustible materials, e.g. plywood, with sufficient thickness can be utilised as well; especially surface-treated combustible material (e.g. coated with fire retardant material) that is consequently classified as non-combustible. In the case wood is used for the vertical barriers, the thickness is preferably no less than 10 mm, more preferably no less than 13 mm (½"). The solid vertical barriers span vertically the entire width and storage height, covering the longitudinal flue spaces, preferably with a maximum 75 mm (3") opening at the rack's structural elements.

[0035] Preferably, the ceiling-level sprinklers to be employed in the present system present one or more of the following characteristics:

- Pendent-type;
- K-factor in the range of 160 to 290, namely about 280;
- a RTI in the range of 95 to 115, namely about 100;
- temperature: in the range of 68 to 141°C, namely about 74°C;
- min design density: 50 mm/min (1.23 gpm/ft^2), preferably between 56 (1.38 gpm/ft^2) and 65 mm/min (1.60 gpm/ft^2);
- distance to ceiling: between 7.5 cm to 50 cm, preferably not more than 30 cm;
- nominal spacing for each sprinkler, max. 9 m^2 (i.e. a sprinkler spacing of max. 3 m).

[0036] The extinguishing agent any be water or any appropriate fluid. The water supply in the piping network connecting the sprinklers is preferably designed to provide the sprinklers with water at the allowed pressure range for normal spray sprinklers, which means between 0.5 and 12 bar. The pressure for the normal spacing of 3 m may be about 3.4 bars.

[0037] As it has been explained, the present system has been developed for the storage of very hazardous goods, such as plastics goods, and more specifically exposed expanded plastics, exposed plastic goods and candles. As it is known, candles and exposed expanded plastic are the highest hazard categories. Hence, products falling under commodities class 1 to 4 and Plastics can be properly stored and protected with the present system. Accordingly, the present system is suited for protection of materials having a heat of combustion generally ranging between 12,000 and 20,000 Btu/lb (27,910-46,520 kJ/kg).

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The present invention will now be described, by way of example, with reference to the accompanying drawing, in which:

FIG. 1: is schematic view of a preferred embodiment of the present fire sprinkler system;

FIG. 2: is a view of the rack of Fig.1, from its small side;

FIG. 3: is a sketch illustrating the storage rack and sprinkler locations as used in example 1;

FIG. 4: is a graph showing the result of the opening of the sprinklers on the temperature of the rack in the vicinity of the ignition point in example 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0039] Figs. 1 and 2 schematically illustrate a preferred arrangement of a fire sprinkler system and storage rack in accordance with the invention. Reference sign 10 indicates a double row rack installed in a storage area of a warehouse or other enclosure (with floor 12 and ceiling 14), which has a max. ceiling height of 12 m. The rack 10 offers a max. storage height of 8.5 m, i.e. it is designed to store goods up to that height.

[0040] The rack 10 consists of a metal (aluminium or iron) structure and has open shelves 16. The open shelves are covered by the stored material, which avoids water penetration from the top. The shelves 16 are arranged to offer a max. storage depth of 4.6 m, while maintaining a longitudinal flue 18 of no less than 0.2 m. The rack 10 can be provided with steel separation bars or other means to maintain the longitudinal flue.

[0041] It shall be appreciated that the rack is provided with solid vertical barriers 20, here 13 mm thick wood, that span over the rack's depth and storage height (i.e. up to the height of the products stored in the rack). The contours of the vertical barriers 20 are shown in dashed lines in Fig.2. These vertical barriers 20 help limiting the longitudinal propagation of the fire. They are longitudinally spaced and arranged transversely in the rack (thus

parallel to one another). A desired number of vertical barriers 20 can be arranged in the rack, and this will typically depend on the rack's length. The maximum distance of 5.8 m (19 ft) between two consecutive vertical barriers is however to be respected. It may be noted that conventionally, the term storage height designates the max. allowable height of the products stored on a rack (the rack height being slightly lower). However, in the present case, the vertical barriers advantageously extend up to the storage height; therefore, the height of the rack, with the vertical barriers, is the same as the storage height.

[0042] It shall further be appreciated that the sprinkler system is designed to operate with ceiling-level sprinklers only. The ceiling-level sprinklers, indicated 22 in Fig.1, have a standard thermal sensitivity, i.e. an RTI of 80 or greater and preferably a K-factor of at least 115 L/(min·bar$^{1/2}$ (may be above 160 (11 gpm/(psi)$^{1/2}$) or preferably above 260 (18.1 gpm/(psi)½)). The sprinklers 22 are of the pendent type, arranged at a distance between 7.5 and 30 cm (3" - 1 ft) from the ceiling 22 and here mounted on a same piping 24.

[0043] Surprisingly, the combined use of solid vertical barriers 20 in a high rise storage rack 10 with standard response sprinklers 22 permits to control a fire ignited in a rack section between two consecutive vertical barriers 20 for a period of time sufficient to allow fire fighters intervention.

[0044] No transverse flue spaces are required.

Example 1:

[0045] A fire test using the above-described concept of ceiling-level sprinklers only and high rise storage racks with solid vertical barriers mounted on certain frames of the racks in order to limit the horizontal propagation of the fire was carried out. The test configuration is illustrated in Fig.3. The system comprises 20 sprinklers indicated S1...S20. Sprinklers indicated S5b, S10b, S15b and S20b are so-called target sprinklers.

[0046] The double-row rack 50 has a length of 12 m. Each row (I and S) has width of 1.85 m and a longitudinal flue space of 600 mm is maintained by steel separation bars. The shelves are of the open type and there are 5 levels plus one on the floor. The height of the steel frames is 7 m, but it is loaded with goods up to a height of 8.5 m. Two vertical barriers 52 are arranged in the rack with a spacing of 5.8 m; they each have a height of 8.5 m and a width of the depth of the rack, here 4.3 m. The vertical barriers 52 are consist of B1 fire resistant wood panels of 14 mm (0.55 in) thickness.

[0047] Sprinkler specifications and installation configuration:

Sprinklers installed at ceiling only; Pendent type;

Standard response (RTI 103); Temperature: 74 °C (165 °F);

K-factor: 275 (19: US);

Pressure: 3.4 bar (49.3 psi);

Nominal spacing for each sprinkler: 9 m^2 (96.9 ft^2);

Distance between deflectors and ceiling: 30 cm (11.81 in);

Density: 56 mm/min (1.38 gpm/ft^2);

Extinguishing agent: Water only.

[0048] The goods in the storage rack 50 are on oversized wooden pallets of various dimensions and are comprised of candles and mattresses (simulated with sheets of polyurethane foam). There are also some dummies pallets in the rack, which are comprised of empty cardboard cartons.

[0049] A square pool fire of 0.25 m^2 was used as ignition device. The pool fire was made in a steel plate having a height 50 mm and a thickness of 2 mm. The tray was first filled with water to a depth of 1 cm. The quantity of fuel used for the ignition was one liter of heptane poured on top of the water. The ignition point, indicated 54 in Fig. 3, was located on the floor, between the two large pallets in the lower bay of rack I.

[0050] Reference sign 56 indicates a target rack that was placed in front of the test rack 50 and loaded with dummy-goods, i.e. empty cartons on pallets. The cartons were placed on normal European wood pallets, and on each pallet the dummy-goods were wrapped with rolled plastic foil.

[0051] The target rack 56 is a single row rack with the following characteristics: Length: 5.7 m; Width: 1.0 m; Height of the frame: 8 m; Levels of storage: 5 + one on the floor, like the test rack.

[0052] The test rack 50 and the target rack 56 rack are placed face to face, such that the pallets in the target rack are directly in front of the ignition point 54 in the test rack 50. The width of the aisle between the test and target rack is 3 m.

[0053] Fig.4 is a graphic where temperatures of the section of a steel angle iron above the ignition point and the number of opened sprinklers are plotted versus time. Indeed, to monitor the temperature about the ignition point, a section of steel angle iron was mounted against the ceiling of the lower bay, above the ignition point. The section of steel angle iron was equipped with 3 thermocouples designated T1, T2, and T3.

[0054] The graphic of the steel angle iron temperature in Fig.4 shows that the sprinkler installation has reduced the power of the fire and controlled it during the 30 minutes of the test. Upon this 30 min of controlled fire, the fire was extinguished by fire fighters.

[0055] After the test, the two sides of the test rack (Racks I and S), only the pallets located between the vertical barriers had burned. The pallets located outside

the barriers had not burned: the plastic foil of some of these pallets had partially melted. The cartons were deformed by the water. The pallets located in the target rack had no traces of burning: the plastic foil of some of these pallets had partially melted.

Claims

1. A system comprising an enclosure, one or more racks (10,50) for the storage of goods and a fire sprinkler system,
said enclosure having a ceiling (14) and a floor (12), and having a storage area comprising said one or more racks (10; 50), wherein
said one or more racks (10,50) offer a depth and a storage height of up to 8.5 m;
said sprinkler system comprises ceiling-level sprinklers (22; S1...S20) having a standard thermal sensitivity, **characterized in that** said one or more racks (10,50) comprise vertical solid barriers (20; 52) spanning over the rack's depth and storage height, the maximum distance between two successive solid barriers (20) being of 5.8 m.

2. The system according to claim 1, wherein said ceiling-level sprinklers (22; S1...S20) have a RTI of 80 or greater, preferably of about 103.

3. The system according to claim 1 or 2, wherein said ceiling-level sprinklers have a K-factor of at least 160, preferably at least 260.

4. The system according to claim 1 or 2, wherein said ceiling-level sprinklers have a K-factor of about 280 and more.

5. The system according to any one of the preceding claims, wherein the ceiling height of said enclosure is no more than 12 m.

6. The system according to any one of the preceding claims, wherein said racks offer a storage height in the range of 6.5 to 8.5 m.

7. The system according to any one of the preceding claims, wherein said racks offer a storage height in the range of 7.5 to 8.5 m.

8. The system according to any one of the preceding claims, wherein said rack(s) is(are) of the double row rack type, and preferably have a depth of no more than 4.6 m, including a min. 0.2 m longitudinal flue.

9. The system according to any one of the preceding claims, wherein said rack(s) comprise open shelves (16).

10. The system according to any one of the preceding claims, wherein each vertical solid barrier (20; 52) is arranged perpendicularly to the rack's length.

11. The system according to any one of the preceding claims, wherein an aisle of min. 2 m, preferably min. 3m, separates two neighbouring, parallel racks.

12. The system according to any one of the preceding claims, wherein said rack comprises at least two rows, and spacing means are provided to maintain a longitudinal flue space of at least 20 cm between the rows.

13. The system according to any one of the preceding claims, wherein the design density is between 45 and 70 L/(min·m^2), preferably between 56 and 65 L/(min·m^2).

14. The system according to any one of the preceding claims, comprising ceiling-level sprinklers only.

15. Use of the system according to any one of the preceding claims for the storage of Class 1 to 4 and Plastic commodities, in particular carton unexpanded plastic, cartoned expanded plastic, uncartoned unexpanded plastic and uncartoned expanded plastic and also candles (wax).

Patentansprüche

1. System, aufweisend eine Einfassung, ein oder mehr Regale (10, 50) zum Lagern von Waren sowie ein Brandsprinklersystem,
wobei die Einfassung eine Decke (14) und einen Boden (12) sowie einen Lagerbereich aufweist, der das eine oder die mehreren Regale (10; 50) umfasst, wobei
das eine oder die mehreren Regale (10, 50) eine Tiefe und eine Lagerhöhe von bis zu 8,5 m bieten;
wobei das Sprinklersystem Sprinkler auf Deckenhöhe (22; S1...S20) mit einer genormten Wärmeempfindlichkeit aufweist, **dadurch gekennzeichnet, dass** das eine oder die mehreren Regale (10, 50) vertikale massive Schwellen (20; 52) aufweisen, die die Tiefe und Lagerhöhe der Regale überspannen, wobei der maximale Abstand zwischen zwei aufeinanderfolgenden massiven Schwellen (20) 5,8 m beträgt.

2. System nach Anspruch 1, wobei die Sprinkler auf Deckenhöhe (22; S1...S20) einen RTI-Wert von mindestens 80, vorzugsweise von etwa 103 aufweisen.

3. System nach Anspruch 1 oder 2, wobei die Sprinkler auf Deckenhöhe einen K-Faktor von mindestens 160, vorzugsweise mindestens 260 aufweisen.

4. System nach Anspruch 1 oder 2, wobei die Sprinkler auf Deckenhöhe einen K-Faktor von etwa mindestens 280 aufweisen.

5. System nach einem der vorhergehenden Ansprüche, wobei die Deckenhöhe der Einfassung nicht mehr als 12 m beträgt.

6. System nach einem der vorhergehenden Ansprüche, wobei die Regale eine Lagerhöhe im Bereich von 6,5 bis 8,5 m bieten.

7. System nach einem der vorhergehenden Ansprüche, wobei die Regale eine Lagerhöhe im Bereich von 7,5 bis 8,5 m bieten.

8. System nach einem der vorhergehenden Ansprüche, wobei das Regal (die Regale) vom doppelreihigen Regaltyp ist (sind) und vorzugsweise eine Tiefe von höchstens 4,6 m aufweist (aufweisen), einschließlich eines längsgerichteten Rauchzugs von mindestens 0,2 m.

9. System nach einem der vorhergehenden Ansprüche, wobei das Regal (die Regale) offene Regalbretter (16) aufweist (aufweisen).

10. System nach einem der vorhergehenden Ansprüche, wobei jede vertikale massive Schwelle (20; 52) senkrecht zur Länge des Regals angeordnet ist.

11. system nach einem der vorhergehenden Ansprüche, wobei ein Gang von mindestens 2 m, vorzugsweise mindestens 3 m, zwei benachbarte parallele Regale voneinander trennt.

12. System nach einem der vorhergehenden Ansprüche, wobei das Regal mindestens zwei Reihen aufweist und Beabstandungsmittel vorgesehen sind, um einen längsgerichteten Rauchzugraum von mindestens 20 cm zwischen den Reihen zu schaffen.

13. System nach einem der vorhergehenden Ansprüche, wobei die Löschleistung zwischen 45 und 70 L/(min·m^2), vorzugsweise zwischen 56 und 65 L/(min·m^2) beträgt.

14. System nach einem der vorhergehenden Ansprüche, das nur Sprinkler auf Deckenhöhe aufweist.

15. Verwendung des Systems nach einem der vorhergehenden Ansprüche zur Lagerung von Gütern der Klassen 1 bis 4 sowie Kunststoffgütern, insbesondere kartoniertem nicht expandiertem Kunststoff, kartoniertem Schaumkunststoff, nicht kartoniertem nicht expandiertem Kunststoff sowie nicht kartoniertem Schaumkunststoff und auch Kerzen (Wachs).

Revendications

1. Système comprenant une enceinte, une ou plusieurs étagères (10, 50) pour le stockage de marchandises et un système de gicleurs d'incendie, ladite enceinte ayant un plafond (14) et un sol (12), et ayant une zone de stockage comprenant ladite ou lesdites étagère(s) (10, 50),
dans lequel ladite ou lesdites étagère(s) (10, 50) offre(nt) une profondeur et une hauteur de stockage jusqu'à 8,5 m ; ledit système de gicleurs d'incendie comprend des gicleurs de plafond (22 ; S1 ... S20) ayant une sensibilité thermique standard, **caractérisé en ce que** ladite ou lesdites étagère(s) (10, 50) comprend (comprennent) des barrières pleines verticales (20; 52) s'étendant sur la profondeur de l' étagère et la hauteur de stockage, la distance maximum entre deux barrières pleines successives (20) étant de 5,8 m ;

2. Système selon la revendication 1, dans lequel lesdits gicleurs de plafond (22 ; S1...S20) ont un RTI de 80 ou plus, préférablement d'environ 103.

3. Système selon la revendication 1 ou 2, dans lequel lesdits gicleurs de plafond ont un facteur K d'au moins 160, préférablement au moins 260.

4. Système selon la revendication 1 ou 2, dans lequel lesdits gicleurs de plafond ont un facteur K d'environ 280 et plus.

5. Système selon l'une quelconque des revendications précédentes, dans lequel la hauteur de plafond de ladite enceinte n'excède pas 12 m.

6. Système selon l'une quelconque des revendications précédentes, dans lequel lesdites étagères offrent une hauteur de stockage dans la plage de 6,5 à 8,5 m.

7. Système selon l'une quelconque des revendications précédentes, dans lequel lesdites étagères offrent une hauteur de stockage dans la plage de 7,5 à 8,5 m.

8. Système selon l'une quelconque des revendications précédentes, dans lequel ladite (lesdites) étagère(s) est (sont) du type étagère à double rangée, et préférablement ont une profondeur n'excédant pas 4,6 m, incluant un espace libre longitudinal minimum de 0,2 m.

9. Système selon l'une quelconque des revendications précédentes, dans lequel ladite (lesdites) étagère(s) comprend (comprennent) des rayonnages ouverts (16).

10. Système selon l'une quelconque des revendications précédentes, dans lequel chaque barrière pleine verticale (20 ; 52) est agencée perpendiculairement à la longueur du rack.

11. Système selon l'une quelconque des revendications précédentes, dans lequel une allée de minimum 2 m, préférablement minimum 3 m, sépare deux étagères parallèles voisines.

12. Système selon l'une quelconque des revendications précédentes, dans lequel ladite étagère comprend au moins deux rangées, et des moyens d'espacement sont prévus pour maintenir un espace libre longitudinal d'au moins 20 cm entre les rangées.

13. Système selon l'une quelconque des revendications précédentes, dans lequel la densité nominale est entre 45 et 70 l/(min·m^2), préférablement entre 56 et 65 l/(min·m^2).

14. Système selon l'une quelconque des revendications précédentes, comprenant uniquement des gicleurs de plafond.

15. Utilisation du système selon l'une quelconque des revendications précédentes pour le stockage de marchandises de Classe 1 à 4 et Plastiques, en particulier du plastique non expansé en caisses carton, du plastique expansé en caisses carton, du plastique non expansé non en caisses carton et du plastique expansé non en caisses carton et également des bougies (cire).

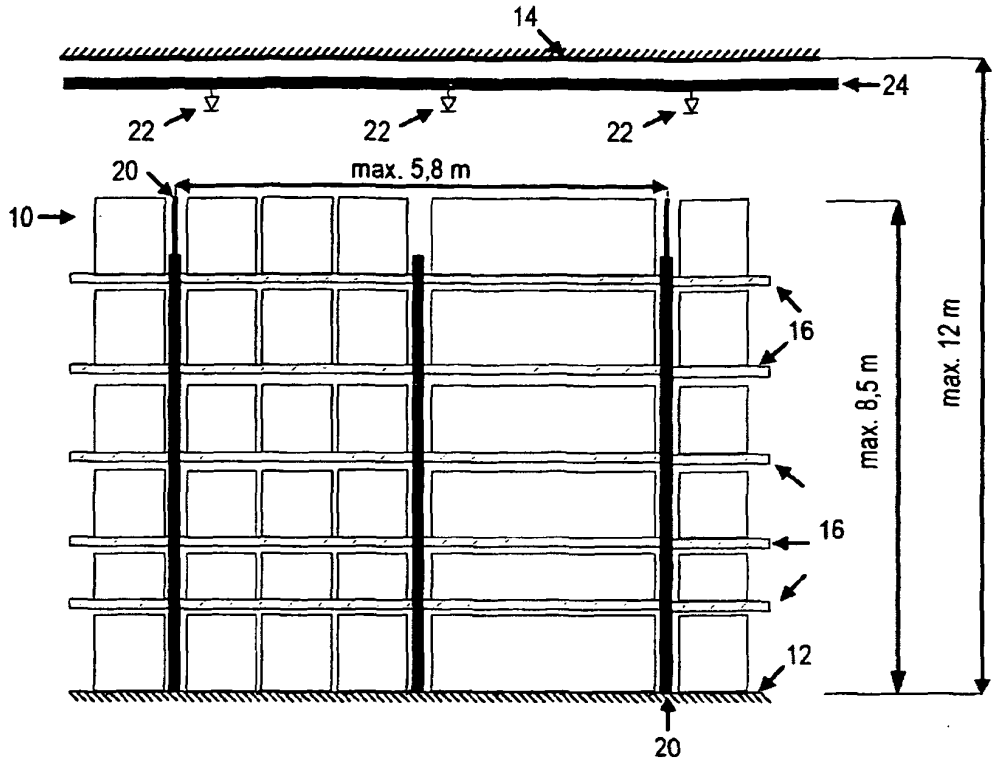

14
24
22
22
22
20
max. 5,8 m
10
16
16
12
20
max. 8,5 m
max. 12 m

Fig.1

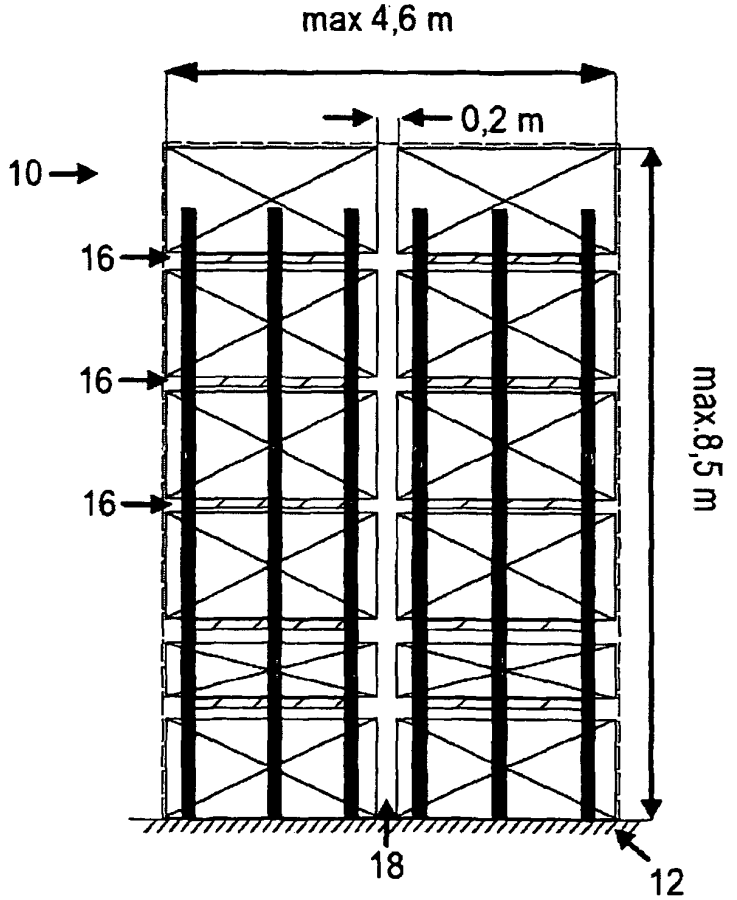

max 4,6 m
0,2 m
10
16
16
16
18
12
max.8,5 m

Fig. 2

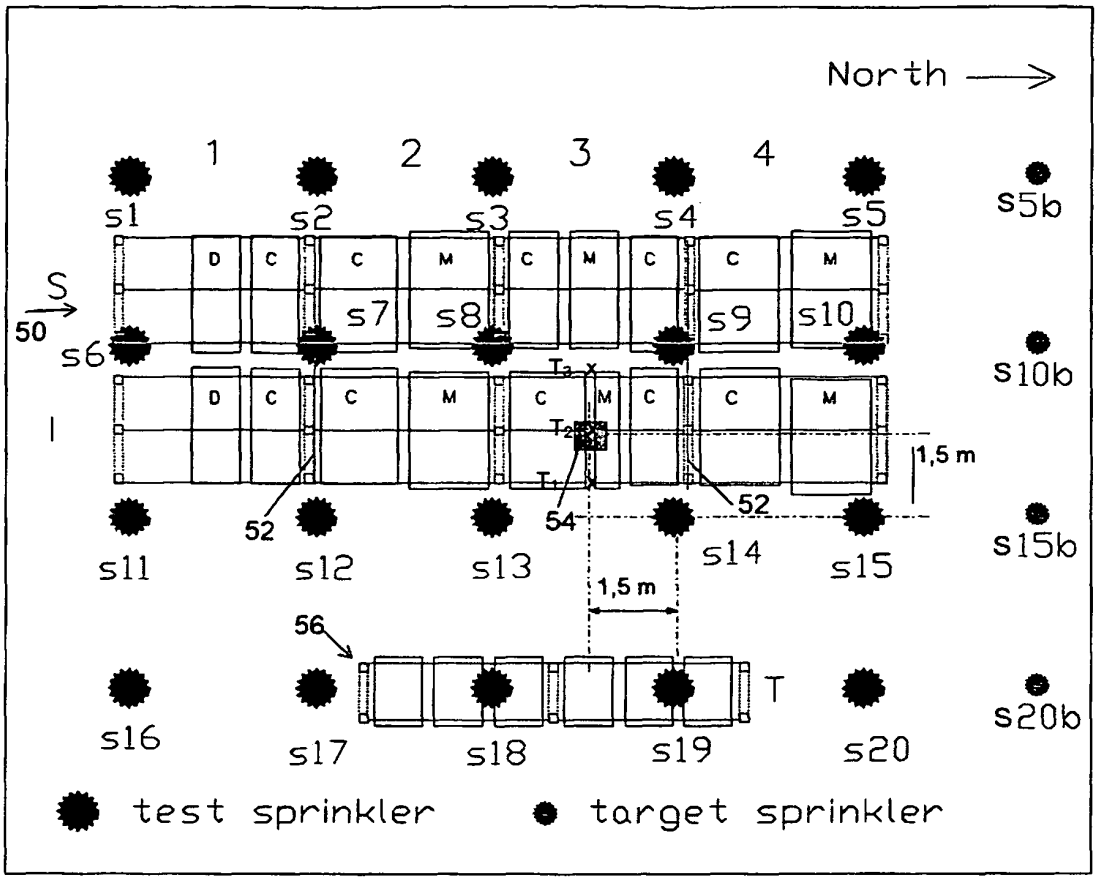

North
1
2
3
4
s1
s2
s3
s4
s5
s5b
S
50
s6
s7
s8
s9
s10
s10b
I
1,5 m
52
54
52
s11
s12
s13
s14
s15
s15b
1,5 m
56
T
s16
s17
s18
s19
s20
s20b
test sprinkler
target sprinkler

Fig. 3

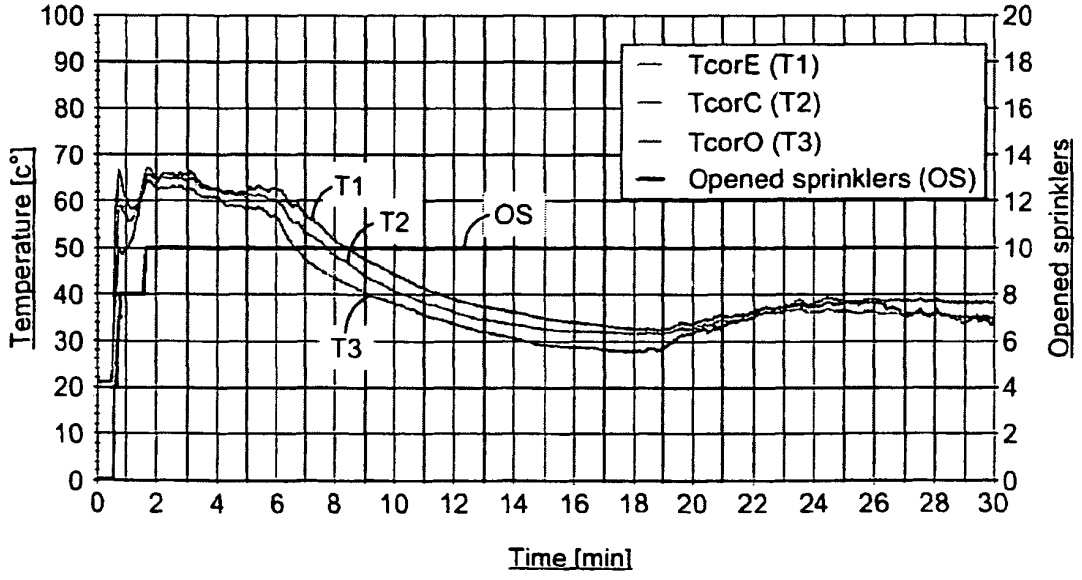

TcorE (T1)
TcorC (T2)
TcorO (T3)
Opened sprinklers (OS)
T1
T2
T3
OS
Temperature [c°]
Opened sprinklers
Time [min]

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- WO 9856510 A **[0019]**