

Device and method for Explosive Quenching of Fires

Description

The present invention relates to a device for explosive quenching of fires, with two flexible hoses disposed next to one another and transversely to the direction of danger, and closable at both ends, for accommodating quenching agents, and each with an explosive material in or on the hoses, by means of ignition of which in each case a pulse is generated and the quenching agent is atomised to form a mist and applied to the fire. The invention further relates to a method of explosive quenching of fires with the device described.

Both such a device and such a method for explosive quenching of fires is for example known from DE 195 00 477 C1. The principle of explosive quenching is based on the fact that during detonation of the explosive material within or in the vicinity of a homogenous medium in the form of a quenching agent, an extremely high pressure is built up, so that for example a compressive shock runs through the water in the hose, which imparts to it an enormous impulse, atomises it into the finest particles and throws it from the centre of the explosive charge symmetrically into the environment. The advantage of atomisation of a preferably aqueous quenching agent resides in the extremely high effective quenching agent surface area in proportion to the quantity of quenching agent used.

The disadvantages of the device under the corresponding method known from DE 19 500 477 C1 reside in the unsatisfactory distribution of the quenching agent in the environment of the explosive hose upon detonation of the explosive charge. It has become apparent that when one single explosive hose is used, the quenching agent is distributed roughly uniformly into one vertical lobe and one left-hand and one right-hand horizontal lobe, practically no delivery of quenching agent taking place at an angle of 45° to the ground surface. The delivery of

quenching agent at a 45° angle is however highly desirable in order to achieve an effective range and optimum surface coverage. The utilisation of two explosive hoses disposed parallel next to one another has no effect on the disadvantage of unsatisfactory spray characteristic at a 45° angle to the ground surface. Only the height and the volume of the vertical lobe are considerably increased.

The present invention applies itself to this problem, the object of which is seen to be further to develop both the already mentioned device known from DE 195 00 477 C1 for explosive quenching of fires, and further to develop the corresponding method, so that a concentrated delivery of quenching agent in the direction of danger is possible with satisfactory penetration of space and surface coverage.

In achieving the set object, the device for explosive quenching of fires of the type already mentioned is designed according to the invention in that the pulse from the first hose facing away from the direction of risk is greater than the pulse of the second hose facing the direction of risk. By the pulse of a body is known to be understood the product of its mass and its velocity. Furthermore, the density identifies the ratio of a mass of a body to its volume.

Thus the pulse imparted to the quenching agent by the detonation is dependent on the volume and the density of the quenching agent and on the size of the explosive charge which ensures the velocity of the quenching agent particles. The alignment of the range of quenching agent towards the area of risk and the desired ejection characteristic is thus achieved in that the product of mass and velocity of the quenching agent of the first explosive hose which, seen from the area of risk lies behind the second explosive hose, imparts a larger pulse to the quenching agent in the second hose, than the latter has obtained by its own explosive charge, resulting in a deviation of the main mass of the quenching agent into the direction of ition of pulses.

The purpose underlying the invention is further achieved by a method adapted to the device according to the invention, in which the essential factor is that the explosives of the first and of the second hose are ignited simultaneously, in order to achieve the superimposition of pulses described above. Both the device according to the invention and the method have a series of advantages, which again considerably increase the efficiency during explosive quenching of fires. On the one hand there resides in an advantage in the aimed ejection of the quenching agent itself, so that a more efficient utilisation of the quenching agent used can be achieved. In the known device and in the corresponding method, the quenching agent is emitted disadvantageously symmetrically to both sides of the explosive hose or hoses, and in addition the horizontal lobes of quenching agent are disposed in such a flat manner over the ground surface that the efficiency of the use of quenching agent is extremely unsatisfactory. In the embodiments according to the invention the quenching agent is emitted asymmetrically in the direction of the area of risk and at an optimum angle to the ground surface, so that also an optimum distribution and range of the quenching agent is achieved. As a further advantage, by selection of one larger and one smaller explosive hose, the quantity of quenching agent not emitted in the direction of the area of risk is kept low. Advantageous further developments of the device according to the invention are given in claims 2 to 6, and of the method according to the invention in claims 8 and 9. Experimental tests have shown that the proportional number λ , which indicates the proportion of the impulse I_1 of the first hose to the impulse I_2 of the second hose and can be shown by the formula

$$\frac{I_1}{I_2} = \lambda = \frac{(d_1 \sqrt{q_1} \cdot \rho_1)}{(d_2 \sqrt{q_2} \cdot \rho_2)}$$

(d = hose diameter, q = quantity of explosive, p = density of quenching agent) must be at least equal to 2 in order to achieve a satisfactory directional effect. To this extent, in a first further development of the device according to the invention, the pulse I_1 emitted by the first hose is roughly twice as great as the pulse I_2 emitted from the second hose. It has already been explained in the preceding that the pulse imparted to the quenching agent by detonation of the explosive charge with respect to the present invention gives substantially a function of the diameter of the hose in which the quenching agent is accommodated, further the density of the quenching agent, and finally the size of the explosive charge, expressed by the quantity of explosive q. As for example explosive cords as preferably used at present, are obtainable in Germany only in commercially available sizes of 12, 20, 40 or 100 g/m, in order to optimise the use of quenching agent it becomes necessary to co-ordinate with one another the diameter of the hoses used, the size of the explosive charge and the type of quenching agent used. The quenching agent for example can consist of pure water with the known density 1, or of a pre-foamed quenching agent with a substantially lower density.

Taking these factors into account, a further development of the device for explosive quenching of fires with a first explosive hose with a first diameter and a first quenching agent with a first density, and with a second explosive hose with a second diameter and a second quenching agent with a second density brings about the desired directional characteristic of the ejection of quenching agent in that the quantity of explosive, the diameter and the density of the quenching agent of the first hose facing away from the area of risk in relation to the quantity of explosive, the diameter and the density of quenching agent of the second hose facing the area of risk behave according to the formula

$$\frac{q_1}{q_2} = 4 \cdot \left(\frac{d_2}{d_1} \right)^2 \cdot \frac{\rho_2}{\rho_1}$$

As a result this further development, the device according to the invention permits any combinations of size of the two explosive hoses with specific compositions of quenching agent, for which, according to the formula given, a good approximation of the necessary quantities of explosive can be calculated. Otherwise expressed, when using explosive cords in commercially available discrete sizes, i.e. with a predetermined quantity of explosive, the corresponding hose diameters can be determined taking into account the composition of the quenching agent. Finally, it is possible with this further development to fill an explosive hose with pre-foamed quenching agent instead of pure water, so that the water requirement can be considerably reduced. This is of great advantage particularly in inaccessible places, for example in the case of forest fires.

The second hose facing the area of risk preferably has a larger diameter than that of the first hose facing away from the area of risk. The background of this further development is that the second hose which is located closer to the potential or existing seat of fire, functions predominantly as a delivery system for quenching agent, whilst the other (first) hose substantially acts as a pulse emitter. It has also been shown experimentally that it is sufficient if the second hose facing the area of risk, which predominantly operates as a delivery system for quenching agent, is provided with a smaller explosive cord, which substantially only has the purpose of bursting the second explosive hose simultaneously with ignition of the explosive cord of the first hose.

To this extent, a further development of the invention provides that the quantity of explosive of the first hose is greater than the quantity of explosive of the second hose. In a particularly preferred way, the first quenching agent in the first hose is water, and the second quenching agent in the second hose is a mixture of water and a quenching additive, so that environmental stress and costs due to the quenching agent additive can be kept as low as possible. The quenching additive can for example be a pure foam former or a so-called

"retarder". By a retarder is meant either salts, which penetrate into the pores of the burning material and therefore prevent its exhalation, or thickening gels, which are applied in the manner of a protective coating on the burning material and thus smother the fire.

In further development of the method according to the invention, according to which the pulse emitted by the first hose must be greater than the pulse emitted from the second hose, it is once again provided that the magnitude substantially determining the pulse, namely the quantity of explosive, the diameter and the density of the quenching agent of the explosive hoses, are dimensioned according to the already-mentioned formula

$$\frac{q_1}{q_2} \approx 4 \cdot \left(\frac{d_2}{d_1} \right)^2 \cdot \frac{\rho_2}{\rho_1}$$

and that the explosives of the first and of the second hose (1, 2) are ignited simultaneously.

In order to use the quenching device or to apply the method for preventative fire protection on stationary installations, ignition of the explosive is preferably effected on the basis of a signal from a device for early recognition of fire. In this case there are meant by the term "stationary installations" for example oil or gas tanks, refineries, oil drilling or transporting installations, storage spaces, airport take-off and landing strips, or aircraft parking areas, without this enumeration being exhaustive.

A device for early recognition of fire includes a sensor by means of which the presence of a fire parameter such as smoke or the like is recognised in the earliest stage of initiation

of a fire, and leads to triggering off an alarm. In the following, two embodiments given by way of example of the device according to the invention and the corresponding method will be explained in more detail with reference to a drawing. Shown are:

Figure 1: a schematic view of the explosive diagram with a single hose according to prior art;

Figure 2: a schematic view of the explosive diagram with two explosive hoses according to prior art lying next to one another;

Figure 3: a schematic view of two explosive hoses in explanation of the first embodiment according to the invention;

Figure 4: a schematic view of two hoses with differing diameters in explanation of the second embodiment according to the invention; and

Figure 5: a schematic view of the explosive diagram according to the second embodiment according to the invention.

Figures 1 and 2 show schematically the explosive diagrams during use of a single explosive hose 1 and of two explosive hoses 1, 2 disposed in parallel next to one another according to prior art. A common factor in both explosive diagrams is that the distribution of the quenching agent is symmetrical to both sides of the explosive hose or hoses. In each case a vertical lobe 6 and a left-hand horizontal lobe 7 and a right-hand horizontal lobe 8 are formed. The horizontal lobes 7, 8 are located flat above the ground 9.

It is clearly recognisable that in both explosive diagrams there is no emission of quenching agent at a 45° angle to the ground 9. The only difference between the explosive diagrams of Figures 1 and 2 resides in the fact that the vertical lobe 6

when two explosive hoses 1, 2 are used is considerably higher and of larger volume than when one single hose according to Figure 1 is used. The lack of ejection of quenching agent at a 45° angle to the ground 9, recognisable in the explosive diagrams, and the low distribution of the horizontal lobes 7, 8 results in an efficient and unsatisfactory use of quenching agent. For a surface covering and wide ejection of quenching agent in the direction of danger 5, deflection of the main mass of the quenching agent at an angle of 45° to the ground 9 is highly desirable.

Figure 3 shows a schematic view of two identical explosive hoses 1, 2 disposed parallel and next to one another. The hoses are filled with a quenching agent closed at both ends. An explosive 3, 4 in the form of a flexible explosive cord is disposed in each hose 1, 2. The explosive cords are connected in a way not shown here to an igniter device, by means of which ignition of the explosive charge is effected, so that the quenching agent is atomised to form a mist and applied to the fire. In order to achieve a directed ejection of quenching agent upon detonation of the explosive, in this first embodiment of the device according to the invention, the quantity of explosive q1 of the first hose 1 facing away from the area of risk is greater than the quantity of explosive q2 of the second hose 2 facing the area of risk (with reference to Figures 3 and 4, the area of risk is on the right). Thus a larger impulse is emitted from the first hose and from the second hose, which leads to the desired directional effect in the case of the superimposition of pulses caused by the explosion of both hoses.

Figure 4 shows a similar schematic view of two explosive hoses 1, 2 as in Figure 3, in this case the explosive hose 1, in order to explain the second embodiment of the invention, having a smaller diameter than the explosive hose 2. Further, the first hose 1 contains a first quenching agent in the form of pure water, while the second hose contains a second quenching agent in the form of a pre-foamed mixture of water and a

quenching additive. Here also both hoses 1, 2 are each equipped with a flexible explosive cord 3, 4, which extends through the entire length of the explosive hoses 1, 2. In this embodiment of the device according to the invention, i.e. in the case of explosive hoses with differing diameters ($d_1 \neq d_2$), the quantity of explosive q_1 , the diameter d_1 and the density of quenching agent ρ_1 of the first hose 1 facing away from the area of risk (on the right in Figure 4) with respect to the quantity of explosive q_2 , to the diameter d_2 and to the density of quenching agent ρ_2 of the second hose facing the area of risk behave according to the formula

$$\frac{q_1}{q_2} = 4 \cdot \left(\frac{d_2}{d_1}\right)^2 \cdot \frac{\rho_2}{\rho_1}$$

By means of this formula a good approximation of the ratios of explosive charge/hose diameter/density of quenching agent can be calculated for the use of two explosive hoses 1, 2 disposed parallel next to one another with the objective of achieving a directed ejection of the quenching agent upon detonation of the explosive. The following approximative values may be named as an example for the configuration of the explosive hoses 1, 2 according to the formula named above:

$$\begin{aligned} d_1 &= 14 \text{ cm;} \\ q_1 &= 100 \text{ g/m;} \\ d_2 &= 18 \text{ cm;} \\ q_2 &= 12 \text{ g/m.} \end{aligned}$$

In the case of these exemplary values an ejection of quenching agent focused on the area of risk is achieved, insofar as hose

1 is the one which is facing away from the area of risk and hose 2 is the one facing the area of risk.

Figure 5 shows a schematic view of an explosive diagram as achievable with the second embodiment according to the invention. In this example the first hose 1 facing away from the area of risk has a smaller diameter than the second hose 2 facing the area of risk. In accordance with the above named formulae the hose 1 is however provided with a considerably larger explosive charge for this purpose. The result in the explosive diagram is a greatly increased lobe 8 of quenching agent, directed towards the right towards the direction of risk, which is generated by a superimposition of pulses of the quenching agent thrown out from the two explosive hoses 1, 2. The lobe 8 of quenching agent is a mixture of the vertical lobe 6 and the pure horizontal lobe 8 according to Figure 2 and throws the main mass of the quenching agent to the right-hand side towards the direction of risk 5. In comparison therewith the left-hand horizontal lobe 7 has remained small, which likewise indicates an extremely directed and efficient use of quenching agent.

The method according to the invention will be explained again now with reference to Figure 5.

The two flexible hoses 1, 2, closable at both ends, of which the hose 1 has a first diameter d_1 and the second hose a second diameter d_2 , are laid out transversely to the direction of risk and parallel to one another in front of an area of risk, from which a risk of fire emerges in the direction of arrow 5. Then the hoses 1, 2 are each fitted with a flexible explosive cord 3, 4 and each filled with a quenching agent and closed at the ends. The explosive cords 3, 4 are connected in a way not shown here to an igniter device. By means of detonating the explosive cords 3, 4 the quenching agents contained in the hoses 1, 2 are atomised to form a mist and applied to the fire. By generating pulses of differing sizes in both hoses 1, 2, a directed ejection of quenching agent is achieved. In the

explosive diagram shown in Figure 5 the smaller hose 1 was fitted with a larger quantity of explosive than the larger hose 2. Finally, the explosive cords of the first and of the second hose 1, 2 were simultaneously ignited, so that a superimposition of pulses resulted.



Patent Claims

1. Device for explosive quenching of fires with two flexible hoses (1, 2) disposed next to one another and transversely to the direction of risk (5), and closable at both ends, for accommodating a first and a second quenching agent, and each with an explosive (3, 4) in or on the hoses (1, 2) by means of ignition of which a respective pulse (I_1 , I_2) is generated, by means of which the quenching agent is atomised to form a mist and applied to the fire,

characterised in that the pulse (I_1) which emerges from the first hose (1) facing away from the area of risk is greater than the pulse (I_2) which emerges from the second hose (2) facing the area of risk.

2. Device according to claim 1, characterised in that the pulse (I_1) emerging from the first hose (1) is at least roughly twice as large as the pulse (I_2) emerging from the second hose (2).

3. Device according to claim 1 or 2, with a first flexible hose (1) closable at both ends with a first diameter (d_1) for accommodating a first quenching agent, and with a second flexible hose (2) closable at both ends with a second diameter (d_2) for accommodating a second quenching agent, characterised in that the quantity of explosive (q_1), the diameter (d_1) and the density of the quenching agent (ρ_1) of the first hose (1) facing away from the area of risk behaves in relation to the quantity of explosive (q_2) the diameter (d_2) and the density of the quenching agent (ρ_2) of the second hose (2) facing the area of risk behave according to the formula

$$\frac{q_1}{q_2} \approx 4 \cdot \left(\frac{d_2}{d_1}\right)^2 \cdot \frac{\rho_2}{\rho_1}$$



4. Device according to one of claims 1 to 3, characterised in that the second hose (2) facing the area of risk has a larger diameter (d_2) than that of the first hose (1) facing away from the area of risk.
5. Device according to one of claims 1 to 4, characterised in that the quantity of explosive (q_1) of the first hose (1) is greater than the quantity of explosive (q_2) of the second hose (2).
6. Device according to one of claims 1 to 4, characterised in that the first quenching agent is water and the second quenching agent is a water/retarder mixture or a water/foam mixture.
7. Method for explosive quenching of fires, in which two flexible hoses (1, 2) closable at both ends, are laid out transversely in the direction of risk in front of an area of risk, each equipped with an explosive (3, 4) and each filled with a quenching agent, and in which, by means of igniting the explosive (3, 4) a respective pulse (I_1 , I_2) is generated, by means of which the quenching agents are atomised to form a mist and are applied to the fire, characterised in that by means of corresponding dimensioning of the quantity of explosive (q_1) of the diameter (d_1) and of the density of the quenching agent (ρ_1) of the first hose (1) and of the quantity of explosive (q_2), of the diameter (d_2) and of the density of the quenching agent (ρ_2) of the second hose (2), a greater pulse (I_1) is generated in the first hose (1) facing away from the area of risk than the pulse (I_2) of the second hose (2) facing the area of risk, and in that the explosives of the first and of the second hoses (1, 2) are ignited simultaneously.
8. Method according to claim 7, in which a first flexible hose (1) closable at both ends with a first diameter (d_1) and a second flexible hose (2) closable at both ends with a second diameter (d_2) are laid out transversely to the direction of risk in front of an area of risk, each equipped with an explo-



sive (3, 4) and filled with a first quenching agent or with a second quenching agent, characterised in that the quantity of explosive (q_1), the first diameter (d_1) and the density of the quenching agent (ρ_1) of the first hose (1) facing away from the area of risk and the quantity of explosive (q_2), the second diameter (d_2) and the density of the quenching agent (ρ_2) of the second hose (2) facing the area of risk are dimensioned according to the formula

$$\frac{q_1}{q_2} \approx 4 \cdot \left(\frac{d_2}{d_1}\right)^2 \cdot \frac{\rho_2}{\rho_1}$$

and in that the explosives of the first and of the second hose (1, 2) are simultaneously ignited.

9. Method according to claims 7 or 8, serving for preventative fire protection on stationary installations, characterised in that ignition of the explosives (3, 4) is effected on the basis of a signal from a device for early fire recognition.