популяцию белых крыс: между временем пребывания на открытом пространстве ПКЛ и количеством выходов в него появилась обратная зависимость ($r_к$=0,07; $r_{оп}$=-0,37), что противоречит ожидаемому нами результату. Изменилась направленность корреляционной связи между количеством стоек на ОР и временем пребывания на открытом пространстве ($r_к$=0,84; $r_{оп}$=-0,45), а так же между стойками и количеством выглядываний из ЗР ($r_к$=-0,54; $r_{оп}$=0,41). Дефицит серотонина в головном мозге привел к отсутствию имевшей место в контроле обратной корреляционной зависимости между выходами на ОР и выглядываниями из ЗР ($r_к$=-0,56; $r_{оп}$=0,23).

Выводы. Таким образом, установлено, что модификации тревожного поведения в результате снижение содержания серотонина в головном мозге введением п-хлорфенилаланина зависят от исходного уровня тревожности крыс: чем выше исходный уровень выраженности данного показателя, тем устойчивее животные к снижению серотонинового статуса. Приблизительно 1/3 из подгрупп с низкой и средней тревожностью отвечают депрессивно-подобным состоянием на действие ПХФА.

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УДК 504.05

PHOTOGRAPHIC RESEARCH OF THE GAS FLARES QUENCHING BY IMPULSE LIQUID JETS OF HIGH RATE

N. I. Yagudina, A. N. Semko, M. V. Bezkrovna

Resume. This article describes the known methods of gas flares fire fighting; it analyzes them and presents the new method. Extinguishing by using of impulse liquid jets is new perspective way, it’s ecological and economic technique and shown results of experiment prove it. Velocity of impulse jet is about 300 m/s and duration of firefighting process is about one second. Here is the description of this method.

Keywords: impulse jets, impulse water cannon, gas flares.

The development of technical progress, in addition to obvious advantages for the economy, suggests the presence of hidden threats and dangers. We cam include to them fires in the spheres of oil and gas industry. In Ukraine, the volumes of oil and gas production have increased over the last year [1], and the maintenance of security at the proper level is an extraordinary challenge for authorities of this fields. The problem of fire gas fountains is relevant from both an environmental and an economic point of view: the fires of such fountains can lead not only to significant losses of valuable raw materials, as well as they have a very negative influence on the subsequent gas production because such fires are accompanied by a rapid drop in field reservoir pressure, flooding of separate fields and the destruction of the wellbore or its wellhead [2].

This work is shown to present a new method of extinguishing of gas flares, which is radically different from those ones that are used now in Ukraine.

International Association of Oil & Gas Producers in [3] provides the basic statements about the methods of the control of the emitted gas, they have been used to prevent emergencies. To date, the main ones are flaring (controlled burning of flares) and venting (controlled emission of gases directly into the atmosphere).

Flaring is the controlled burning of natural gas in the course of routine oil and gas production operations. During fl aring, the burned gas generates mainly water vapour and carbon dioxide. Efficient combustion in the fl ame depends on achieving good mixing between the fuel gas and air, and on the absence of liquids.

Venting is the controlled release of gases into the atmosphere in the course of oil and gas production operations. the natural gases associated with the oil production are released directly to the atmosphere and not burned. Safe venting is assured when the gas is released at high pressure and is lighter than air.

The aim of minimising flaring and venting can be achieved through a variety of mechanisms which may range from marketing initiatives to maintenance strategies to new technologies.

However, cases of fires in the gas fields take place [4], the causes are any source of ignition:

• sparks from stones being thrown and equipment in an emergency,
• lightning,
• failure of electrical equipment,
• sparks at using steel tools in the course of emergency work, etc.

As you can see it’s often not possible to foresee fire, that’s why the prospect of the proposed method is due primarily to the possibility of a quick response.

To extinguish fires oil and gas flares many methods and techniques are developed [5]: injection of water into the well, the detonation of explosive charge, a down-hole drilling and pumping it into a special solution, a combined method, etc. In Ukraine and CIS countries in fire fighting of gas flares methods described below are most commonly used [6, 7].

Water monitors. To extinguish low-power gas flares this method is practically irreplaceable, but powerful fires open its following shortcomings.

Powerful gas fountains, if the wellhead isn't destroyed (fountains without the formation of the crater) are accompanied by a loud noise [8] (roar), reaching up to such an extent that a person can not hear, and no funds of loud-speaking facilities can not be used for operational and communication commands in combat areas. In such cases, the message is transmitted only in writing or silent alarms.

This method requires a long preparation, a large amount of equipment, as well as a high level of synchronization of staff.The last factor is difficult to achieve because of the loud noise.

Automobiles of gas-water fire-fighting. They are equipped with turbo engines that are capable to "burn" large amounts of fuel during the operation, creating a flow of exhaust gases. This method can not be called environmentally friendly. Firstly threre is a large amount of emissions, and secondly, 90% of the water discharged by car spent in vain and led to flooding a large area. Thus, the elimination of the consequences of suppression becomes problematic.

The impact on the burning hearth with pneumatic powder fire suppressors is made by the volley launch with the pulsed installations (pulse-2m, -3,-Storm). The main disadvantage of this method - the restriction or total lack of visibility after the launch of a fire-extinguishing mixture, which does not allow to evaluate the result of suppression quickly and unequivocally.

A new way to fight with gas flares deserves special attention – it's the use of pulsed liquid jets of high velocity, it means that the speed of the jets movement is higher than the rate of release of gas from the well. Base of this method is in using of water mist, which has long been used in automatic and automated systems for fire protection.

Fire suppression based on using water mist consist of three main physical effects: evaporation cooling, oxygen displacement and radiation blocking.

The first one is related to latent heat of water evaporating from liquid to gas phase. Droplets haracterized by small diameter and high relative velocity are rapidly heated by convection and then evaporate [9,10,11]. As a common classical reference [9,10], if the flame temperature is 1000 °C, the droplet diameter is 150 μm and the spray velocity is 2.5 m s-1, water droplets evaporate after an average penetration of just 90 mm into the flame.

With regard to oxygen displacement, the combustion rate of a fire Rf depends on temperature and mass fraction of the reactants. The most powerful explosion occured when the methane concentration reaches 9.5%, as in this case it uses the entire volume of air oxygen. The temperature of explosion of methane-air mixture can reach 2650 ° C if the explosion took place in a confined space, and 1850 ° C if the explosion products can spread freely.

The third component of fire – blocking radiation – operates as follows: the thermal radiation from high-temperature flame to the surrounding objects is blocked by liquid droplets through the processes of absorption and dispersion. These effects are not only don't allow evaporation and burning of fuel, but also inhibit the growth and spread of fire. The maximum blocking of thermal radiation is achieved if droplet diameter has the same order of magnitude as the maximum emission wavelength of the fire source [12].

It's important for the successful use of this technique to choose not only just the kind of extinguishing agents, but also the speed of the jet, which plays a key role. Creating of pulse of high-speed jets is made by using a special installation - powder impulse water cannon (IW) (Figure 1).

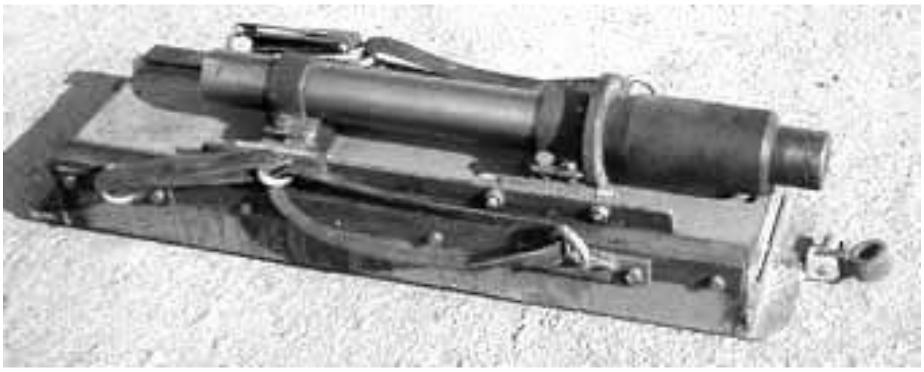

Fig. 1 Impulse water cannon

Schematic representation of the IW (Fig. 2) can reveal the mechanism of its work [13].

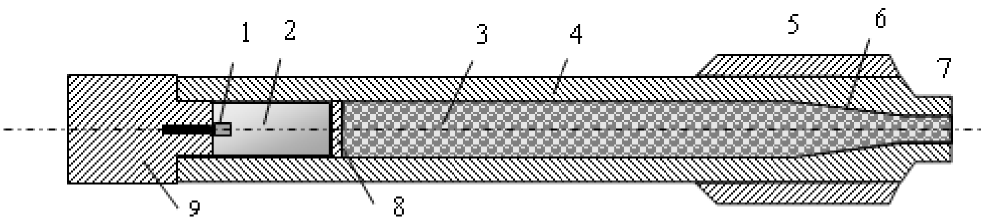

Fig.2. The scheme powder pulse jet 1. ignitor 2. combustion chamber 3. water charge 4. barrel 5. bandage, 6. nozzle 7. collimator 8. wad, 9. shutter.

The powder charge in the combustion chamber is ignited by an igniter. Wad moves at high speed to the nozzle, "pushing" water charge outwardly. The jet is obtained compact by a smooth narrowing (its diameter at the nozzle exit 15 mm). It moves to the source of combustion, slowly dissipating and forming a cloud of spray around the center (finely dispersed water, as discussed earlier). In this form impulse jet virtually "cuts off" the flare from the well in a single shot.

Of course, a full-scale suppression of real flames, it is not possible at this stage. It is therefore necessary to make modeling of the extinguishing of the gas flare with high-speed pulse jets. The aim of the simulation of this process is to test the effectiveness of the method on a smaller scale, to determine the similarity criteria, and then be able to transfer the obtained achievements at full-scale conditions.

The field experiments were conducted using the basis of the investigations. Powder IW 1 was placed at a distance from 5 to 15 m to the gas flare 3. IW jet was directed to the right place at the well flare using the laser sight. Gas flare fed from a cylinder of liquefied gas, whose flow rate was determined using a pressure gauge mounted on the cylinder valve. In the experiments distance from the pulse water cannon to flare and the value of the powder charge, which influenced on the speed of the liquid pulse jet, was varied.

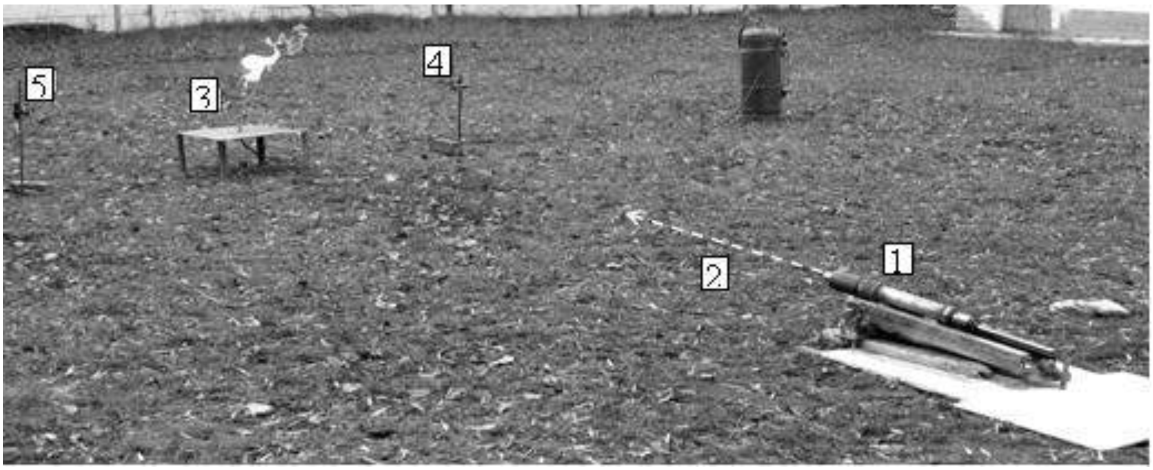

Fig. 3 Schematic of the experiment on fire gas flare at the landfill. 1 – gunpowder impulse water cannon, 2 – impulse jet of liquid, 3 – gas torch, 4 – laser unit, 5 – speed meter

Initially, the jet flows at low speed. First water particles fly slowly and further ones have higher energy and speed, thereby interacting with the previous ones, with the creation of a radial flow. The jet slowly gains speed, but with the same time breaks up because of this radial flow and the air resistance. A halo of spray surrounding the main stream of water is greater than the diameter of the jet in a few dozen times, but it is moving slowly.

It’s importantly during extinguishing to choose the optimum distance to the combustion source. Too short distance not allows forming fine dispersed water, too long one lead to the complete absence of the jet, but spray cloud isn’t capable to extinguish gas flare by itself.

Table. 1 shows the results of the maximum rate of liquid pulse jet head and the pressure of powder gases for IW.

Table 1

Dependence of the IW parameters of the gunpowder mass

The mass of powder, g	30	20	10
The maximum jet velocity in m / s	685	505	300
The maximum pressure of powder gases, MPa	275	143	46,5

The proposed method of extinguishing of the gas flare is based on the separation of burning flare from the mouth of the well. As a result, the supply of the fuel mixture into the combustion zone stops, energy balance of the combustion is disturbed and combustion ceases. Experimental studies have shown that the velocity of the jet to disrupt flare must be at least 80 – 100 m / s. In addition, the cross-section of the jet to disrupt the torch should not be less than the cross section of flame in the combustion zone.

The analysis of video that was recorded during the experiment, shows the next series of photos:

Fig. 4-5. Photos of experiment.

Figure. 4, we see the process of the jet flight from water cannon, its form is compact, like a knitting needle. In some areas, there is thickening of the jet which in Fig. 5 are significantly enhanced. However, in Figure 5 the jet remains dense and uniform, as can be judged based on its opacity.

Fig. 6-7. Photos of experiment.

In Fig.6 the pulse jet has almost reached the orifice of the torch, we are watching a significant change in its form and structure. We can distinguish the jet center and the outer part which has a kind of "jags" in the direction to the flare. In Fig. 6 jet crosses the center of the flame and "rip" it from the gas source. Fig. 7 shows that the spray head is located beyond target, and a cloud of fine spray keeps moving, "isolating" the flame.

Fig. 8-9. Photos of experiment.

In Fig.8 it can be observed that the jet has become noticeably slower and its structure is transparent – water charge is dissipated in the air. Torch flame lifts gradually, and in fig. 9 it is at a considerable distance from the torch. Flare was extinguished.

Images were obtained using the FREE VIDEO TO JPG CONVERTER 5.0.23.320 and processing of photo information is considerably easier because it's almost impossible to analyze the video with such a high velocity of the process.

The results of experiments have shown that the speed of impulse liquid jet decreases as its distribution, due to the intensive interaction of high speed liquid jet of air. The high speed jet becomes a cloud of spray at a distance of 12 m from the installation for this design of IW. If the flare is placed further away than this, for example, 15 m, the jet doesn't reach the flare and it doesn't extinguish the torch.

According to the carried out work following conclusions can be:

1) The existing methods of extinguishing gas flares were analyzed. It is shown that the known methods of extinguishing of gas flares are not universal and require optimization and new approaches.

2) The main effects caused by using of water mist were determined.

3) Specific features of the structure of the pulse jet and its work were shown.

4) The spread nature of the impulse jet ejected from the IW and the reasons causing it were analyzed.

5) The data of experimental research on gas flares extinguishing by pulsed liquid jets of high speed were submitted.

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