METHODS, APPARATUS AND EQUIPMENS TO PUT OUT FIRES

PANAITESCU VALERIU NICOLAE[1], PAVEL DRAGOŞ-IULIAN[2], POENARU MIHAI [3]

[1].University POLITEHNICA of Bucharest, Romania,
[2].Firefighter Faculty, Police Academy "AL.I.CUZA" of Bucharest, Romania,
[3].The Inspectorate for Emergency Situations "Dealu Spirii" of Bucharest, Romania,

Abstract: In this paper are present some methods, apparatus and equipments uses to put out big fire, which can have serious influence over the environment.

Keywords: water fog, water mist, water spray.

1. THE FIRES STARTED ABOARD OIL TANKERS

One of the major difficulties that the fire officers stumble on during the operation of extinguishing fires started aboard large oil tinkers is the very big dimensions of those. For example a tanker with the capacity of 116000 tones has a length of 265 m, width of 45 m and a depth of 21 m. The tendency of increasing even more the dimensions of this type of ship is very actual. Most fire started a board oil tankers are the result of overflow, explosions or damage suffered from collision, situation in which, in a short time, the liquids spilled on the deck or on the water spread on large areas, surrounding the ship with flames.

Fig. 1

The risk of producing explosions a board an oil tinker appears "thanks to" the combination of flammable vapors in the lower and upper limits, specific for each transported product that can be fused from any open-fire source.
The essential elements of the explosion of on oil tanker are: the source of ignition, the gas hidrocarbures from the oil or from his remnants and the oxygen present in considerably proportion to fuel the burn of the other gases. One come over theses elements in all the phases of exploiting the oil ship the most dangerous phases being the cleaning operation, the loading and the unloading. When a fire ignites, the flames and the gas that are released spread across the supra-structure deck very fast. Thanks to the sudden growth of the temperature to about 1500^0 C the windows crack, the rooms are filled with smoke and hot gases and the installation can be surrounded by flames. Through the destruction of the windows in the living quarters the temperature shortly becomes unbearable, so the crew is stopped from taking the necessary action to stop the situation developed.

For the extinguishing of fires oil ships come with these types of fix installation:

- for the machines rooms: extinguishing installation with light foam and inert gases;
- for that pomp chambers: extinguish installations with pulverized water, with foam or inert gases;
- for tankers: extinguish installations with inert gases or foam.

On the oil tanker's deck we can find a sufficient number of pipes and cannons for the complete cover with foam, and also fire plugs that realized sufficient pressures for the handling of foam-generating pipes and water pipes. The fire pump is usually installed in the machine room at it's capable of fueling with water at best three foam-generating pipes at the pressures of 12-14 atm. The oil tankers for loading and unloading hydrocarbures are designed with fixed installation for extinguishing with water and foam formed by a think network of water and foam cannons that can be used by the members of the civil firefighter department from the port; but also through remote. The berths of ports specially build for docking large ships are equipped with cannons mounted on stockade of over 20m high that can act at the same level with the fire started on the ships. Generally, these installations are remotely commanded from a central point.

The goal of these fixed installation and of the machine from the equipment of port firefighters are the complete the extinguish device of the ship, with the mission of locating the fire (the cooling of the decks and superstructure, the protection of the walls of tankers on fire and of the ones next to, of the castle, etc.). A special task comes, in such circumstance to the special ships for extinguishing fires, that will action from the sea, using the hole ranges of extinguishing installations (water cannons, foam cannons, special installation with dust and N, etc.)

The extinguishing is organized on 3 sectors, like:

a. An intervention sector with the mission of putting out the fire directly at the affected tanker using the extinguish cannons with foam from the affected ship and from the specialized ones, the last could direct the foam at the level of the panel or at the visitation mouth of the burning ship. The action of the cannons will be complete with the action of the foam-generating pipes from the battle machines that are lifted aboard the ship with strings or with devices attacked to the decks or stair of the ship. For the intervention inside the ship's compartments special "c" pipes with the mission of cooling are called in; they are inserted through the stair wells, through the ships thanks or through other openings the bottom of the ships. For directing of the foam directly to the fire, extension tubs can be used for protecting the firefighters from the effects of the radiating heat.
b. An intervention sector with the mission of limiting the spread of the fire to the tanks situated on the bow of the ship and for cooling the deck, using the combined action of the cannons for extinguishing from the ship, as well as devices of the civil firefighters formation port and on the military firefighters. The protection of threatened tankers is accomplished by the inserting in the ships compartments, to their bottom of devices that cool the walls of the tankers, firstly on the direction of the fire spreading. This sector will be given the mission for evacuation of the water that forms the liquid careen and so that influences the stability of the ship up to sinking, operation that is executed aided by the submersible pumps.
c. An intervention sector with the mission of limitation the spread in the castle from the stern of the ship and on the compartments of it's structure especially in the machine compartment, with the necessary number of pipes.

Very important for the three sectors is the evacuation of smoke and hot gases that flood all the compartments of the ship stopping access in the extinguish compartments, delaying the intervention and the lighting of the sectors, evacuation that is done with the aid of electro-exhaust fan and electro-fans from the rescue ships, from the special ships for extinguishing fires and from the machines for evacuating the smoke, gases and for lighting from the civilian and military firefighters. Also, projectors are placed to the entrances in the stair wells and in compartments, once with the start of the ventilation sisters, for the speeding of smoke and hot gas evacuation.

A board an oil tanker fires can spread also in the machine room and in the pumps houses, where many risks for explosions can appear. For extinguishing fires in these rooms, wished of the range of action of the new with the

fix extinguishing installation with CO_2 or steam, jets of extinguishing powder "FLOREX" are used, with special pistols from the special installation with N from the fire department's machine sand ships. After that, mechanical foam can be pressed with the aid of generator pipes, until all the compartments will be covered with foam at last 50 cm thick. The extinguishing action becomes especially difficult in case it started in an emptied tanker, of an explosion followed by a fire. In this case the effect of the special installation for extinguishing with inert gases or CO_2 negligent, just like the installations with foam aboard the ship, because such powerful explosion destroy the lateral walls of the reservoirs where the special installation are, and sometimes even the walls of the ship. The biggest risk present by the oil tankers is the spill of the petroleum from within, causing "black high water", that represent real ecological disaster (we are considering the vegetation and the beings from the ocean). There is a series of methods for retrieving the petroleum that leaked from the oil tankers.

2. FOREST FIRE

Fig. 2

Fig. 3

After the place and after the elements that are burning, forest fire are classified like:

- on the ground or the margin of the forest;
- of cornice;
- underground;
- combined (of cornice and margin of forest);
- of fallen trees.

Causes for the start of such fires: the imprudence of men, long periods of drought, lightning, and for the underground fires because of the phenomena of self lighting. It has been proven that the biggest influences over the relative speed of spreading of the fire of the margin of the forest have the next factors: wind; relative humidity; the resources of combustible material; the humidity of combustible material and the flank's declivity. Fires of cornice that start especially at resins forest have the aspect of the walls of fire that forwards over the forest just like a huge wave. Depending on the burn speed, and it's intensity, cornice fires classify like:

- slow fires: burning speed 8 km/h;
- fast fires: burning speed up to 25 km/h;
- violent fires: burning speed over 25 km/h.

Underground fires start especially in old forest on which ground along the years a thick blanket of dry leaves, branches, wood that rot and form a blanket of must and peat. This fires represent on be imminent danger because if they aren't put out on time they on be transformed in fires of the margin of the forest. Combined fires (the margin of the forest and cornice) are especially violent; they develop high temperatures and have high spreading speeds. Fires of fallen trees, usually, has the aspect of one giant stake burning fallen trees that are ignited one by another. When the fire it's on his full development stage the flames reach high highs, around 30m or more. Extinguishing substance used for forest fire are :

- water, saying that pulverized water with some chemicals has the best results. The extinguishing with water using helicopters and planes is very efficient. The planes reservoirs are emptied at small height, through a sudden discharge, at a flight speed of 140 km/h. Through this a surface of 10 X 50 m can be

sprayed (it varies according to the capacity of the plane's reservoir). For increasing the efficiency and the shock force for putting out forests fires from the air, several airplanes will be simultaneous used. This way has a series of advantages, the most important ones being that fires can be extinguished before ground forces appear, just like the fact that is recommended for extinguishing forest fires with tall flames.

Even of it is very disputed, the helicopter is still used in many countries for transport, rescuing and for direct water interventions. Lately, the fixation of water tanks immediately under the plane is being given up in favor of the hooking of the reservoir with a cable at a suitable distance underneath, the spill taking place under electrical command. The use of the helicopter has a series of advantages:

- they can descent until close to the fire and throw the water on the wanted place;
- they can transport (depending on their type) between 800-5000 liters of water or 15 persons (or 10-12 persons equipped);
- they have access in the rough terrain zones.

For extinguishing fires are used:

- the way of extinguishing with foam is less used, because has a small place of using, considering the topography of the terrain and the assurance of water quantities necessary for producing the foam;
- -the chemical substances: short time or long time delayer. The first are composed out of water and an additive that reduces the evaporation speed of water, to obtain a greater extinguishing effect. Long term delayer are made of a such called "delaying salt" (based on NH_3 or Phosphate) and a colorant that helps in the identification of the zones where such substances were used;
- -extinguishing powders are used only when the concrete condition permits of the access of machines with powders in the area and the woods aren't harmed;
- -explosives are use in special cases only after a through analysis of the situation, for creating a "belt" against the spreading of flames: ditches, water reservoirs and protection areas against fires. As explosives usually TNT is used.

For the making of protection belts against the spreading of flames charges of 250g are used that are inserted in the ground at a depth of 40 cm and at a distance of 2-2,5 m one from another. After the insertion of the load the holes is covered with dirt and stomped on. After the explosion a series of holes are obtained with the diameter of 1-1,2m that together with the surface covered by the layer of ground spilled thick of 4-7 m creates a mineralized belt of around 4m width. At the making of protection ditches charge of 250g are inserted in the ground at a depth of 40 cm depth and width by the formula:

$$C=2\cdot H^3, \tag{1}$$

where: C-the weight of the explosive charge (in g);
H-the drilled depth (in cm).

For cutting down the trees and obtaining free zones 3 ways can be used: a opened one, a closed one and the insertion of explosives under the roots. The first way means the fixation of charges through tying on the outside of the trees . In this case the size of the charge necessary for a tree is calculated by the formula:

$$C=D^2, \tag{2}$$

where: C-the weight of the explosive that (in g);
D- the tree's diameter (in cm).

In this case it is recommended the growth of the charge with 10% for a sure success. For the second way the change is inserted within the tree through an opening made with a drill . The volume of the charge must be ten times smaller than the previous method. For the third way, the size of the charge is determined by the formula:

$$C=50\cdot D, \tag{3}$$

where: C-the weight of the explosives charge (in g);
D-the tree's diameter (in cm).

This final way is recommended not to be very often because as hard to realize. For putting out a fire the knowing the necessary of forces and means is necessary. In case of forests fires at the calculation of forces and means necessary for extinguishing fires we must:

- determine the tallness of the trees;
- determine the thickness of the trees;
- determine the density of the trees;
- determine the cut down time for the trees as such:
  * with the mechanical saw: 6-8 minutes;
  * with the manual saw: 18-20 minutes;
  * with the axe: 25-30 minutes.
- determine the number of the staff. Usually work crew is formed of 2-3 people;
- determine the work front, like so:
  * 10 m for a team at a safety belt;
  * 5 m for a man at frontal attack;
  * 10-15 m for a man lateral attack;
  * 20 m for a mat at surveillance.

The work norms necessary for calculating the necessary time for producing the diverse works with explosives are:

- for creating protection belts against spreading the fire a team of 15 men realize 5,5 km/day;
- for the creation of protection ditches a team of 15 men realize 2 km/day.

For preventing forest's fires we must:

- educate the population in accordance with the obligatory norms of behavior in forest areas;
- to prepare and assure in time materials, appliances and intervention staff;
- to limit the access especially in breeding nurseries;
- to watch from the air the forest areas during drought or permanents patrols;
- to plant warning signs in visible places for preventing accidents;
- to clean the forest by seasonal actions.

At forest fires, where water is used as extinguishing agent in most cases, for the calculation of forces and means we must:

a) Determine the necessary water debits used as extinguishing (cooling, protection) with the relation:

$$q_{i\,nec}=K_2 \times 60 \times A(L) \times i_s\,(i_r, i_{pr})\ [l/min]\ , \qquad (4)$$

where: K_2 - correction coefficient a dimensional;
60 - the number of second in a minute;
A - the extinguishing surface (cooling, protection), in square meters;
L - the length of the burning perimeter (the reservoir's perimeter, the burning installations , the neighboring installation, the length of the walls of protection curtains), in meters;
i_s (i_r , i_{pr}) - the minimal extinguishing intensities, in l/s x m^2 or l/s x m

b) Determine the number of flowing heads for water in fires (N_{ii}), when only one sort of heads are used, using the formula:

$$N_{i\,i}=q_{i\,nec} / q_{i\,i}, \qquad (5)$$

where: q_{ii} - the specific flows for the heads, in l/m.

Another way for determining the number of flowing heads, used more often because different heads are used, is the choosing of the specific debit, of the number of same kind of heads and the, assurance, thru the sum of the debits, so the condition is:

$$\sum q_{ii} \geq q_{i\,nec} \tag{6}$$

c) Determine the partial flows depending on the specific flow (q_{ii}) of the identical heads working simultaneous according to the extinguishing device.

At the completion of calculations determine necessary flow ($q_{i\,nec}$) we must sum up specific flow (q_{ii}), depending of the number of flow heads (N_{ii}) acting simultaneous, obtaining the partially flowing debit (for satisfying a single need in the case of extinguishing action), in l/min. Considering that in an extinguishing intervention all the categories of actions that require water consume are executed, we must determine:

- $q_{ref\ hs}$ - the flow debit of water for extinguishing (for enhanced water we will consider the water necessary for producing it);
- $q_{ref}\, h_{sp}$ - the flow debit of water for producing foam;
- $q_{ref}\, h_r$ - the flow debit of water for cooling;
- $q_{ref}\, h_{spu}$ - the flow debit of water for cooling foam with high bulking coefficient;
- $q_{ref}\, h_{pr}$ - the flow debit of water for protection.

These flow debit are taken in account for making the calculation for determining the necessary quantities of water for the needs and extinguish operation, depending on the duration of each operation (Tt), in minutes. For the simultaneous operations three the adopted devices we must insure the condition:

$$q_{ref} = q_{ref\,hs} + q_{ref\,h\,sp} + q_{ref\,h\,r} + q_{ref\,h\,spu} + q_{ref\,pr}\ \ [\text{l/min}] \tag{7}$$

d) We must determine the necessary quantity of water for extinguish the fire (simultaneous fires - Vih), depending on the duration of extinguishing operations (T_t) and the flow debits on necessary , $q_{ref\,hs\,(sp,\,r,\,pr,\,sp\,u\,)}$ The formula is:

$$v_{ih}\ \frac{\sum q_{ref\_hs}(s_p, r, pr, spu)\, x T_t}{1000}\ \ [\text{m}^3], \tag{8}$$

where: Tt, in minutes, $\sum$ being the sum of the results obtained after de multiplication of flow debits, on necessities, with the duration of the certain extinguishing operation.

e) We must compare the water quantity (V_{ih}) necessary for extinguishing fires (simultaneous fires) with the fire reserve (V_{inc}) and establish means to assure the work continuity in case of taking longer than they should.

For fires at oil products, as extinguishing agent aeromechanical, chemical foam is used. The calculations are identical like the ones concerning putting out fires with water. Halogens substances that contain Cl, Br, F have negative effects on people, if inhaled through breathing, and also on the environment causing the “Green house effect”. Even if halogen’s efficacity is very high at putting out fires it has been decided not to be used anymore to protect the enviroment. It can be noticed that by destroying the ozone through the “Green house effect” the plankton and the vegetation reduce their capacities to absorb CO2 and to give O2. This contributes to the increase of the CO2 concentration levels and also to the “Green house effect” and also to the changing of marine and terrestrial cycles. If the sea algae are destroyed, the fish does not have on what to feed and on dry land the cereal production is dangerousely compromised, so dissapearing or diminishing all of a sudden 2 important feeding sources for humans. So, at 22 march 1985 the Conference of Viena regarding the protection of the ozone layer established major decisions in this area.

CONCLUSIONS

These presented fires are among the most dangerous types of fire that have considerable negative effect both on the environment as well as on people. From experience we can say that, for the extinguish of such fires we need

a great consume of resources, both material and human. So, it is necessary that the prevention of the apparition of such fires to be imperative.

BIBLIOGRAPHY

[1] Benescu Vasile, Moţei Constantin – „*Tehnica şi tactica intervenţiilor*”, vol. II, Bucureşti, 1996;
[2] Benescu Vasile, Moţei Constantin, Mocioi Ionel-Alin – „*Tehnica şi tactica intervenţiilor*”, vol. III, Bucureşti, 1998;
[3] Avram Valer şi colectivul – „*Metodologia calculului forţelor şi mijloacelor necesare pentru stingerea incendiilor*”, Serviciul Editorial şi Cinematografic al M.I., 1984.