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СИСТЕМНО ПРОЕКТИРАНЕ НА ПОЖАРО СПАСИТЕЛНА ТЕХНИКА И НЕЙНИТЕ КОМПОНЕНТИ

SYSTEM DESIGN OF FIRE-RESCUE EQUIPMENT AND ITS COMPONENTS

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Abstract

It is offered as a basic technology to design a modern rescue and fire-fighting equipment to use the methods of system design of complex equipment. As an example is a fire trunk, as a basic element of the system generating the hydraulic jets in fire engineering. Demonstrate the use of creating a three-dimensional model of the fire barrel, as part of the design phase, as well as the example of one of the simplest experiments, it is created with the help of the experimental stand, which is in Academy of Fire Safety Named after Chornobyl Heroes.

Keywords: system design; fire-prevention equipment; hydraulic stream; fire trunk.

INTRODUCTION

The most important element of the counter is a special emergency rescue equipment, and its typical example would be a fire truck. Throughout the world there is a great variety of such techniques and typically it is divided into groups intended to help solve various life tasks. Accordingly, the parameters of means for each of the groups may differ materially. For example, the average tonnage fire vehicles must be able to quickly evacuate to a place of emergency for three to eight rescuers, and five tons of fire extinguishing agent, a special hydraulic equipment, etc.

SUMMARY

The creation of this technology requires the use of modern approaches to the design of complex technical equipment, which is a fire vehicle and its equipment.

One of the areas of improvement of the design of the vehicle shall be, in my opinion, a departure from the purely engineering methods for solving design problems, which, unfortunately, still enjoying the designers and constructors. This may help in the proposed method of design of the system of new technology in general and vehicles in particular.

Applying the system model to design the main components of fire suppression systems, and in our case, Firefighting and rescue vehicle, you can streamline the task of building types of support [1,2] in a logical sequence shown in Fig. 1.

It is important to point out that in the only part of the solution demonstrates the complex task of creating complex technical objects. In this case, it can be argued that in this way you can solve other design problems.

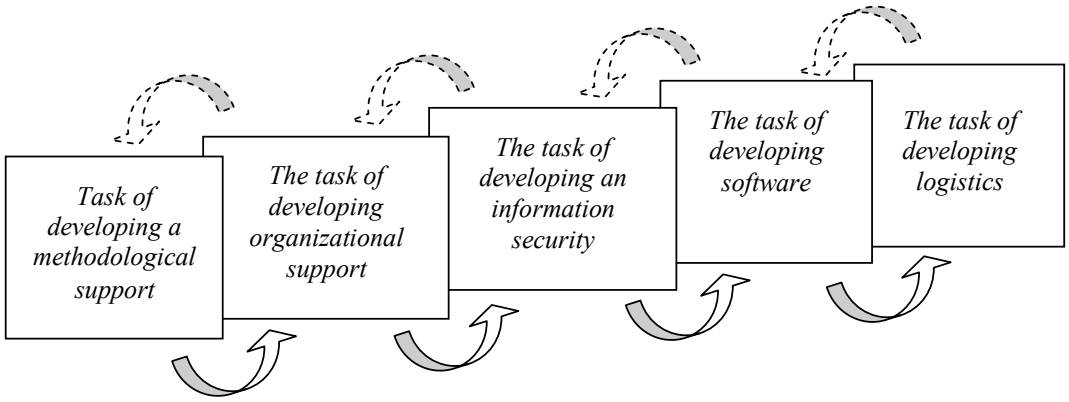

Fig. 1. *Logic sequence of problems of creation of types of providing*

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Next we will focus on the trunks of fire - an important element of fire. Review designs fire-fighting equipment and its components used in the formation of stationary and pulsating jets of fire [3, 4], suggesting that the basic elements of hydraulic circuits are pressure generators and their control systems, devices enable you to create flow pulsations of a certain frequency, control and summing the trunk of a hydraulic system, and finally the trunk (Fig. 2). The logical sequence of tasks of creating forms of support (Fig. 1) and the concept of the formation of jet streams (Fig. 2) are reduced to the creation of a hydraulic bore, through which you can generate a jet with certain fire properties.

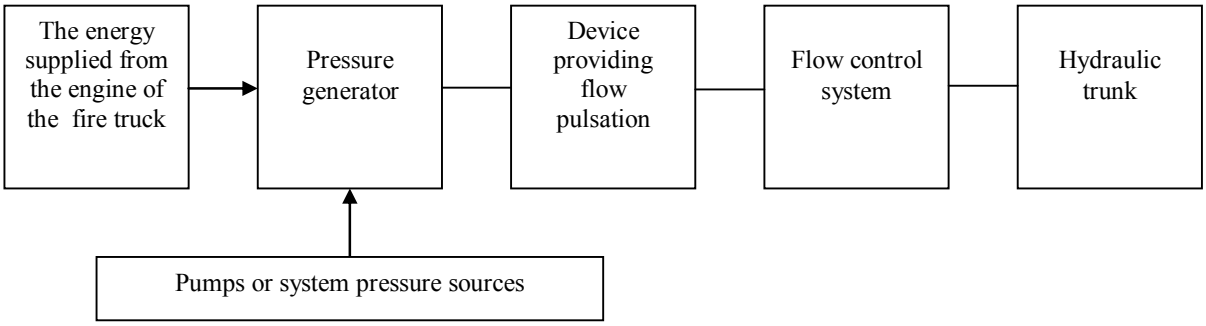


Fig. 2. *Schematic diagram of system of formation of jet streams*

The analysis of this simple scheme (Fig. 2) provides an opportunity to evaluate the hydrodynamic parameters of the jet, the equipment for its formation, to determine the economic feasibility of the technique of designing. The last remark is very important, because at the present time, the economic efficiency of the developed hardware is of particular importance, and on exergy is given an increasing role.

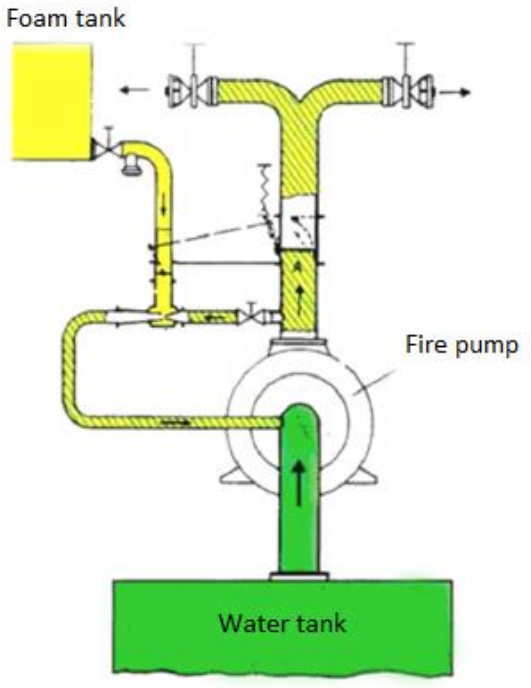


Fig. 3. *Scheme of water foamy communications of the fire truck [3]*

We point out that the use of the term "fire" jet in our case means water (hydraulic) jet used for firefighting.

Regardless of the base chassis all cars – trailers have pumping stations, tanks and tanks for fire extinguishers, pipe fittings, water intake system and feed system frother. All these elements together pipes which form water and foam communication. The above diagram gives an overview of the principle of formation and structure of jets of fire water and foam fire fighting vehicle communications (Fig. 3). Made of high quality materials its basic components: a water tank and foam tank. Tanker trucks are equipped with fire monitors with manual, remote, hydraulic and electric control [3].

Analysis of the low-pressure jets. The majority of studies focused on the hydraulic jets of high and medium pressure, which are widely used in various industries. However, you should pay more attention to the behavior of the low-pressure jets, as these find their realization in agriculture, fire prevention, water utilities, etc. It is, above all, the Jets generated for equipment with a rated pressure of fluids in their output 0.2 ... 4.0 MPa. In fact, this fire range, usually still have – 0.15 ... 0.8 MPa. For these jets, as shown in [1], the current scheme can be represented as follows (Fig. 4).

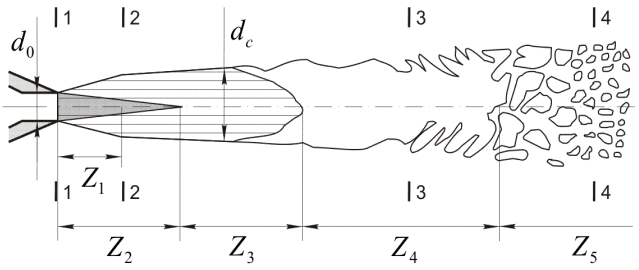


Fig. 4. *The scheme of structure of the free not flooded turbulent stream*

Features of a current of such stream can be explained if to allocate in it five specific sites of Z_1, Z_2, Z_3, Z_4, Z_5 . Z site – kernel of a cone-shaped form; Z_2 – an initial site with an irrotational current of liquid; Z_3 – the main site of a stream (outside of section 2-2 static pressure in a stream becomes equal atmospheric, on Z_3 site still the high density and compactness) remains; on Z_4 site the stream loses the stability and has irregularities in surface formation. At last, on Z_5 site stream disintegration is observed. If to assume that dynamic pressure of the environment in any section of

a site of Z_1 equally P_m, that it is function from average speed of a stream on an initial site U_0, diameter of a trunk d_0, distances from a trunk Z, liquid density ρ, viscosity μ and superficial tension σ. On the basis π-теоремы it is possible to find out that Reynolds's criterion and Weber's criterion will be the main criteria of similarity in this case. Pressure P_m under these conditions it will be equal

$$p_m = p_0 f\left(\frac{l}{d_0}, \frac{U_0 d_0 \rho}{\mu}\right)$$

where $p_0 = \frac{\rho U_0^2}{\mu}$ – the dynamic pressure of the jet at the outlet of the barrel. This is taken into account when carrying out the experiment described above.

Hydrodynamic features of the flow of viscous fluid in the trunks. Consider the features of the flow in the trunks, based on the following scheme: the trunk of view as channel providing a flow restriction, and the entrance should be the so-called hydraulic initial portion. Fig . 5 for the trunk is represented by three sections: in the ring isolated area, in which there is narrowing of the flow area should be unregulated flow length (Fig. 5). At this stage, the deformation of the velocity profile of the cross section 3-3 to section 4-4 under the force of inertia of convective acceleration. It is assumed that in this area the following inequality

$$\frac{\partial U_x}{\partial x} << \frac{\partial U_x}{\partial y},$$

where $U_x = f(x, y)$ – longitudinal velocity component.

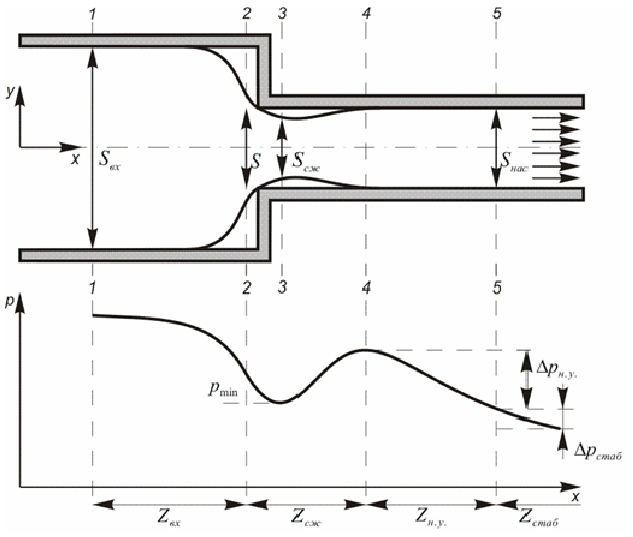


Fig. 5. *the current Scheme in a trunk from positions of existence of a hydrodynamic initial site*

In connection with the manifestation of the forces of inertia of the convective acceleration is not a constant in the initial part is the pressure gradient the pressure gradient is

$$\frac{\partial P}{\partial x} \neq const$$

.

It follows that the energy losses in the cores are provided as the forces of inertia and viscous friction forces, i.e., in accordance with the methodology for the calculation of hydrodynamic initial section.

The experiments to determine the change in pressure along the length of the barrel give some idea of the nature of these losses and point to the complex structure of the flow in the entrance of the trunk (Fig. 6). This explains learned on the piezometric lines of flux in the trunk for a ring isolated area.

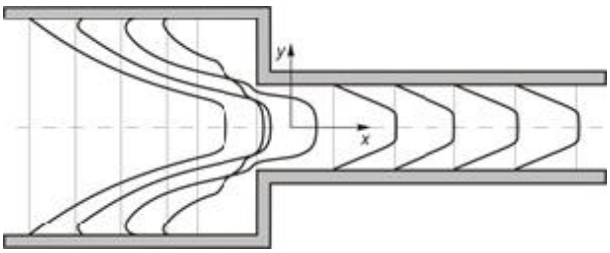


Fig. 6. *The deformation of the velocity profile at the sudden narrowing of the flow*

A similar pattern holds for the plane sudden constriction, where the pressure is quickly restored. In general, for the inner bore providing an abrupt narrowing flow have been four characteristic points, two of which are extrema characteristic point in determining the transition from the flow cross section area take place S to section $S_{сж}$. One extreme points determines the degree of expansion of the secondary flows, while the other corresponds to the section from which the velocity field is formed in a narrow portion of the channel, i.e. in the initial section $Z_{ну}$.

It should be noted that the length of the internal channel of a trunk should be more than a length of a hydrodynamic initial site.

The preliminary stud.

Fig. 7 shows an example of one of the simplest experiments carried out with the help of an experimental stand, which was created in the Academy of Fire Safety Named after Chornobyl Heroes. The result of the experiments was the confirmation of classical ideas about the impact of the water jet velocity U_0 at the barrier pressures P_1 and P_2 in zones I and II. New scientific results were obtained for different types of nozzles for fire jet forming trunks.

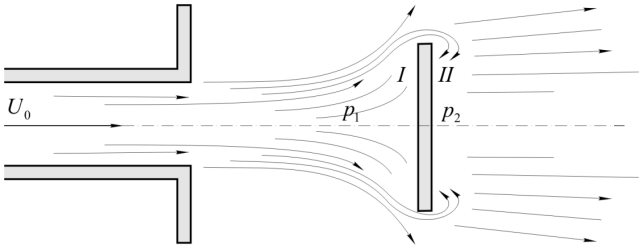


Fig. 7. *An example of use of the stand for studying of a flow of an obstacle (disk) by a liquid [3] stream*

Technologies used new techniques of design objects. Based on the features of the flow of hydraulic jets, shown

in Fig. 4, the establishment of an effective fire barrel requires passing several stages of its design . The following example creates a three-dimensional model of the product, which may be the initial step in creating a fire barrel. We point out that the task of improving the efficiency of the use of fire-fighting vehicle depends in part on improving the efficiency of the barrel, namely increase the range of the jet, saving foam solution, eliminate the effect of changes in operating pressure on dispensing error foaming solution. Here the designer to come to the aid of powerful hybrid modeling, which enable the ascending and descending projects of complex products with full parameterization and associativity, and allow the use of high-quality surface geometry created devices. In our case it is the simplest fire barrel RS -50, which is taken as an example to verify the adequacy of the scientific results obtained using the known practical results of the barrel. In the future, the simulation can be developed for the new trunks.

All of these actions have been implemented through the use of new, simple design technologies, in our case (Fig. 8) used a system of three-dimensional parametric solid modeling T-FLEX CAD 3D, developed by the Moscow Machine Tool Institute and successfully applied by Bulgarian experts .

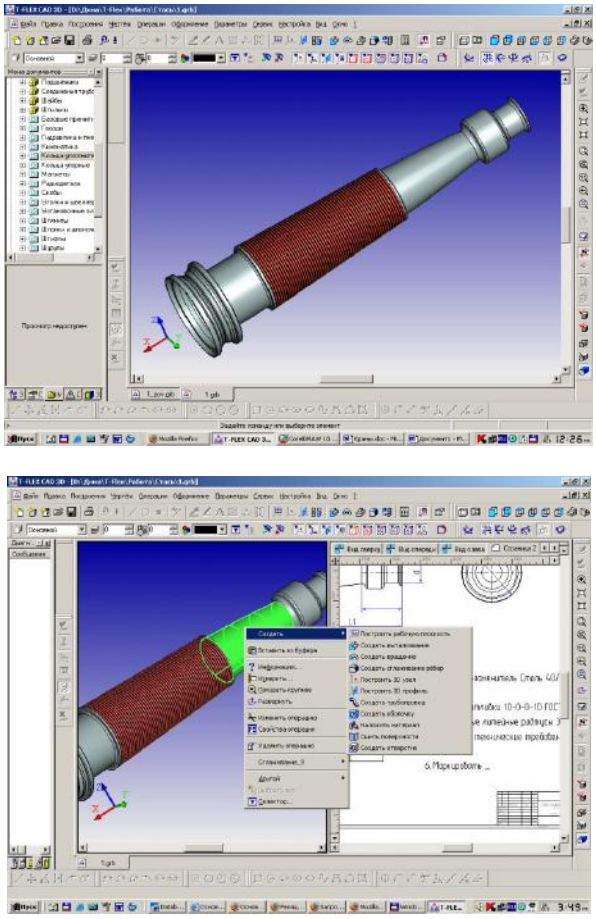
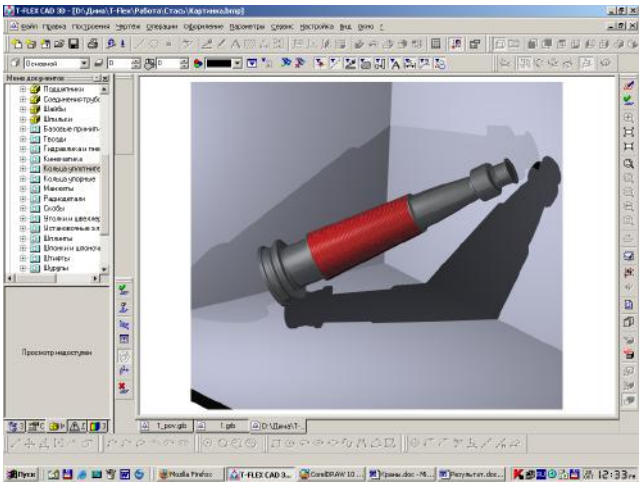


Fig. 8. *Creation of the parametrical national team 3D models of trunk RS-50 with changeable characteristics*

Using the concept of the product life cycle, we note that after development the drawings at the design bureau, copying them, they are going to the department to technologists. There on a every detail of the technology experts write route-operational technology for its production on the shop floors. The filling process maps are time-consuming and can be automated with systems such as T-FLEX.

(a)



(b)

Fig. 9. *Real trunk (a), photorealistic image of a product (b)*

The system of this type allow you to work not only with the individual three-dimensional objects, but with three-dimensional assembly models. Mechanism assembly parametric design model has been successfully applied in the two-dimensional drawing, and the design of three-dimensional objects assembly. Convenient, intuitive user interface in conjunction with specially designed features allows any designer to create complex three-dimensional model of the assembly.

The present level of computer hardware and software design principles in many cases can reduce the problem of software development and technical support to the tasks of selecting from a variety of the latest available. Trends in the development of computer technology greatly complicate and make it inappropriate design of specialized technical support, since the rate of change of generations of computer hardware and software versions are constantly progressing. In this case, focus our attention on the fact that the task of developing the technical support (Fig. 1) can not be considered only as the final stage of the system model of a new vehicle. It is directly connected with the development of the software and is the last link of the traditional approach in the construction of complex systems such as fire safety equipment. In the case of simulation of its elements – fire barrel, we note that the correct choice of its design features will improve the performance characteristics and, ultimately, close to solving the problem of creating a modern fire and rescue equipment.

CONCLUSION

Creating a modern fire and rescue equipment should provide a solution to the difficult problem of civil protection against all kinds of accidents and disasters, man-made disasters, natural and military nature. Operational Rescue Service of Civil Protection – special paramilitary formation, which is entrusted with protecting the population and territories from emergency situations, participation in the activities of territorial defense, as well as international relief and other humanitarian operations. Fire and rescue equipment, fire and technical rescue equipment, fire fighting and personal protective equipment, other property intended for fire fighting, disaster recovery, floods, earthquakes and other man-made disasters, biological, radiation, chemical and environmental and military must meet the current requirements of object creation of new technology.

As shown in work, creation of technology of system design of modern equipment and its elements can be carried out only at the system accounting of many factors (only some of them are presented As shown in the work, the creation of system design technology of modern technology and its elements can be implemented only if the system taking into account many factors (only some of them are presented in this paper) that influence the design process of complex objects. This is confirmed by examples of the creation of three-dimensional models of fire barrels, their design, construction and subsequent use in experimental research.

The result of the experiments conducted on the basis of studies of the structure and abnormally viscous flow of viscous liquids in packing clarified the flow of a fluid, obtained of the distribution of pressure and velocity, and shows how using the additional "injection" can affect the flow of the specified parameters.

The result of the carried-out experiments, on the basis of research of structure of a stream of viscous and abnormally viscous liquids in the field of a nozzle found out features of a current of liquid, ideas of distribution of pressure and speeds are received, and also is shown, how by means of additional «injection» it is possible to influence the specified parameters of a stream.

The theoretical results obtained with the modern methods of system design and simulation can significantly improve the properties of the future fire-fighting equipment, increasing its market competitiveness.

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