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SUBSTANTIATION OF THE POSSIBILITY OF ACCELERATED REFUELING OF AUTO-ARMORED VEHICLES IN CONDITIONS OF SPECIAL OPERATIONS

Conducting special operations to neutralize illegal armed groups that operate over wide areas is a challenging task. Its successful solution requires a comprehensive support of the operation. Conducting special operation is not possible without a clear and permanent system of logistics. The course and outcome of the operation depends on how well and timely the troops will be provided with everything necessary. The current battle is characterized by high dynamism, strength and short-term, abrupt changes in the situation. Modern and fast refueling of the armored vehicles with fuel in combat is one of the basic conditions for support combat readiness. Reduction of time filling by fuel armored vehicles is an important task that affects of the success of military operations. **Analysis of existing methods** of fueling vehicles (armored vehicles) in field conditions, with the corresponding not hiding signs for refueling fuel technology, with a concentration on technology and site servicing considerable time to conduct refueling in terms of illegal armed groups, shows the vitality of means low servicing. To improve the survivability of the system "vehicle - vehicle refueling" by reducing time refueling dispersal vehicles during refueling for fuel flow can use the mechanical energy of the car, which fueled (without using additional means of filling). However, as the capacitances of fuel used in flexible containers that provide fuel displacement are at running wheel of the car, which fueled. **The work** proved and proposed a new way to deliver fuel and rapid refueling of cars (armored vehicles) in the field conditions during the special operation that will reduce the likelihood of defeats increased survivability and technology, to refuse filling existing methods. **Results** of calculation are consistent with previous experimental studies that argue that the elastic reservoir is not broken when hitting the wheel of the car and allow you to use it to determine the parameters of armored vehicles. Using the method of rapid refueling of cars would reduce the likelihood of defeat armored vehicles cars and increase its survivability by 15 - 25% in contrast to the existing methods of filling.

Keywords: special operation; illegal armed groups; logistics; material support; places of permanent deployment; combat situation; the tactics of warfare; the organization providing the troops with fuel; parachutless method for rapid refueling vehicles (armored vehicles); experimental studies; mathematical model of stress-deformed state.

Introduction

The special operation to destroy illegal armed groups that operate in large parts of the state, is a difficult task, and its success requires a comprehensive solution to ensure its implementation. The special operation conduction is impossible without a well-established and permanent logistics support system. The course and outcome of the operation depends on how fully and promptly the troops will be provided with everything needful [1]. Not supported troops are not able to realize their combat capabilities. The outcome of combat operations depends on the sustainability and good functioning of logistics.

One of the main places in the logistic support of troops assigned to financial support, which is designed to meet the needs of troops in financial needs [2].

A special role in the financial support given to the special operation providing fuel armored equipment. The organization providing the troops with fuel in a special operation near the places of permanent deployment in populated areas, is not much different from the usual conditions, and experts do not cause particular difficulties. However, the organization providing armored fuel technology in terms of the special operation to destroy illegal armed formations, apart from places of permanent deployment, causing considerable difficulties.

Modern combat of special operation [3] to destroy illegal armed formations, characterized by high dynamism, intensity and short duration, abrupt changes in the situation. Timely and fast refueling fuel armored equipment on the battlefield have a basic condition for maintaining the combat readiness of troops. Reduced time is a major task which affects the success of the military operation.

Objective of work and setting goals. The aim of this work is to develop a new method of rapid refueling vehicles (armored vehicles) in terms of military operations or other combat zone.

Statement of the problem is to choose the most rational way of rapid refueling vehicles (armored vehicles) in the shortest possible time, in the conditions identified with increased external threat sources.

The ways of refueling vehicles (armored vehicles) in the field

During warfare refueling of military vehicles is produced, usually secretly, at night or in poor visibility conditions, as the exhaustion of fuel, depending on the combat situation.

Refueling is made by the driver (trucks, cars), delivered the fuel, and a driver to refuel the car. Refueling combat vehicles (Infantry fighting vehicle, armored troop-carrier) before the fight is done in their concentration area prior to the line of deployment. In this area, they are completely refuel fuel, lubricants and industrial fluids.

When the location of the military unit deployed in the field Field refueling point of nominally-Personnel resources of military units: the field of filling points, road tankers and tank trucks (Fig. 1).

Fig 1. Refueling of armored equipment in the field

There are three ways of vehicles refueling in the field [4]:

• the first way – vehicles to refuel move to the means of refueling;

• the second method - refueling equipment supplied to refuel vehicles;

• a third way - a mixed (some units are refueled first, and the other – by the second method, or simultaneously in two ways).

Filling machines are organized on the basis of the situation and conditions.

Technique in designated refueling areas must be located so as to make full use of productivity tools refueling with minimal moving them from place to place. In addition, the division of funds refueling and transport of fuel must have platform allows simultaneous refueling of several pieces of equipment of the units, providing invisibility of works and reliable fire safety.

However, the process of delivering fuel vehicle refueling companies to refuel the car, may be carried out under conditions of constant fire influence of illegal armed groups.

Road tankers are obvious unmasked signs and so may be affected by small arms illegal armed groups. With the defeat of the automobile tanker, can occur not only by the loss of fuel due to its uncontrolled leakage from the fuel compartment, but also the complete destruction of the tanker and other vehicles (armored vehicles), placed at a short distance.

Reservoir development for refueling of vehicles (armored vehicles) in the conditions of the special operations

Methods for filling machines [5] based on the principle of fuel overflow from one fuel tank (cistern) to another under the influence of external forces. In this flow of fuel is possible, as by gravity, and with the use of pumps with different power drives.

A generalized process of filling armored techniques using these methods can be viewed as a process that takes place in the system of "tank of fuel – means the transfer of fuel – refuel the car."

Trying to reduce the number of elements of this system allows you to simplify the process of refueling and offer to use as a means of pumping fuel, the weight of the car to refuel.

The consequence of this there is a need to use as fuel tanks specially designed flexible tank, which can provide displacement of the fuel of them at running and moving them longitudinally of the machine. The main advantages of special elastic reservoirs are:

- a slight weight relative to the weight of the transported or stored cargo in them;
- the possibility of clotting in the small volume of the roll, which causes good transportability unladed;
- low ground pressure in the filled condition, which allows deploying tanks on any terrain, including swampy;
- lightweight towed through the water;
- the ability to ensure their without parachute dropping [6].

These advantages, together with the possibility of rapid refueling vehicles by extrusion of fuel in the vehicle tank (including the impact on the underlying tank to refuel the vehicle), do rubberized tanks indispensable for carrying out special operations to destroy illegal armed formations, military operations, natural disasters relief and man-made disasters.

Analysis of existing characteristics of resources fueling vehicles (armored vehicles) shows, that the development of modern weapons and change tactics of warfare, new qualifying standards for the creation of a qualitatively new means of field refueling. Capabilities of without parachute dropping of fuel in special tanks of rubber allow us to offer a new method of rapid refueling vehicles in combat [7].

The essence of the method for rapid refueling vehicles (armored vehicles) is to place the tank with fuel under the wheel of the car, followed by a longitudinal hitting it. Refueling of vehicles proposed method consists in displacing the liquid from the tank by pressurizing in it, by hitting him on the wheels of the car and the overflow of fuel into the fuel tank [8]. Scheme of refueling process is shown in the Fig. 2.

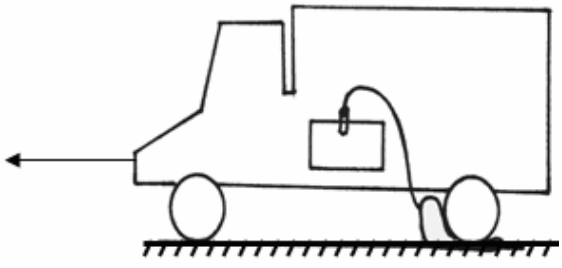

Fig. 2. Scheme of refueling process.

When driving in on the flexible reservoir by the wheel of the car, it is deformed, whereby there is formed an overpressure P_{res} liquid in it. Thus under the

influence of excessive fuel pressure *Pres* during the forward motion of the wheel will follow to the discharge hose and flow to the fuel tank of the machine. Part of the fuel due to the interactions of the car wheels with the reservoir flows in the opposite direction to the movement of the machine.

To determine the pressure in the tank *Pres* use basic theory of interaction wheel position with a deformable base. When driving in on the fluid reservoir by the wheel (Fig. 3), there is distortion of the wheel and the tank. The fluid pressure in the tank is rising. The observations of the process of hitting the car wheels on a tank of liquid led to the assumption that the fluid pressure increase in the tank when hit by a vehicle wheel is called traction force P_{wh}, which proceed on an area S1 of the contact wheel with a reservoir.

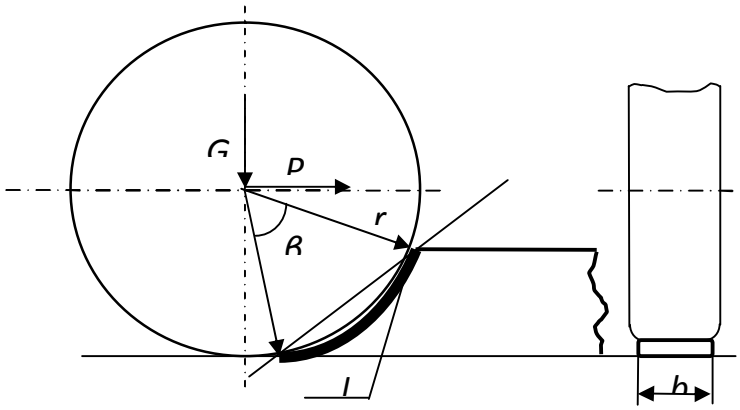

Fig. 3. Scheme of driving a vehicle wheels on the tank

The pressure in the tank P_{res} by the formula [8, 9]:

$$p_{res.} = p_{car.} + \rho a(x_0 - x) + \rho g(z_0 - z), \quad (1)$$

where x, z – horizontal and vertical coordinates; a, g – acceleration appropriate$

$$p_{car} = \frac{P_{wh}}{S_1}. \quad (2)$$

Traction force on the wheel P_{wh} is the ratio of the torque on the wheel M_{wh} to the rolling radius of the wheel r_{wh} [10]:

$$P_{wh} = \frac{M_{wh}}{r_{wh}}, \quad (3)$$

where $M_{wh} = M_e \cdot U_{mp} \cdot \eta$ – the torque on the wheel; M_e – the torque to the engine; U_{mp} – the ratio of the transmission; η – the transmission efficiency.

The car will go if the condition will be:

$$P\text{wh} \le G\text{wh} \cdot \phi, \quad (4)$$

where G_{wh} – load to the wheel; φ – the coefficient of adhesion.

The contact area of the wheel S1 with a reservoir is given by [8]:

$$S_1 = l \cdot b \cdot K_n,$$

where $l \approx r \cdot \beta$ – length of the wheel contact with the reservoir; r – the radius of the wheel; β – radial measure of the central angle; b – the width of the tank; K_n – coefficient of saturation of the tire tread.

When driving a car with a torque value of the place on the engine and the drive wheels is a variable, which in turn causes a change in the traction force on the wheels. As a result, the liquids pressure in the tank will also be variable.

A mathematical model to determine the pressure in the tank when the vehicle is moving, will be:

$$p_{tank.} = pvh + \rho a(x_0 - x) + \rho g(z_0 - z);$$

$$p_{Aem.} = \frac{P_к}{S_1};$$

$$S_1 = l \cdot b \cdot K_n;$$

$$Mwh = M_e \cdot U_{mp} \cdot \eta;$$

$$P_{wh} = \frac{M_{wh}}{r_{wh}} \le Gwh \cdot \phi.$$

on condition: $V_{liquid} \ge V_{free}$

where V_{liquid} – the volume of liquids in the reservoir before a wheel; V_{free} – free volume of the tank in front of the wheel.

$$p_{tank.} = \rho a(x_0 - x) + \rho g(z_0 - z)$$

on condition: $V_{liquid} \prec V_{free}$.

When driving in on a tank ($S_1 = 0{,}03$ m^2, $S_2 = 0{,}003$ m^2 - nozzle area) fluid of the rear axle of the truck GAZ – 3309 with tire size (8,25 – 20) inches ((240 – 580) mm), $p_{tank.} \approx 40000$ Pa.

To confirm the principle displacement of fluid capabilities of the flexible container when hit by a vehicle wheel were conducted qualitative experimental studies of the process shown in Fig. 4.

When conducting qualitative experimental study as a flexible container with a liquid [11] has been chosen a model of container with a diameter nozzle of 0.028 m and a capacity of 0.035 m^3.

Truck GAZ-3309 has been used as a vehicle with the size of the tire (8,25 - 20) inches (240 - 580) mm. Measuring container placed at the height of the vehicle fuel tank.

Fig. 4. The displacement of liquid
by the vehicle wheel of an elastic reservoir

Model of flexible container filled with liquid and placed under the rear outer wheel of the car (Fig. 4). To one end of the nozzle was attached the pressure hose and secured with a clamp, and the other end of the pressure hose joined the gauge tank. When driving in on the model of the tank on the rear wheels at a speed of 5 kph was observed, that the fluid displacement from the reservoir and overflow it along the hoses on the gauge tank.

It was found that the amount of displaced liquid is (75 - 80)% of the available amount of liquid in the tank before driving ($p_{tank.} \approx 37{,}000$ Pa.), And the tank was not damaged and was suitable for further use. When driving in on the model of the tank on the rear wheels at a speed of 10 kph, it was revealed that the amount of liquid displaced is (30 - 35)% of the available amount of liquid in the tank before a collision ($p_{tank.} \approx 39{,}000$ Pa.), the tank also had no damage and it was suitable for further use.

Conclusions

1. Existing methods for delivery and refueling the auto-armored vehicles with fuel in combat conditions do not meet modern requirements for security and timely delivery to the site requirements.

2. Was worked out a new method of delivery and refueling of the auto-armored vehicles in the field when performing special operations.

3. Experimentally confirmed the principle possibility of displacement of liquid fuel from the elastic tank for longitudinal driving by a auto-armored vehicles the reservoir model during and after hitting the wheel is not torn, damaged and had remained intact for future use.

4. The work revealed a pattern of influence the speed driving of the vehicle on the volume of the displaced fluid from the reservoir, and it is shown that when the speed driving of the auto-armored vehicles 1.2 mps, the volume of liquid displaced from the tank is 70% of the initial volume, which was before the driving, while increasing the driving rate on the tank up to 2.8 mps, and it decreases 30% from the original before the driving.

5. The results of the calculation of the mathematical model are consistent with the previous experimental studies that argue that a flexible reservoir is not broken at the time of driving of the longitudinal wheel of a car and allow you to use it to determine the parameters of the auto-armored vehicles.

6. Using the method of accelerated vehicle refueling of the auto-armored vehicles can reduce the likelihood of injury and increase its survivability by 15 - 25%, in contrast to the existing methods of refueling.

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Обґрунтування можливості прискореного заправлення автобронетехніки в умовах проведення спеціальних операцій

А.В. Ковтун, В.О. Табуненко

Проведення спеціальної операції по знешкодженню незаконних збройних формувань, які діють на значній території, є складною задачею. Її успішне рішення вимагає всебічного забезпечення проведення операції. Проведення спеціальної операції неможливо без чіткої і постійно діючої системи тилового забезпечення. Хід і результат операції залежить від того, наскільки повно і своєчасно війська будуть забезпечені всім необхідним. Сучасний бій характеризується високою динамічністю, напруженістю и короткостроковістю, різкими змінами обстановки. Сучасна і швидке дозаправлення автобронетанкової техніки пальним в бойових умовах є однією з основних умов підтримки боєготовності військ. Скорочення часу заправлення авто бронетанкової техніки пальним є важливим завданням, яке впливає на успіх проведення бойової операції. **Аналіз існуючих способів** заправлення автомобілів (бронетехніки) в польових умовах, з відповідними демаскуючими признаками техніки для заправлення пальним, з зосередженням техніки на місці заправлення і значним часом на проведення заправлення, в умовах дії незаконних збройних формувань, свідчить про низьку живучість технічних засобів заправлення. Для підвищення живучості системи „автомобіль - засіб заправлення” за рахунок зменшення часу заправлення, розосередженням автомобілів під час заправлення, для перетікання пального можна використовувати механічну енергію автомобіля, який заправляється (не використовуючи додаткових засобів заправлення). При цьому, в якості ємностей з пальним використовуються еластичні резервуари, які забезпечують витиснення пального з них при наїзді колесом автомобіля, який заправляється. **В роботі** обґрунтовано та запропоновано новий спосіб доставки пального і прискореного заправлення автомобілів (бронетехніки) в польових умовах при проведенні спеціальної операції, що дозволить зменшити ймовірність ураження та збільшити живучість техніки, на відмову від існуючих способів заправлення. **Результати** розрахунку співпадають з результатами попередніх експериментальних досліджень, які стверджують, що еластичний резервуар не розривається під час наїзду колесом автомобіля та дозволяють використовувати її для визначення параметрів авто бронетанкової техніки. Використання способу прискореного заправлення автомобілів дозволить зменшити імовірність ураження авто бронетанкової техніки та збільшити її живучість на 15 – 25 % на відміну від існуючих способів заправки.

Ключові слова: спеціальна операція; незаконні збройні формування; тилове забезпечення; матеріальне забезпечення; пункт постійної дислокації; бойова обстановка; тактика ведення бойових дій; організація забезпечення військ пальним; беспарашутний скидання пального; спосіб прискореної заправки автомобілів (бронетехніки); експериментальні дослідження; математична модель напружено-деформованого стану.

Обоснование возможности ускоренной дозаправки автобронетехники в условиях проведении специальных операций

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Проведение специальной операции по обезвреживанию незаконных вооруженных формирований, действующих на значительной территории, является сложной задачей. Ее успешное решение требует всестороннего обеспечения проведения операции. Проведения специальной операции невозможно без четкой и постоянно действующей системы тылового обеспечения. Ход и результат операции зависит от того, насколько полно и своевременно войска будут обеспечены всем необходимым. Современный бой характеризуется высокой динамичностью, напряженностью и краткосрочностью, резкими изменениями обстановки. Современная и быстрая дозаправка авто бронетанковой техники горючим в боевых условиях является одним из основных условий поддержания боеготовности войск. Сокращение времени заправки авто бронетанковой техники горючим является важной задачей, которая влияет на успех проведения боевой операции. **Анализ существующих способов** заправки автомобилей (бронетехники) в полевых условиях, с соответствующими демаскирующими признаками заправочной техники, с сосредоточением техники на месте заправки и значительным временем на проведение заправки, в условиях воздействия незаконных вооруженных формирований, свидетельствует о низкой живучести технических средств заправки. Для повышения живучести системы „автомобиль - средство заправки” за счет уменьшения времени заправки, рассредоточенности автомобилей во время заправки, для перетекания горючего можно использовать механическую энергию заправляемого автомобиля (не используя дополнительных средств заправки). При этом, в качестве емкостей с горючим используются эластичные резервуары, которые обеспечивают вытеснение горючего из них при наезде колесом заправляемого автомобиля. **В работе** обоснован и предложен новый способ доставки горючего и ускоренной заправки автомобилей (бронетехники) в полевых условиях при проведении специальной операции, что позволит уменьшить вероятность поражения и увеличить живучесть техники, в отличие от существующих способов заправки. **Результаты** расчета совпадают с результатами предыдущих экспериментальных исследований, которые утверждают, что эластичный резервуар НЕ разрывается во время наезда колесом автомобиля и позволяют использовать ее для определения параметров авто бронетанковой техники. Использование способа ускоренного заправки автомобилей позволит уменьшить вероятность поражения авто бронетанковой техники и увеличить ее живучесть на 15 - 25% в отличие от существующих способов заправки.

Ключевые слова: специальная операция; незаконные вооруженные формирования; тыловое обеспечение; материальное обеспечение; пункт постоянной дислокации; боевая обстановка; тактика ведения боевых действий; организация обеспечения войск горючим; беспарашютный сброс горючего; способ ускоренной заправки автомобилей (бронетехники); экспериментальные исследования; математическая модель напряженно-деформированного состояния.