

Fire extinguishing systems for dump trucks

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Abstract. The paper presents a classification of fire extinguishing systems for dump trucks. The principles of fire-extinguishing systems operation are given according to the method of actuation and purpose of applied extinguishing agents. Manufacturers of fire-extinguishing systems for mine dump trucks are marked, and technical characteristics of their systems are represented. As a result of the research, it has been determined that the main direction of development of fire-extinguishing systems is connected with extinguishing of class E fires, because of increase in demand on CW with electromechanical transmission, the most perspective systems of fire-extinguishing are systems with automatic switching, with possibility of manual switching.

1 Introduction

Quarry dump trucks (DT) The high fire hazard of open-pit mining operations is a major concern. Powerful internal combustion engines (ICE) lead to high-temperature heating of the exhaust system components DT, which, in turn, together with the large amount of fuel and lubricants and networks of pipes and hoses, creates a risk of fire DT (Fig.1) [1-4]. Also, not to be forgotten is the possibility of coal dust buildup on parts DT, working at the mines.



Fig. 1 Combustion of a dump truck

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At DT with electromechanical transmission to ICE electrical components of the traction electric drive are added (generator, electric motor, installation of ventilated braking resistors (IVBR), control cabinet) [5-8], which increase the risk of fire DT. For example, if the cooling fan breaks down IVBR, the resistor sections heat up to the melting point of the enclosure metalwork, causing a fire DT.

Considering the cost DT, as well as safety at hazardous industrial sites where machines are operated, DT must be equipped with fire extinguishing equipment. The installation of fire extinguishing equipment is regulated by [9-11].

At present, there are DT fire extinguishing systems available from a variety of manufacturers and in different versions.

However, when creating new DT of RF production [12-21] all versions of fire extinguishing systems and their manufacturers should be considered.

2 Classification of fire extinguishing systems

Extinguishing systems are classified according to the method of operation and type of extinguishing agent (Fig. 2).

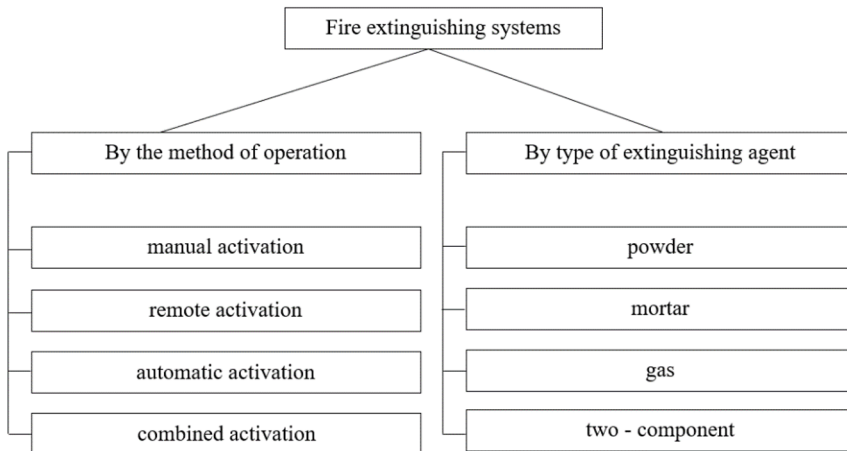


Fig. 2 Classification of fire extinguishing systems for dump trucks

Principle of operation of a manually-operated fire extinguishing system:

1. In the event of a fire, the driver stops the engine.
2. Starts the fire-fighting system by opening the gas cylinder valve.
3. The gas from the cylinder enters the powder tank and, through the powder line under pressure, ejects the extinguishing powder to the preset extinguishing points.

Principle of operation of a remote-controlled extinguishing system:

1. The control panel analyses the functionality of the fire-fighting system's communication lines and the presence of power supply in the circuit. In the event of a fault in the communication lines and the electrical release device, it gives a light and sound signal to the engine driver.

2. The system is activated (started) by the driver:

- by switching on from the in-cab control panel;
- by pressing the power button from a remote manual switch mounted outside the workplace, in a place accessible from the ground;
- by means of a mechanical start from the gas cylinder locking and starting head.

Principle of operation of an automatic fire extinguishing system.

The system automatically activates the powder line actuator when the temperature of the heat detector in the area to be protected is reached. If a fire is detected, the powder line can also be activated by the operator by pressing the electric start button on the automatic start device or the remote start button, or by slapping the actuator's manual button with the palm of his hand. The mortar line is manually actuated.

The automatic activation device performs:

- light signalling the presence of power in the circuit;
- light signalling of faults in the heat detector line, remote control switch circuit and electric starter circuit;
- protection of the automatic switch-on device in the event of a short circuit and over-voltage from the external power supply (vehicle on-board network);
- backup power supply for the automatic switch-on device in the event of an external power failure;
- control of temperature variations in the area where the heat detectors are located;
- audible and visual alarm when the temperature of a specific heat detector reaches 100°C, and "FIRE" when a critical temperature is reached;
- automatic switch-on of the powder line of the system when a critical temperature is reached;
- emergency switching on of the powder line by pressing the electric start button on the control panel or the remote start button or the manual start button on the shut-off and start-up head.

Combined actuation is realised by installing manual actuation in the system with automatic actuation.

Powder extinguishing systems are effective against fires caused by conventional fuels (class A), flammable liquids and gases (class B) and fires in electrical installations (class C). Thus, powder systems can provide comprehensive fire protection regardless of the cause.

Powder systems are effective against Class A and B fires and act as fast cooling and dampening agents, they are non-toxic, non-hazardous and non-aggressive. They quickly suppress fires, cool components and create a film covering the flammable liquid to prevent reignition.

The gas fire extinguishing system is designed to contain and extinguish class E fires. Spray elements are installed in compartments where high voltage appliances are located. The extinguishing process is based on a rapid deceleration of the fire and displacement of oxygen.

As the number of hybrid and electrical enclosures increases, so does the need for fire protection for electrical cabinets and compartments. The product is non-corrosive and does not conduct electricity, making it suitable for the protection of electrical components.

Two-component systems consist of a powder and a solution. The system combines rapid fire suppression and full volume filling thanks to the powder and rapid cooling thanks to the solution. Using a two-component system dramatically increases the capability of any system by combining the advantages of both agents.

3 Main manufacturers of fire extinguishing systems DT

Manufacturers of fire extinguishing systems for DT are:

- ANSUL (USA);
- AFEX (USA);
- LTD «SSPB» (Russia);
- ETERNIS LTD. (Russia);

- DAFO (Sweden);
- PRI–SAFETY (China);
- BelAZ (Belarus);
- TYCO (USA);
- JSC Mining Rescue Technologies (Russia).
- EPOTOS GROUP (Russia).

The technical data of each manufacturer's extinguishing system is given in tables 1-9.

Table 1. Technical characteristics of the fire extinguishing system ANSUL A–101

Parameter	Value
Extinguishing class	A, B, C, E.
Extinguishing agent:	
powder	FORAY
liquid	LVS
Weight of powdered extinguishing agent cylinder, kg	4.5; 9.1; 13.6; 22.7; 56.7; 113.4
Cylinder volume of liquid extinguishing agent, l	57; 114
Inclusion type	Manual/Auto

Table 2. Technical characteristics of the fire extinguishing system AFEX

Parameter	Value
Extinguishing class	A, B, C, E.
Weight of powdered extinguishing agent cylinder, kg	9,1; 13,6; 27,2; 56,7
Cylinder volume of liquid extinguishing agent, l	18,93; 56,78
Inclusion type	Manual/Auto

Table 3. Technical characteristics of the fire extinguishing system LTD «SSPB»

Parameter	Value
Extinguishing class	A, B, C, E.
Mass of extinguishing agent, kg	110
Cylinder capacity, m ³	120
Quantity DPE, pc	5
Time of action, s	10...25
Inclusion type	Manual/Auto
Operating temperature range, C	–60 +125
System lifetime minimum, l	10
Response time, max. s	3
Circuit check safe current, A max.	0.2
Operating current, A, not less	0.6
Electrical resistance, Ohm	2...5

Table 4. Technical characteristics of the fire extinguishing system ETERNIS LTD.

Parameter	Value
Extinguishing class	A, B, C, E.
Operating temperature	–40...+50°C
Inclusion type	Manual/Auto

Table 5. Fire extinguishing system characteristics DAFO

Parameter	Value
Fire class for modules FORREX	A, B, C.
Fire class for modules PFK	E.
Total mass of extinguishing agent, kg	90
Total cylinder volume, m ³	98
Time of action, s	10...15s
Inclusion type	Manual/Auto

Operating temperature range, C	-30 +50
System lifetime minimum, l	1
Response time, max. s	1

Table 6. System characteristics PRI-SAFETY

Parameter	Value
Extinguishing class	A, B, C, E.
Weight of powdered extinguishing agent cylinder, kg	6, 9, 12, 18, 25, 50, 100
Weight of foam extinguishing agent canister, l	6, 9, 12, 18, 25, 50, 100
Working pressure, bar	14
Test pressure, bar	27
System activation temperature, C ⁰	140

Table 7. Fire extinguishing system characteristics BelAZ

Parameter	Value
Extinguishing class	A, B, C
Types of extinguishing agent: powder line solution line	extinguishing powder aqueous calcium chloride solution
Mass of extinguishing agent, kg powder line of the engine compartment rear axle powder line mortar line	50 6 33
Working gas	nitrogen or air
Operating pressure in system tanks, MPa, max.	1.2
Extinguishing agent throw distance, m, not less: solution powder	10 4
Extinguishing agent release time, s, max: solution propulsion compartment powder rear axle powder	60 60 15
Power supply voltage of the remote control unit, V	24
Inclusion type	Manual/Auto

Table 8. Characteristics of the fire extinguishing system at the Mining Rescue Technologies Research and Development Centre

Parameter	SKP-M	SP 50	SP-A.50	SKP-AM	SKP-AM.130-2K
Extinguishing class	A, B, C	A, B, C	A, B, C	A, B, C	A, B, C
Types of extinguishing agent (FEA) powder lines	Vexon powder –AVS				
	aqueous calcium chloride solution	–	–	aqueous calcium chloride solution	Cooling liquid
Switching on:		remote or manual	Automatic, remote or manual		
powder line of the engine bay	remote or manual	–	–	Automatic, remote or manual	Automatic, remote or manual
rear axle powder line	automatic or manual	–	–	Automatic, remote or manual	Automatic, remote or manual

Parameter	SKP-M	SP 50	SP-A.50	SKP-AM	SKP-AM.130-2K
solution line	manual	–	–	Automatic, remote or manual	Automatic, remote or manual
FEA weight total, kg:	126		20	126	150
powder	76	–		76	66
solution	50	–		50	84
System construction weight, kg, max.	165		22	165	212
Total system weight, kg, max.	291		42	291	362
Fire extinguishing capacity:					50
powder line of the engine compartment - protected volume, m ³	70		20	70	8
rear axle powder line - protected volume, m ³	5	–	–	5	8
mortar line - protected area, m ²	3,75	–	–	3,75	45
Working gas	nitrogen or air				
Gas cylinder capacity, dm ³ , no more:		8	2		7
powder line of the engine bay	8	–	–	8	40
rear axle powder line	40	–	–	40	40
solution line	7	–	–	7	5
Pressure in the gas cylinder powder line propulsion compartment and mortar line at a temperature of 20 °C, MPa:	from 11.7 till 13.5				
Operating pressure in system tanks, MPa, no more	1.2				
FEA distance:					4
mortar, m, at least	10	–	–	10	4
powder, m, at least	4	4	4	4	10
Release time FEA, s, not more than:		60	60		90
propulsion compartment powder	100	–	–	100	8
rear axle powder	15	–	–	15	8
of the solution	60	–	–	60	60
Length of the flexible solution line hose, m, not less than	20	–	–	20	15
Power supply voltage of the remote control unit remote activation,	24	24	24	24	18–36
Consumption current, A max:					
in a working mode	0.5		0.05	0.1	0.5
in system triggering mode	10		0.05	0.1	0.5
Operating temperature, °C:	-50 to 50				from - 55 to 55
Total average lifetime	10				10

Parameter	SKP-M	SP 50	SP-A.50	SKP-AM	SKP-AM.130-2K
of the system, years					
Guaranteed service life, years	1				2
Speed, s, not more:					3
powder line of the engine compartment from the electric start	3	3	3	3	3
powder lines by hand	3	3	3	3	3
rear axle powder line from VSP	10	3	3	3	3
manual mortar line	10	–	–	10	10

Table 9. Technical characteristics of the fire extinguishing system EPOTOS GROUP

Parameter	Value
Extinguishing class	A, B, C, E.
Weight of powder extinguishing agent, kg	48
Cylinder volume of liquid extinguishing agent, l	48
Inclusion type	Manual/Auto

Analysing the technical characteristics of fire extinguishing systems from various manufacturers, it is worth noting the desire to create fire extinguishing systems for extinguishing classes A, B, C, E. These extinguishing systems are most appropriate for DT with electro-mechanical transmission, allowing fire to be extinguished in time with minimal damage.

4 Conclusions

As a result of the review of the classification of fire extinguishing systems DT and their manufacturers, it is worth noting the following:

- there is a variety of fire extinguishing systems DT by mode of operation and type of extinguishing agent;
- there are currently 10 manufacturers of fire extinguishing systems;
- the main development of fire extinguishing systems is related to extinguishing class E fires, due to the increasing demand for DT with electromechanical transmission;
- the most promising extinguishing systems are those with automatic activation, with manual activation options.

5 Acknowledgments

The work was financially supported by the Ministry of Science and Higher Education of the Russian Federation under the agreement No. 075-11-2022-016 of April 07, 2022, with KAMAZ PJSC on the integrated project "Creation of high-tech production of autonomous mining dump trucks with a load capacity of 240 tons with a domestic traction drive for operation in the system of digital open-cast mining", with the participation of the Kuzbass State Technical University named after T.F. Gorbachev with regard to research and development and technological works.

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