



SORPTION OF HAZARDOUS MATERIALS IN ROAD TRANSPORT

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Summary: *Area of road transport as a part of logistic security management is great. Automobile sectors as a part of the chief user in road transport, which increase of recourse and from it implicating traffic accident especially from last ten years, are characteristic phenomenon's and open necessities solutions for lot of problems, from which are in front line contamination of environment.*

In basic characteristic of traffic accident within are the intervention coupled with liquidation of leak dangerous materials, have specific position propellant. Their relative low toxicity is compensation with big quantity, which is finding in every time centred in ring of whole communication system.

Introduction

Area of road transport as a part of logistic security management is great. Only in area of Europe with this are coupled more than 12 millions working places, that every year together supply European economy by part 490 milliards euro. Only automotive sectors invest every year on research and technological development 19 milliards euro, by with is the biggest private investor in transport in Europe.

Analogous to other industrialized regions on the world too Slovak economy increase and growth parallel with expand of road transport sector. Increase of recourses in road transport in last ten years open needed of solution for complete line of problems, in that in front line is especially contamination of environment.

1 VEHICLES

Road transport as the most using transport in Slovakia – good frequency of road networks, connections of all objects (cities, village, industry objects) record in last ten years strong expansion as in transport of products so in transport of persons. Its progressive development is made for develop of automotive equipments, that cover continuous transport materials and persons, but also made negative situations impair on environment. Structure of automotive park and its progressive increasing worm's eyes view of economic and personal needs of population markedly show on this problematic.

Table 1. Vehicle in SR [2], [3]

Year	Vehicles together	From that		
		Passenger car	Lorries trucks	Buses
1995	1 240 573	1 015 794	212 967	11 812
2000	1 401 643	1 174 244	216 479	10 920
2003	1 289 320	1 085 544	192 262	11 514
2004	1 362 903	1 146 000	205 590	11 313
2005	1 384 594	1 162 294	212 152	10 148
2006	1 594 383	1 333 749	251 852	8 782
2007	1 723 202	1 433 948	278 774	10 480
2008	1 869 119	1 544 888	313 694	10 537
2009	1 931 866	1 589 044	333 422	9 400

In term of constructions solution of individual type and kind motors vehicles (and quantity of transport industrial substances- major driving flue) can be this introduction vehicles divided into two basic groups – group of vehicles with cubature of tank on Fuel about 40 l and lorry vehicles with cubature of tank on Fuel about 400 l (at 200 to 800 l and more). At passengers cars are possible specified 1/3 vehicles with diesel engine and 2/3 vehicles with petrol engine, and lorry vehicles are diesel engine.

On the based of evidence data at individual types and kinds motors vehicles on area of Slovak republic (table n. 1) show us that at assumption only 70 % real mobility, every moment on communications about 1.350.000 units of vehicles (1.110.000 private cars a 240.000 lorries trucks), what represent by calculation for transport of fuel cubature (in tank has about 50% cubature) about 14.800.000 l petrol and 55.400.000 (7.400.000 + 48.000.000) l diesel.

At 50 % real mobility it is about 965.000 units of vehicles (794.000 passengers cars and 171.000 lorries trucks), what represent be calculation of fuel about 10.600.000 l petrol and 39.500.000 (5.300.000 + 34.200.000) l diesel. Others operate substances (oils, acids and others.) from point of view transporting quantity are not take to reflections.

Presentation cubature of fuel clearly declare, which dangerous substances major in term of quantity are in present transport situation on communication priority major in term of probability its outflow to place. Although present cubatures of fuel are “time diffused” (present values are averaged) and its effect on surrounding area is conditional weather situations (summer, winter, rain, wind) are, space centred into road communication areas. On the base of its toxic properties in compare with toxicity of others dangerous chemical substances transporting between individual industrial objects (production, storage, processing, distribution) are time periodic and space less dangerous and therefore sometimes more dissemination especially on area in which there are finding [4].

2 TRAFFIC ACCIDENT

Increase in the number of vehicles increases, although not directly proportional to the ratio of the number of road accidents in the economic but also environmental effects, which are incurred as a result of road accidents, is still higher and increasingly are transmitted to the society.

Traffic accidents are the characteristic phenomena of car traffic in its time, though in the beginning they were fewer and fewer consequences than in terms of casualties and destroyed material values, as well as secondary consequences on the environment.

Table 2. Accidents in SR [5],[6]

Year	Numbers		
	Vehicles	Accidents	Damages in mil. Sk
2003	1 289 320	60 304	3 815,72
2004	1 362 903	61 233	4 023,38
2005	1 384 594	59 991	3 999,87
2006	1 594 383	62 040	4 232,71
2007	1 723 202	61 071	4 516,72
2008	1 869 119	59 008	4 506,10
2009	1 931 866	25 961	?

The statistical records of traffic accidents show that some accidents are fairly evenly dispersed along the length of road, but some accidents are concentrated in the so called. Accident sections (sites). These sites or sections with an accumulation of accidents are considered as sites with very negative effects of environmental terms. Therefore it's to the forefront (regardless of the extent and quality of accepted and implemented preventive measures) as well as eliminating problems resulting environmental impact of road accidents.

Table 3. Traffic accidents in terms of the type of vehicle [6]

Vehicle	Road accident		Equipments with Fuel	
	numbers	%	petrol	diesel
Year 2006				
Passenger cars	40 482	65,25	26 988	13 494
Lorries trucks	6 772	10,92	-	6 772
Special cars	6 761	10,90	-	6 761
Buses	658	1,04	-	658
Tractors	174	0,28	-	174
Year 2007				
Passenger cars	39 686	64,98	26 457	13 229
Lorries trucks	7 597	12,44	-	7 597
Special cars	5 102	8,35	-	5 102
Buses	541	0,89	-	541
Tractors	144	0,24	-	144

To simplify the statistical calculations, we then build the following data: passenger cars - 65%, goods vehicles (including special vehicles, buses and tractors) - 22%. Trailers - about 8%,

motorcycles and quadricycles - about 5% are the possible leakage of fluids a negligible amount. When considering that the accident vehicle was in the tank 50% of the volume of fuel tanks, then we conclude that the environment could get: in 2006 about 58 000 ° l of petrol and 310 200 ° l of diesel in 2007, about 70 500 ° L petrol and 378 600 ° l diesel.

The general characteristics of the accidents and data response units HaZZ rescue, technical and environmental interventions in which interventions in road traffic accidents associated with the location, isolation and subsequent disposal of spillage of hazardous substances (particularly fuel), we derive the data.

Table 4. Traffic accidents in terms of intervention HaZZ [6],[7]

Year	Numbers			Quantity of PHM	
	recources	accidents	intervention HaZZ	petrol	diesel
2003	1 289 320	60 304	9 294	8 054	44 928
2004	1 362 903	61 233	8 910	7 722	43 062
2005	1 384 594	59 991	7 652	6 632	36 976
2006	1 594 383	62 040	6 359	5 512	30 736
2007	1 723 202	61 071	7 749	6 716	37 458
2008	1 869 119	59 008	8 405	6 972	43 952

Assuming only 10% leakage of fuel to get in a car accident outside the tank to be based from year 2003 to 2008 a guide to approximately EUR 41 600l of petrol and 237 100 litres of diesel (which is at about 18 000km most used communications in SR - highway speed roads, roads I. II. and III. classes - about 2.5 litres of fuel per 1 km of communications per year). These quantities are discharged into the environment at the very beginning of scattered and partially reflected surface communication (ground), and subsequently captured by sorption substances.

We realize that not always and not immediately succeed in time to cover the leaking fuel and fluids suitable replacement or sorbent material (soil, sand, sawdust, etc.). The features of each type of fuel and fluids we conclude that part of the liquid gets into the atmosphere by evaporation, sorption of the intercepted communication in the material (asphalt, concrete, etc..) Section gets into the surrounding terrain (gravel, soil and so on.), only a fraction is captured in the sorption agents, the quality and quantity is subject to both the place of accident (self-communication, miscommunication space), the time availability of rescue units (units HaZZ, volunteers) as well as their material and technical facilities.

3 FUELS

The petrochemical industry produces and manages large amounts of chemicals that have become part of our life and to man and his environment, a serious risk. The vast majority of these substances has wide-ranging physical, chemical, toxicological and biological properties, thus can affect the environment and objects contained therein. Their effects are time and space, road access, as well as the extent of operation varied from immediate withdrawal after long-term consequences in the course of generations.

Petrol is the collective name for various, but similar to each other chemicals, which is a mixture of easy and medium volatile saturated hydrocarbons (alkanes, aromatics and cyclanes with 5 to 12 carbon atoms) by the saturated and unsaturated aromatic hydrocarbons (isooctane, benzene), which improve its properties as a fuel (octane numbers)¹ and added substances called additives (each less

¹ numerical value of the gas mixture, measured relative to the mixture izooktánu and n-heptane

than 0.1% by volume) to carry out series of complementary functions (cleaning intake tract, anti-aging and freezing, anti-knock effects, etc.).

Liquid mixture, a clear, colourless to yellowish, slightly volatile, typically foul-smelling, highly flammable, the ignition point is below 21°C, density 0.720 to 0.775 g/cm³ at 15°C, boiling point between 35 to 210°C. The water-insoluble petrol, by contrast, is easily dissolved in pure alcohol, ether, chloroform etc. On the other hand, gasoline is a good solvent for fats, good solvent for fats, oils and resin.

In the toxicological classification of the mixture contains petrol (min. 80° %), benzene (up to° 1° %), ethanol, MTBE, ETBE, toluene, ethyl benzene, naphthalene, cyclohexane, trimethyl benzene, ether, oxygen substances (to 2.7° %). Generally, petrol is rated as carcinogen category II, but benzene as a component of gasoline is valued as carcinogen category · I and mutagenic substance of category II. The file name under the UN-ADR code - 1203, Kemler-code - 33, a classification code F1, 3rd Class

Diesel is the collective name for various, but similar to each other chemicals, which is a mixture of medium-volatile saturated hydrocarbons (alkanes, aromatics and cyclanes with 10 to 22 carbon atoms), with low content minerals and sulphur. Ignition of diesel depends both on composition and properties of diesel, but also from the engine operating parameters, the comparison parameters introduced – cetane number² (analogy octane number parametrov).

Liquid mixture, clear, yellow to brown colour, medium volatile, typically foul-smelling, flammable, ignition point 55 °C, density 0.820 to 0.845 g/cm³ at 15 °C, boiling point 170 to 390 °C. The water insoluble oil is, well dissolved in alcohol, petrol, ether.

In terms of toxicological classification is evaluated diesel as carcinogen category III risk of mutagenic effects and dangerous for the environment. The file name under the UN-ADR code - 1202, Kemler-code - 30, a classification code F1, 3rd Class

Petrol and diesel are products of large-scale continuous fractional distillation of crude oil, which contains a wide range of aromatic and oils saturated and unsaturated hydrocarbons. These differences are based on the type of used, the method of fractional distillation technology settings, and the method of trimming the product but also the nature of the individual ingredients from the manufacturer or retailer.



Picture 1. Diesel and Petrol

4 SORBENTS

Council particulate porous substance has a specific feature, capable of on its surface (or in their internal structures) absorb a significant amount of chemicals in liquid or gaseous form. Absorbed amount, up to hundred times exceed the actual volume and the amount of absorbed substance is dependent only on the amount of sorbent used.

Depending on the nature of links between the surface and adsorbed molecules are referred to either physical adsorption or chemical adsorption. Physical adsorption is reversible, because adsorbed is fixed on the surface of the absorbent by weak intermolecular forces. At chemical adsorption there is most electrochemical link between adsorbant and adsorbent, and the heat is released. In contrast to physical adsorption is chemical adsorption slowly. Adsorption proceeds with increasing temperature monotonically decreases.

² volume percentage of the cetane in mixed with alfa-methylnaphthalene

According to the mechanism for drawing agents can distinguish several types of sorption and the mechanical, physical, physical-chemical and chemical. Mechanical sorption is grossly-dispersion mechanical retention of particles in the pores of the substance is subject to physical adsorption surface phenomena on the boundary phases make changes of the concentration of gases, fluids, electrolytes and non-electrolytes, physical-chemical (exchange) sorption which takes place between the ion exchange substance colloidal complex and substance in a solution of equivalent proportions and chemical (adsorption), whose essence is non-refundable mooring particular anion, capable of constituting a sparingly soluble or insoluble compounds, which after precipitation may also hold a mechanically.

According to the origin divided sorption means of natural and synthetic (industrially produced). Natural sorbents generally have low adsorption capacity and are suitable only for small-scale interventions. These include sand, peat, wood sawdust, powdered sulfur and others. Their are often available directly at the crash site, but for their low adsorption capacity and demanding ecological disposal is gradually retreating from their use, or modifications are preferred synthesis resources liquid adsorption but mainly solid state ..

Synthetic prepared sorbents are substances of state agents, different chemical composition, designed to have maximum surface - powder, loose form. They are particularly suitable for removing thin layers of liquid spillage over a large area. Their negative characteristics, they are stored and used freely, are dust and dirty.

The most important conditions of the sorbent by liquidation of hazardous chemicals, is its sorption capacity. In assessing the sorption capacity is to be considered whether the sorbent is suitable for use on hard surfaces, or even in the water (the hydrophobic properties). In terms of environmental protection is needed to determine whether the absorbed substances not released under mechanical handling of the sorbent, the capacity retention of climate change (temperature, humidity, etc.). Or whether it contains substances that have the ability to spread dangerous substances contained in components (life elimination). The final decision about which type of sorbent used, it must also consider the so-called "minor features" such as dust, reaction with sorbets material, ease of removal after the intervention or the possibility of using the water and possible means of disposal.

VAPEx –hydrophobic amorphous and expanded perlite (aluminum silicate), free-flowing, granular, porous material is white to gray white, whose surface is coated with a thin layer of hydrophobic coating (about 0.2% hydrophobic oil). In terms of chemical composition contains min. 67% SiO₂, max. 19% Al₂O₃ max. 8% Na₂O + K₂O, max. 5% MgO + CaO and max. 2.8% Fe₂O₃.



Pictures 2. VAPEx

Inorganic origin gave him a flameproof and resistant to fungi and microorganisms. It is chemically inert and resistant to temperatures ranging from -200 °C to +900 °C, when properly stored has unlimited shelf life. It has low water absorption and high affinity to non-polar liquids (oil products) in contact with a mixture of water and non-polar liquids (eg petroleum products) binds to its surface in the open pores preferably non-polar substances. The downside is a big dust product. Sorption capacity - 1 000 l vapex absorbs at least 250 l of oil, 130 l 80 l diesel or gasoline.

ROP-EX – sorption substance is produced from discarded tires and industrial rubber mechanically disintegrated in pulp form, with particle sizes from 0.01 mm to 0.7 mm (in the distribution packages

are also particles larger than 1 cm), bulk density 400 kg/m³. It has good sorption property, which is sufficiently stable sorption removal of any substance can only be mechanically strong (pressing, centrifugation). The disadvantage is a stain and a high dust environment in which it was used. Sorption capacity - 1 kg ROP-EX absorbs at least 2 l of oil or 2.5 liters of fuel.



Picture 3. ROP-EX

ZEOLITS - Today we know the 175 types of zeolites, most of which has been prepared synthetically. The naturally occurring has 45 kinds of zeolites, most of which are cristobalite, chabazit, mordenite and clinoptilolite. Natural zeolites have many different kinds of cations, while the synthetic zeolites are mostly monocations or dications. The various types of natural or synthetic zeolites have a stable crystal grid that differs from other similar types of grids that the cavity forming system connected channels are of the exact type of zeolite is always the same diameter. Created microporous (cellular) structure in which the volume of cavities and channels to almost 50%, the dimensions of these cavities and channels (from 0.2 nm to 0.7 nm) and are therefore suitable for the specific capture molecules.



Picture 4. ZEOLITS

The industrial use of zeolites is governed by the granular material grading from 0 to 4 mm, which is grey-green colour, odourless, with a density from 2220 to 2440 kg/m³. Granular material is a water-insoluble, non-toxic, thermal stable up to 450 °C, in a natural environment free of toxic breakdown products.

Sorption substances VAPEX and ROP-EX are based adsorption resources used by HaZZ (Fire and rescue department of Slovak republic) by liquidation losses mainly petroleum products (mainly petrol and diesel) to get into the environment from accidents of vehicles on road communications. They have their advantages and shortcomings in the practical implementation of the disposal of certain hazardous chemicals. ZEOLITY perspective as a new and natural resources which are

currently receiving in the forefront main in terms of ecological safety of the environment. The question is particularly the assessment of the sorption properties of certain hazardous chemicals and stability of the resulting mixtures of pollutants.

Conclusion

The growing level of security vehicles to protect the body forces as well as technical adaptations and placement of fuel tanks and fluids in the various types of motor vehicles to us that there whenever accidents occur and to escape the dangerous substances in the area. Nevertheless, the issue of safe tracking and disposal of spillage, using appropriate means of adsorption has an irreplaceable position in dealing with environmental protection.

The specific aspects of the problem is the follow up Disposal of adsorption of substances to ensure a continuity of operations on a given road section usually immediately removed outside the area (shoulder and below.) in a favorable situation where they are loaded into bins by communications manager or liquidator of an accident (less frequent situation) or are left to the operation of natural effects. Basic physical and chemical (state, solubility, volatility, sorption, reactivity, hydrolysis, oxidation-reduction processes) as well as selected specific (the partition coefficient of substance land agent / water, the substance / air, soil / water, water / air, bioaccumulation, biodegradation) sorption properties of substances affect the subsequent behaviour of those chemicals in the natural environment in the natural environments.

References

- [1] http://ec.europa.eu/research/leaflets/surface_transport/article_2770_sk.html,
- [2] <http://www.minv.sk/?statisticke-prehlady-agendy-vozidiel>
- [3] Cestná databanka dopravy SSC, ŠÚ SR, Bratislava, 1996-2006, 2007-2008,
- [4] Janásek D., Potoček T., Svetlík J.: Nebezpečné látky, ŽU Žilina 2004, ISBN 80-8070-243-8
- [5] <http://www.minv.sk/?statisticke-prehlady-agendy-vozidiel>
- [6] <http://www.minv.sk/?dopravne-nehody>
- [7] Ročenka Hasičského a záchranného zboru, MV SR – Prezídium HaZZ, Bratislava, ročníky 2003 – 2008,()
- [8] Operačný program „Doprava 2007 – 2013“, MDPT SR, Bratislava 200