

Artículo de investigación

Organization of vehicle traffic based on environmental monitoring of the air basin

Organización del tráfico de vehículos basado en el monitoreo ambiental de la cuenca atmosférica
Organizaçãõ do tráfeço de veículos com base no monitoramento ambiental da bacia aérea

Recibido: 10 de mayo de 2018. Aceptado: 11 de junio de 2018

Written by:

Ilnar F. Suleimanov⁶¹

Elena V. Moskova⁶¹

Renat G. Sabirov⁶¹

Ruslan F. Kalimullin⁶²

Andrey A. Filippov⁶²

Abstract

Modern scientific knowledge of a problem of environmental pollution by the motor transport is based on idea of negative impact of all transport complex, and not just separate objects of transport. The problem of environmental pollution by objects of a motor transportation complex is aggravated with rapid growth of vehicular fleet. In total with insufficient development of a street road network and low level of quality of management of motor transportation streams it leads to emergence of a critical ecological situation in the cities. Along with the progressing deterioration of atmospheric air also other environmental problems connected with production of automotive vehicles, spare parts and operational materials, operation, service, storage and vehicle scrappage become aggravated.

In the circumstances restriction of emissions of pollutants from motor transportation streams taking into account pollution of the air basin with stationary sources has high degree of relevance. At realization of actions of this direction also projection of quality of the air basin on the basis of environmental monitoring and imitating modeling of motor transportation streams is significant objective current.

Establishment of quotas for emissions of pollutants from motor transportation streams taking into account the polluting background and achievement of the established quotas at the expense of the organization of the movement of cars is represented to one of effective ways of

Resumen

El conocimiento científico moderno de un problema de contaminación ambiental por el transporte de automóviles se basa en la idea del impacto negativo de todos los complejos de transporte, y no solo de los objetos de transporte separados. El problema de la contaminación ambiental por objetos de un complejo de transporte de motor se ve agravado con el rápido crecimiento de la flota vehicular. En total, con un desarrollo insuficiente de una red vial de calles y un bajo nivel de calidad de la gestión de las rutas de transporte motor, conduce a la emergencia de una situación ecológica crítica en las ciudades. Junto con el deterioro progresivo del aire atmosférico también se agravan otros problemas ambientales relacionados con la producción de vehículos automotores, piezas de repuesto y materiales operacionales, operación, servicio, almacenamiento y chatarra de vehículos.

En estas circunstancias, la restricción de las emisiones de contaminantes de las corrientes de transporte motor teniendo en cuenta la contaminación de la cuenca atmosférica con fuentes estacionarias tiene un alto grado de relevancia. En la realización de las acciones de esta dirección también la proyección de la cualidad de la balsa de aire sobre la base de la observación del medio ambiente y la imitación del modelado de los flujos del transporte a motor es la corriente objetivo significativa.

El establecimiento de cuotas para las emisiones de contaminantes de los flujos de transporte

⁶¹ Kazan Federal University

⁶² Orenburg State University. E-mail: ecolog_777@mail.ru
Tel. 89179045977

permission of a problem situation. The offered way of a predetermined development of the technique of the system analysis defining the sequence of stages of carrying out the analysis and methods of their performance, uniting mathematical modeling and programming, techniques of sampling of air, the laboratory and tool analysis and statistical processing of results of an experiment.

In this regard, the way of restriction of emissions of pollutants from motor transportation streams by introduction of quotas for which realization the algorithm, the special software and a settlement and tool technique of environmental monitoring of motor transportation streams is offered is developed.

Keywords: Motor transportation streams, environmental monitoring, emissions of harmful substances, industrial enterprises.

motor teniendo en cuenta el fondo contaminante y el logro de las cuotas establecidas a expensas de la organización del movimiento de automóviles está representado por una de las formas efectivas de autorización de una situación problemática. La manera de desarrollo predeterminado de la técnica del análisis del sistema define la secuencia de etapas de realización del análisis y métodos de su desempeño, uniendo el modelado y programación matemática, técnicas de muestreo de aire, el análisis de laboratorio y herramienta y el procesamiento estadístico de resultados de un experimento.

En este sentido, se desarrolla la forma de restricción de las emisiones de contaminantes de las corrientes de transporte motor mediante la introducción de cuotas para las cuales se ofrece la realización del algoritmo, el software especial y una técnica de asentamiento y herramienta de monitoreo ambiental de las corrientes de transporte motor.

Palabras claves: Flujos de transporte motor, monitoreo ambiental, emisiones de sustancias nocivas, empresas industriales.

Resumo

O conhecimento científico moderno de um problema da poluição ambiental pelo transporte motor é baseado na ideia do impacto negativo de todo o complexo de transporte, e não apenas objetos de transporte separados. O problema da poluição ambiental por objetos de um complexo de transporte motorizado é agravado com o rápido crescimento da frota de veículos. No total com o desenvolvimento insuficiente de uma rede rodoviária de rua e o baixo nível da qualidade da gestão de correntes de transporte motoras leva à emergência de uma situação ecológica crítica nas cidades. Juntamente com a deterioração progressiva do ar atmosférico, outros problemas ambientais relacionados à produção de veículos automotivos, peças sobressalentes e materiais operacionais, operação, manutenção, armazenamento e sucateamento de veículos se agravam.

Nas circunstâncias a restrição de emissões de poluentes de correntes de transporte de motor que levam em conta a poluição da bacia aérea com fontes estacionárias tem o alto grau da relevância. No momento da realização de ações desta direção também a projeção da qualidade da bacia aérea com base no monitoramento ambiental e imitando a modelagem de correntes de transporte de motor é a corrente objetiva significativa.

O estabelecimento de cotas para emissões de poluentes de fluxos de transporte de motor que levam em conta o fundo poluindo e realização das cotas estabelecidas às custas da organização do movimento de carros é representado a um de modos efetivos de permissão de uma situação de problema. O caminho oferecido desenvolvimento predeterminado da técnica da análise de sistema definindo a seqüência de etapas de executar a análise e métodos de seu desempenho, unindo modelagem matemática e programação, técnicas de amostragem de ar, a análise de laboratório e ferramenta e processamento estatístico de resultados de um experimento.

Neste sentido, o caminho de restrição de emissões de poluentes de fluxos de transporte de motor pela introdução de cotas para a qual a realização o algoritmo, o software especial e uma técnica de ajuste e instrumento de monitorização ambiental de fluxos de transporte de motor se oferece desenvolve-se.

Palavras-chave: Correntes de transporte motor, monitoramento ambiental, emissões de substâncias nocivas, empreendimentos industriais.

Introduction

In the cities with the developed industry the share of a contribution of pollutants of the fulfilled gases of cars makes more than 50% of cumulative harmful emissions in the air basin in the presence of rather high polluting background of stationary sources (the industrial enterprises, thermal power plants, parkings and garages, refueling complexes, etc.) (Korchagin et al, 2013). At the same time, unlike stationary sources which emissions are subject to rationing motor transportation streams (at the irrational organization of the movement and the high polluting background) create the ground concentration of pollutants which are repeatedly exceeding them the maximum-permissible concentration (MPC). In the circumstances restriction of emissions of pollutants from motor transportation streams taking into account pollution of the air basin with stationary sources has high degree of relevance. At realization of actions of this direction also projection of quality of the air basin on the basis of environmental monitoring and imitating modeling of motor transportation streams is significant objective current (Lozhkin et al, 2007; Suleymanov et al, 2011).

In this regard the researches directed to identification of regularities of formation of emissions of pollutants from motor transportation streams in the conditions of the industrial city, restriction of emissions and ensuring ecological safety of a motor transportation complex are relevant

(Suleymanov et al, 2013; Suleymanov et al, 2014).

Methods

In the developed technique (figure 2) the continuity of process of environmental monitoring at the expense of a binding by the time of changes of characteristics of motor transportation streams is provided that is fixed at on-site investigation (block 1), considered in settlement assessment by drawing up digital cards of distribution of ground concentration of pollutants (blocks 2, 4) and the choice of control points (block 5).

The condition of continuity is met also during tool assessment (block 6) which is necessary for specification of results of calculations of the maximum ground concentration (block 7), zonings of digital cards on the RKIZA level of pollution of atmospheric air (blocks 8, 9) and experimental justification of quotas for emissions of pollutants for motor transportation streams (block 10).

Thus, the developed technique is allocated with all signs of a technique of environmental monitoring of motor transportation streams which distinctive feature is accounting of the polluting background of stationary sources (block 3) at experimental justification of quotas for emissions of pollutants for mobile sources - motor transportation streams (Suleimanov et al, 2017).

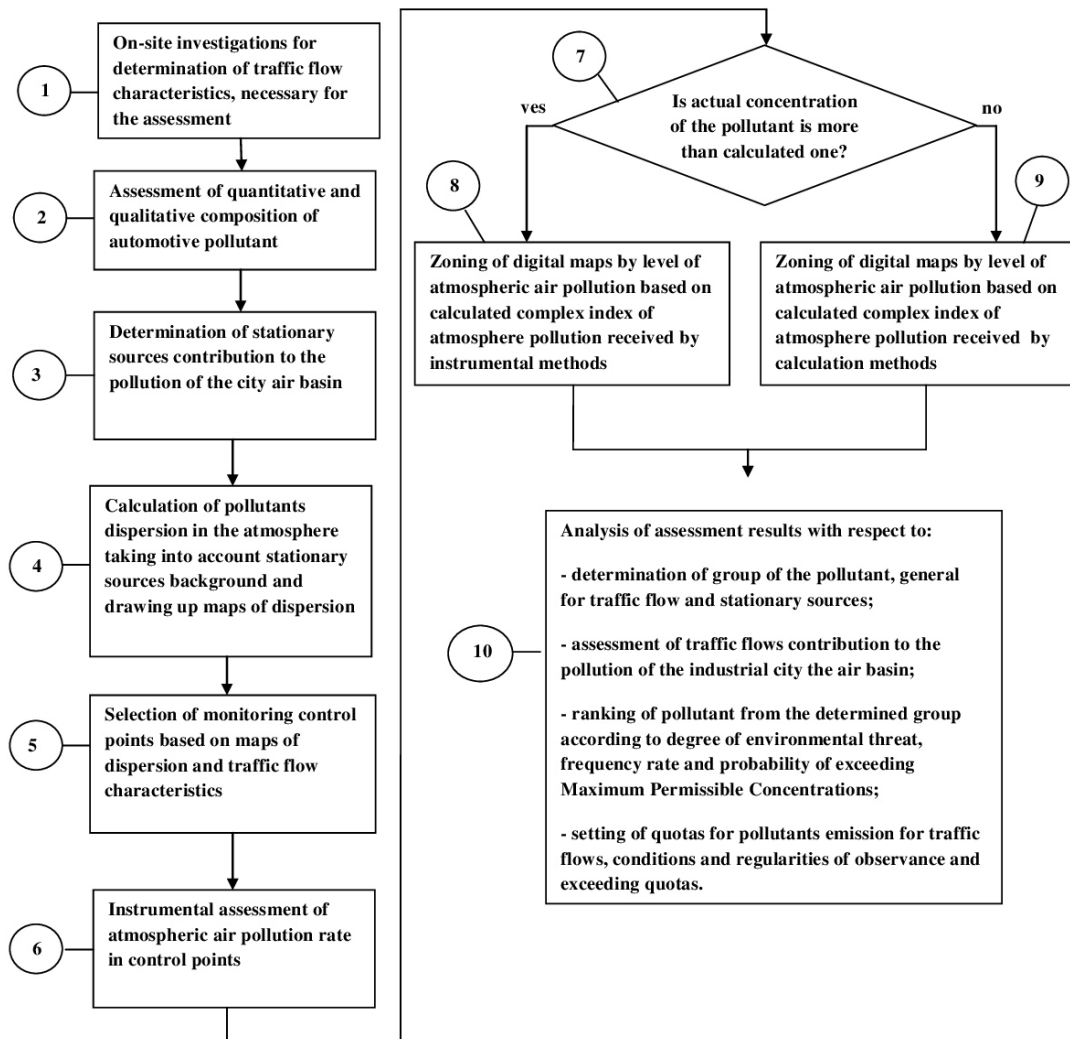


Figure 1 - Function chart of a settlement and tool technique of environmental monitoring of motor transportation streams

The way of restriction of emissions of pollutants from motor transportation streams by introduction of quotas for which realization the algorithm (figure 2) is offered is developed.

In an algorithm special computer programs are used: 1) blocks 2, 3 - UPRZA "Ecologist" of beliefs. 4.5., Standard option; 2) blocks 5, 12 - "Definition of the settlement complex index of air pollution"; 3) the block 6 - "Calculation of

quotas for emissions of pollutants from the industrial enterprises and motor transport"; 4) the block 10 - "The program for development of administrative decisions in the field of optimization of parameters of sites of a street road network". On all programs, except the existing unified program of calculation of dispersion of air pollution "Ecologist", certificates on the state registration are received.

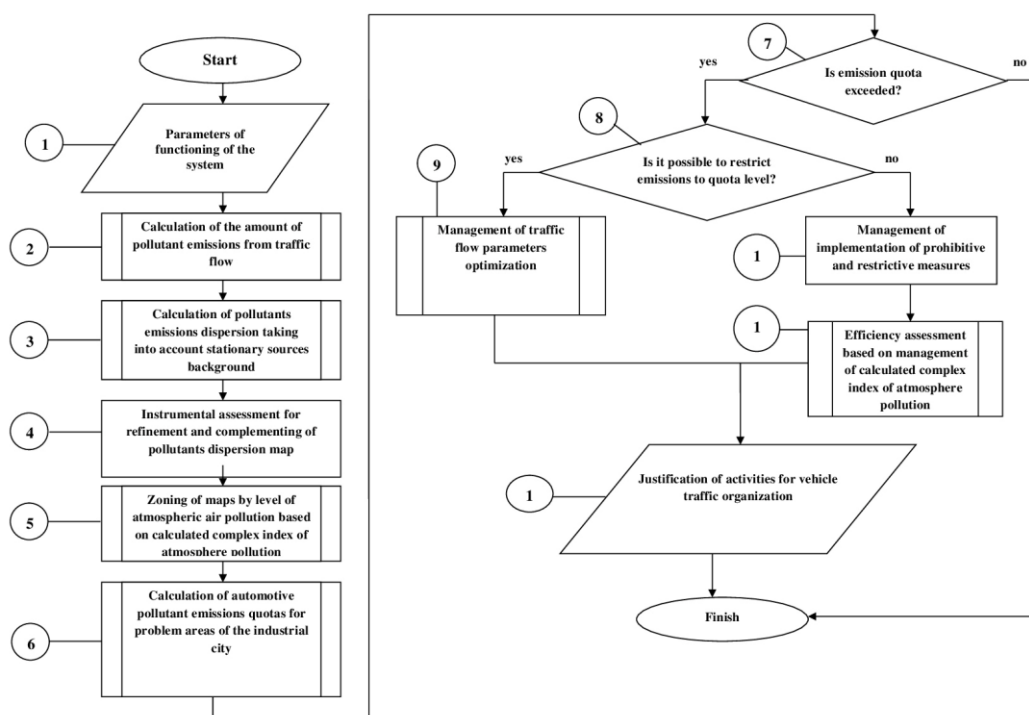


Figure 2. An algorithm of restriction of emissions of pollutants from motor transportation streams

Initial information on ecological characteristics functioning of system gathers on a basis: 1) calculation of number of emissions of pollutants from motor transportation streams; 2) inventories of sources of allocation and definition of maximum-permissible emissions of pollutants from stationary sources.

Important condition of realization of an algorithm is existence of the settlement and tool technique of environmental monitoring of motor transportation streams considering effects of joint presence in the air basin of emissions of mobile and stationary sources.

Results and Discussion

By results of on-site investigations (the block 1, the figure 1) the contribution of cargo transport and buses (category of vehicles (automatic telephone exchange) which, in comparison with automobile transport, is more powerful source of emissions of pollutants) to total intensity of the movement in a residential zone of the city (about 11%) is defined that there is much less same indicator for the industrial zone (about 24%). At higher level of pollution of the air basin of the industrial zone, in comparison with a residential zone (at the expense of stationary sources), also more difficult ecological situation on the

surveyed sites of a street road network of the city takes place (Suleimanov et al, 2015; Khabibullin et al, 2013; Kajino, 2003).

Results of assessment of a contribution of motor transportation streams to pollution of the air basin Naberezhnye Chelny (blocks 2, 3, the figure 1) show: motor transportation streams are priority sources of emissions in the air basin of the city (about 64%). The considerable share falling on emissions from stationary sources (about 36%) shows features of the industrial city which are considered in work at restriction of emissions of pollutants from motor transportation streams by establishment of quotas.

Pollutants from motor transportation streams Naberezhnye Chelny on decrease of number of emissions make the following row: carbon oxide (SO) of-32854 tons/year; nitrogen oxides (NO_x) - 4596 tons/year; total hydrocarbons (C_nH_m) of-3296 tons/year; dioxide of sulfur (SO₂)-467 of ton/year; soot (ton/year S)-87.

Summary calculation of dispersion of 143 pollutants forming 28 groups of a summation (blocks 3, 4, the figure 1) is executed and digital cards of distribution of ground concentration of these pollutants Naberezhnye Chelny are made. Excess of maximum allowable concentration on

pollutants from groups of a summation WITH and NOh is predicted. For FROM a zone with values of the maximum ground concentration more than one maximum allowable concentration is observed at 100% of the surveyed highways. Excess of maximum allowable concentration on NOh is expected more than at 70% of the surveyed highways. For WITH and NOh is fixed increase in contents during removal from the industrial zone towards the downtown where the maximum intensity of motor transportation streams is observed.

By results of the analysis made on the developed digital cards for the most problem sites of a street road network Naberezhnye Chelny two groups of pollutants are allocated: 1) contained in emissions of motor transportation streams and stationary sources; 2) contained only in emissions of stationary sources. The last at a further research are not considered as their maximum ground concentration does not exceed maximum allowable concentration. Thus, problems of tool assessment (blocks 5, 6, the figure 1) and establishments of quotas for emissions for motor transportation streams (the block 10, the figure 1) become simpler because the decision lies in the first group of pollutants.

By results of tool assessment the digital card Naberezhnye Chelny is broken into zones (blocks 7, 8, 9, the figure 1) on the level of pollution of atmospheric air on the basis of RKIZA (figure 3).

Sites of a street road network with levels "very high", "high" and "raised" make according to 7%, 25% and 40% of the territory Naberezhnye Chelny. Pollution of the air basin on these sites is formed mainly at the expense of motor transportation streams (more than 70%) at the high polluting background of stationary sources (about 30%). Use of quotas at restriction of emissions of the polluting means from motor transportation streams will allow reaching low level (on RKIZA) pollution of atmospheric air.

On the basis of the analysis of results of settlement and tool environmental monitoring of motor transportation streams (the block 10, the figure 3) quotas for emissions of pollutants for motor transportation streams of all ecologically unsuccessful sites of a street road network Naberezhnye Chelny are established. Observance of the established quotas requires reduction of the actual number of emissions of STARS from motor transportation streams for 40...67% for WITH and 40...59% for NO2

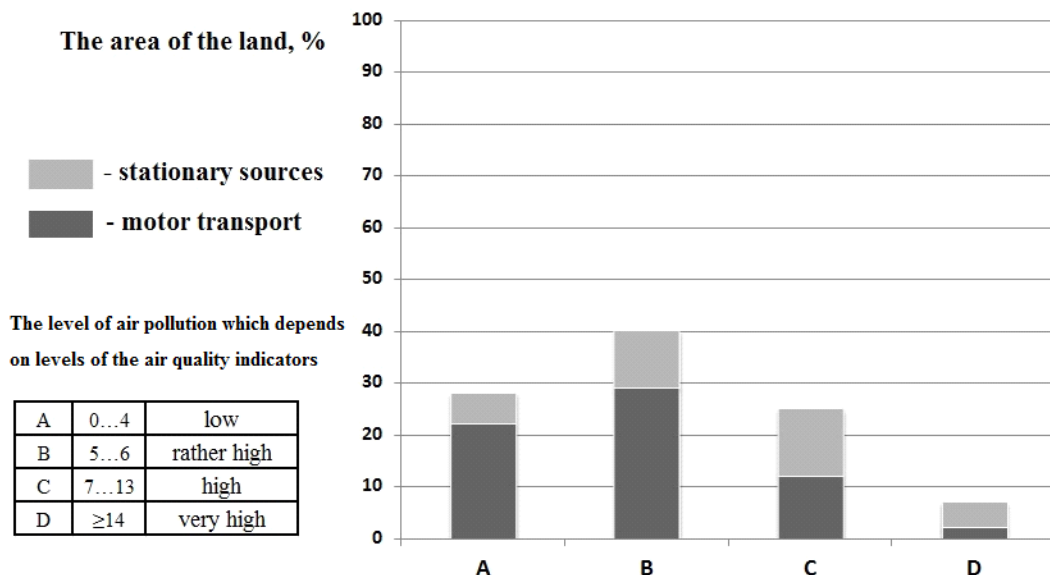


Figure 3 - Results of settlement and tool environmental monitoring of motor transportation streams Naberezhnye Chelny

By results of settlement and tool environmental monitoring of motor transportation streams for

carrying out an imitating experiment the most problem site of a street road network

Naberezhnye Chelny - the intersection of avenues of the World and Friendship of the People is chosen.

Increase in a share of cargo automatic telephone exchanges and buses in a motor transportation stream from 10% to 50% at invariable intensity of the movement leads to growth of RKIZA by 2,1 times, that is to increase in level of ecological danger with raised to high. Increase in intensity of the movement by 20% at invariable structure of a motor transportation stream leads to growth of RKIZA by 1,4 times that also leads to increase in level of ecological danger with raised to high. And the bigger negative ecological effect is shown at increase in a share of cargo automatic telephone exchanges and buses in a motor transportation stream. The number of emissions of pollutants in the neighborhood of the intersection is 3,5 times higher, than at the movement of motor transportation streams on stages in the absence of traffic lights on them.

Feature of the explored site of a street road network is existence of powerful stationary sources of pollution of the air basin, in particular PJSC KAMAZ that predetermines low quotas for emissions of pollutants for motor transportation streams and also limited conditions of their observance. In the neighborhood of the intersection they make: for WITH - 4,45 g / with; for NO₂ - 0,24 g / page. At the actual number of emissions of CO and NO₂ of 9,46 and 0,45 g / about necessary levels of decrease make 65% and 54% respectively.

The most effective for the explored site of a street road network is the organization of an outcome at the intersection in different levels. In close proximity to the intersection the RKIZA value will decrease with 8 to 5 that is estimated as transition is one step lower in the accepted hierarchy of levels of ecological danger that is with high on the increased level. The positive ecological effect from the realized action extends not only to the intersection, but also to stages. During removal from a zone of influence of the intersection decrease in RKIZA value with 7 to 4 is expected that is estimated as transition is two steps lower, that is with high on the low level of ecological danger.

Summary

The way of restriction of emissions of pollutants from motor transportation streams by introduction of quotas for which realization the

algorithm, the special software and a settlement and tool technique of environmental monitoring of motor transportation streams is offered is developed.

The analysis of results of environmental monitoring of motor transportation streams Naberezhnye Chelny made by the developed technique showed:

- excess of maximum allowable concentration on pollutants from groups of a summation WITH (at 100% of the surveyed highways) and NO₂ (more than at 70% of the surveyed highways);
- sites of a street road network with levels of pollution of atmospheric air on RKIZA "very high", "high" and "raised" make according to 7%, 25, % and 40% of the territory of the city;
- pollution of the air basin on these sites is formed mainly at the expense of motor transportation streams (more than 70%) at the high polluting background of stationary sources (about 30%);
- observance of the established quotas requires reduction of the actual number of emissions of pollutants from motor transportation streams on 40 ... 67% for CO and 40 ... 59% for NO₂ that will allow to reach the level of pollution of atmospheric air on RKIZA "low".

On the example of the most problem site of a street road network Naberezhnye Chelny - the intersection of avenues of the World and Friendship of the People - it is offered to organize an outcome in different levels that will lead to decrease in RKIZA values with 8 to 5 in close proximity to the intersection and with 7 to 4 during removal from it.

Conclusions

Purpose of the developed settlement and tool technique of environmental monitoring of motor transportation streams consists in continuous observation and tracking of critical conditions which sign the high and very high degrees of danger of level of pollution of atmospheric air expressed by the settlement complex index of air pollution are.

Feature of the developed technique is specification and addition of information obtained by calculation methods, results of tool control which are analyzed regarding establishment of quotas for emissions of pollutants from motor transportation streams taking into account the polluting background and achievement of the established quotas at the

expense of the organization of the movement of cars.

Acknowledgements

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

Reference

- Kajino, M. (2003). Modeling Liquid Water Content of Atmospheric Aerosols. IIASA IR 03-046.
- Khabibullin R.G., Makarova I.V., Belyaev E.I., Suleimanov I.F., Pernebekov S.S., Ussipbayev U.A., Junusbekov A.S., Balabekov Z.A. (2013). The Study and Management of Reliability Parameters for Automotive Equipment Using Simulation Modeling. *Life Science Journal*, 10 (12s), pp. 828-831.
- Korchagin V. A., Gorban M.V., Rizayeva Y.N., Goncharov O.Y. (2013). Comparative assessment of level of ecological danger of vehicles//Topical issues of innovative development of a transport complex: internal materials of the Scientific Conference Oryol, pp. 261-266.
- Lozhkin V.N., Guilty A.A., Lozhkina O.V. (2007). *Automobile and the environment - SPb.: NPK "Atmosphere" at GGO of A.I. Voyeykov*, p. 305.
- Suleimanov I.F., Mavrin G.V., Kalimulina M.R., Bondarenko E.V., Kalimullin R.F., Filippov A.A. (2017). The use of simulation modeling in traffic flow management. *Journal of Fundamental and Applied Sciences*. No. 15 (9), pp. 1840-1848.

- DOI: 10.4314/jfas.v9i1s.824
WOS:000413464300032, ISSN: 1112-9867.
- Suleimanov I.F., Mavrin G.V., Kalimulina M.R., Bondarenko E.V., Kalimullin R.F., Filippov A.A. (2017). Assessment of atmospheric pollution in the city of Naberezhnye Chelny with emissions from motor vehicles and industrial enterprises, *Journal of Fundamental and Applied Sciences*. No. 35 (9), pp. 1059-1066. DOI: 10.4314/jfas.v9i2s.80 WOS:000413464300032, ISSN: 1112-9867
- Suleimanov I.F., Mavrin G.V., Kharlyamov D.A., Belyaev E.I., Mansurova A.I. (2015). Pollution of the Air Basin in the Cities by Motor Transport and the Industrial Enterprises, *Quality Assessment of Atmospheric Air with the Use of Calculation Methods and Instrumental Control*. *Modern Applied Science*. Vol. 9, No. 4, pp. 12-20.
- Suleymanov I.F., Mavrin G. V., Harlyamov D.A. (2011). Application of settlement monitoring for assessment of air pollution of the urban environment//the Scientific and technical bulletin of the Volga region. No. 2, pp. 107-111.
- Suleymanov I.F., Mavrin G. V., Mavrin G. V. (2014). Researches of the movement of traffic flows and assessment of quality of atmospheric air on the basis of tool methods on highways of the city//the Motor transportation enterprise. No. 1, pp. 46-51.
- Suleymanov I.F., Mavrin G. V., Mavrin V.G., Belyaev E.I., Khabibulin R.G., Makarova I.V. (2013). Natural researches of traffic flows and application of tool methods for assessment of quality of atmospheric air. *World of transport and technological machines*. No. 4 (43), pp. 116-124.