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ACTUAL PROBLEMS OF ASSOCIATED PETROLEUM GAS UTILIZATION

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ABSTRACT:
The article contains a detailed consideration of ecological, economic and legislative problems associated with the utilization of associated petroleum gas generated during the development of oil fields. Analyzed the experience of the Republic of Kazakhstan in solving this problem for the last decade, provided an evaluation of the current state of the applicable legislative reforms in this sphere. In the operative part of the article, there is a set of proposals contributing to the optimal and economically efficient solution of the issues related to the utilization of associated petroleum gas and increasing the effectiveness of cooperation of subsurface users, entrepreneurs, and state authorities.

INTRODUCTION

The utilization of associated petroleum gas generated during the development of oil fields is one of the serious ecological and economic problems of the oil and gas industry of the country. For Kazakhstan, this problem has an especially global dimension in view of a high gas factor contained in Kazakh oil and gas-condensate fields. This problem correlates with global tendency directed for reduction of associated gas flaring that promoted the creation in 2002 of the Global Partnership on reduction of associated gas volumes, the participants of which were oriented for collaborative work on elimination of barriers that hindered the reduction of associated gas flaring by means of application of the best world experience and implementation of special programs for each country, including Kazakhstan. Unlike most CIS countries,

for Kazakhstan, this problem has an especially global dimension due to a high gas factor contained in Kazakh oil and gas-condensate fields.

Analyzing this problem, the authors would like to note that if for the majority the issues of associated petroleum gas utilization are connected with a negative impact on the environment our opinion is that an equally important aspect of this problem is “nonrenewable energy resources waste”. Recently, the technological process of oil production meant as burning flares in which associated petroleum gas was burnt with all its hydrocarbons. Because an associated petroleum gas represents a mixture of gases and vaporous hydrocarbons, that constitute a highly valuable raw material for petroleum chemistry. Moreover, 100% solution of this problem will provide a significant contribution the energy security formation of the country.

An example of the irrational use of hydrocarbons with huge economic losses, which, in turn, leads to dire environmental and social consequences, is the flaring of associated gas. Most gas flares are used at sites that are engaged in the production, processing, transportation or storage of hydrocarbons. Examples of such facilities include pipelines, hydrocarbon storage facilities, gas and crude oil refineries, refineries, well testing equipment, gas injection facilities, and waste storage sites.

Every year, with oil production in Kazakhstan, over 2 billion cubic meters of associated gas are flared. Currently, according to official figures, only two thirds of 9 billion cubic meters of the associated petroleum gas (APG) produced annually in the country are disposed or recycled (Abrosimov, Dolomatova, & Telyasheva 2002; Podavalov, 2010). Flaring APG has a significant impact on climate. With "technological losses" and burning of APG, carbon dioxide, methane and soot are released into the atmosphere. As is known, carbon dioxide and methane are the most active greenhouse gases that aggravate the global problem of climate warming.

Incineration of associated gas is accompanied by thermal pollution of the environment. In particular, the radius of thermal destruction of the soil around a flare ranges between 10 and 25 meters and the radius of thermal destruction of the vegetation ranges between 50 and 150 meters. In this case, both the APG combustion products including nitric oxide, sulfur dioxide, carbon monoxide, and various unburned hydrocarbons enter the atmosphere (Burnham, Han, Clark, & Wang, 2011; Gervet, 2007). Significant concentrations of nitrogen and sulfur oxides are observed at a distance of 1-3 km from a flare, concentrations of hydrogen sulfide are observed at a distance of 5-10 km, and those of carbon monoxide and ammonia are observed at approximately 15 km. This leads to a high local incidence of cancer of the lungs and bronchi, lesions of the liver and gastrointestinal tract, nervous system, and vision (Diarov, 2003).

In order to solve this problem, large oil and gas companies are implementing new technologies that promote the disposal and recycling of APG, which ultimately saves resources, gains economic benefits, and reduces environmental pollution. For example, in 2012, at a global forum in London

devoted to reducing associated gas flaring, Tengizchevroil LLC (TCO) was recognized the world leader in reducing associated gas flaring. For more than a decade, TCO has been working to stop gas flaring and increase gas supply to consumers, which was part of an overall environmental protection plan. As a result of these investments, from 2000 to 2010 it was possible to reduce gas flaring volumes by 97%. To reduce gas flaring, TCO introduced changes to existing production processes and main facilities, applying new technological and engineering solutions (Tengizchevroil LLC, 2016). The gas-recycling project provided for the modernization of the integrated process lines of the plant, the implementation of advanced technologies that allowed collecting all the gas that was previously flared, and is now being used for its own needs, is being exported, and its excess is pumped back into the reservoir.

Kazakhstan has adopted a policy of a complete recycling of associated gas used mainly in the new energy sector (Nazarbayev, 2012; Nazarbayev, January 28, 2012). Inaugurated gas turbine power plants such as Tengizchevroil (240 MW), Karachaganak (120MW) Kyzyl Orda (150 MW), Zhanazhol (48 MW), Ural (28 MW) as well as Kandyagash plant (100 MW), which is under construction, and those of Aktyubinsk (360 MW), AgipKCO (230 MW), Zhambyl (240 MW), SBS Steel in Aktobe (180 MW), which are under design, contribute to a more complete recycling of associated gas, providing energy to energy-deficient regions, overcoming energy dependence, efficient import substitution, and creating new jobs. The production of electricity by gas turbine power plants is steadily growing, its share in the total volume of electricity produced in the country is increasing, and its potential is still significant. Such projects are the path to the transition to a "green economy."

In the concept of the transition to a "green economy", where seven main ways of transition are noted, the first direction covers issues of the rational use of mineral and other raw material resources, and first of all, energy resources. In particular, it was noted that Kazakhstan has huge reserves of coal, oil, and gas but their irrational use can lead to widespread depletion of resources, which is already observed in some regions. Therefore, the most important task is the implementation of renewable energy sources, especially since there is a good potential for this. According to expert estimates, the potential of renewable energy resources (hydropower, wind and solar energy) in Kazakhstan is very significant and is estimated to be over 1 trillion kWh per year. A regulatory framework has already been developed, in particular, the Kazakh Assistance in the Use of Renewable Energy Sources Act. In general, according to the concept, target indicators are defined to achieve the total share of alternative and renewable energy sources amounting to 30% by 2030 and 50% by 2050 (Nazarbayev, 2013).

MATERIALS AND METHODS

Experts were trying to reply many times to the question what is really hindering to solve the APG (associated petroleum gas) utilization and start to use it without harm for the environment however they did not come to a consensus. In our opinion, the complex solution to this issue is prevented by some factors, in particular:

1) Financial component of the issue.

Organization of an effective process of utilization and processing of associated gas requires huge capital investments and a payback period of which is a wildcat venture without detailed analyses. Especially it is concerning small, medium and remote oil fields, which are not connected with communication networks, the main pipelines of the National operator, therefore the projects capital intensity is increasing, as it is directly connected with transportation that involves the construction of pipelines, gas distribution networks for considerable distances. The national operator in the area of gas supply is - the KazTransGas JSC National Company. According to the Law of the Republic of Kazakhstan "About the state property" (2015) the national company is a joint-stock company that founder and sole shareholder, unless otherwise provided by the law of the Republic of Kazakhstan, is the Republic of Kazakhstan in the face of the Government of the Republic of Kazakhstan established for effective administration of shares of national companies and other joint-stock companies and participation interests in the authorized capital of limited liability partnerships.

Economic efficiency of such project is also affected by the associated petroleum gas composition. Thus depend on the container in the associated gas components, such as hydrogen sulfide, propane, butane, BFLH (broad fraction of light hydrocarbons) – it could be "rich" or "poor" that affects its attractiveness for service companies. For example, as an alternative method to resolve the question of recycling, there was always considered the issue to attract full cycle companies specialized in service, and engineering well known as EPC-contractors (Engineering, Procurement and Construction contractors) that can realize a recycling project without subsoil's financial recourses attraction. In this case, the project payback for same servicing companies is in a component composition of associated gas that is in case of a relevant technologies and financial investments presence and if associated gas from a definite oil field is "rich for hydrocarbons" so the project will be profitable. thus the company will have an opportunity to reach out these components till the ready commercial product and realize it. In cases, when the component composition is "poor", not containing demanded hydrocarbons, so economic and investment attractiveness of such projects is very low, and in such case, an implementation of the program for APG utilization is considered by subsoil's users as a heavy yoke with zero payback.

EPC contract is a method of contracting in the construction area including engineering (exploration, project works), supply – selection, purchase of materials and equipment for the project, and construction – construction, installation, and adjustment works (Hartman, 2003).

2) Unpreparedness of infrastructure and the problem with equipment availability. Here also may be referred absence of an organized sales/purchasing market for products of APG processing.

In the very beginning of APG programs on utilization and processing implementation (this is period of 2005-2008, 2009 years) the problem with the equipment was acute, as for that period from the required equipment for

construction of complex gas processing facilities, gas-turbine power units, compressor stations and etc. almost nothing was produced in Kazakhstan. Then, due to appeared demand, there were different producers and intermediate companies of such equipment flooded the market, the role of which was in supply (sell) subsoil users the equipment from different producers, starting from American, including Russian and Chinese etc. Accordingly, the range of prices for the considered equipment was significantly higher than the level that currently exists currently at the market. The situation in this direction was improved essentially during the implementation of the State program on national machinery development within 2010-2014 years approved by the Decree of the Government of the Republic of Kazakhstan No. 1002 of 30.09.2010. The initiator of the program acceptance was the Ministry of Industry and New Technologies.

RESULTS AND DISCUSSION

In 2009 there was prepared the analysis of machinery industry of the country during which two unfavorable conclusions were made:

1) Demand for machinery products existing in Kazakhstan is primarily satisfied by import that exceeds domestic production for more than 5 times. At the same time the analysis showed that in the structure of import more than 40% were equipment for oil and gas, mining and metallurgic sectors;
2) Significant dependency from machinery products import obviously shows low development of this industry in general. Foreign trade turnover of machinery products, as an index of development and competitiveness of production, indicated about a weak export orientation of the industry (Decree of the Government, 2010a).

On the basis of this State Program, KazMunaiGas Company developed its own Program on assistance to the development of oil and gas machinery in the RK for 2011-2013 years. In the frames of this program approved and coordinated with the Ministry of Oil and Gas Industry, KazMunaiGas joint with the Union of mechanical producer enterprises of Kazakhstan started to place their orders at the national machinery enterprises. That is, KazMunaiGas in case of necessarily annually correcting and filling up the list of orders for oil and gas equipment that was required by the group of companies of KMG – guaranteed the purchase from the national factories. It is necessary to note that in 1998 when the Program on assistance to the development of oil and gas machinery in the country was just implemented; there were settled in all 20 items of oil and gas equipment by local manufacturers was needed for KMG Company Group. As of 01.12.2012 local machine manufacturers of the republic put into production 370 items of the oil and gas equipment, whereas the total amount of orders corresponds to 420 items. According to estimations of KMG, the settling of 420 items of the oil and gas equipment is planned by 2015 (Decree of the Government, 2010b).

Thus, during realization all of these measures, the situation with the equipment required for utilization, preparing and processing of APG was significantly improved. For the current date, there are 53 enterprises registered in Kazakhstan that produce a wide range of oil and gas equipment. All of them

are included in the Register of potential suppliers of the Samruk-Kazyna Fund. Accordingly, the range of prices significantly reduced for the required equipment. The production of compressors, gas-filling and other gas equipment was organized. In the frames of the Investment Forum which took place in Aktau in 2012 directed to the creation of new product projects for satisfying the needs of large oil and gas projects, it was signed more than 15 memorandums regarding establishing of new producing facilities in Western Kazakhstan. Among them: construction of the plant on oil and gas separators production, module blocks for processing of oil and gas and etc. After that on 23.01.2013 in the frames of the International ForumEXPO-2017: regional initiatives, there was signed the memorandum, according to which until 2015 year on the territory of Mangystau region it is planned to construct the plant producing gas turbines with a low coefficient of emissions. Memorandum was signed between General Electric company in close cooperation with KazAtomProm and the Akimat of Mangistau region. There was a project planned for signing that stipulated the plant on the production of gas and gas reciprocating engines construction under the auspices of the Akimat of Mangystau region.

3) Absence of the entrepreneur initiatives mechanism on support directed for implementation of programs on utilization of APG in oil fields. Specified for burning enormous volumes of APG could be effectively used and turned into entrepreneur activity on APG processing and selling. Such an approach will enable to consider the implementation of APG utilization program not as a problem, but as a prospective business opportunity for entrepreneurs separate categories of or as an associated entrepreneur activity for subsoil users.

For example, we have analyzed all state Programs on business assistance and did not find a reference that APG utilization projects could be lent as a concessional loan or could receive tax preferences etc (Roadmap for Business, 2011).

Analyzing the recent past, it should be acknowledged, that all of us became evidence of systematic acceptance of state measures directed for the reduction of APG burning volumes.

Fast introduction of the prohibition on gas flaring in conditions of unprepared infrastructure, the absence of the equipment produced in the RK, implemented the practice of production operations when gas flaring represented a constituent element of a technological process – was an impossible task for subsoil users from the beginning. Especially it became difficult for small and medium subsoil users, as among to other reasons the issue of financial investments issue was actual for them. Indeed the organization of an efficient process of APG utilization and its processing required substantial capital expenditure – that increased cost of the project almost twice. Altogether, in some oilfields due to as light and inhomogeneous inflow of APG it was impossible to realize standard approaches in solving the problems of utilization, in such cases an additional detailed investigation of the well was essential, and implementation of another scheme of utilization project

specially developed taking considering to specific peculiarities of the field – and it besides required time – which they did not have.

For the first time "prohibition on flaring of associated gas" was indicated on the 1st of December, 2004 through the introduction of amendments to the Law "About Subsoil" and "About oil", at that time the prohibition came into the force from the 1st of January, 2005. Thus, the state without taking into consideration the specificity of the APG utilization issue solving and the necessity of providing a period for implementation of utilization projects of more than 1 month almost prohibited industrial development of wells without APG utilization, an exception was made only for emergency situations and situations presenting a life hazard to the personnel of the company.

Afterward, with the understanding of the complexity of the issue and taking to consideration the criticism and appeals of subsurface users into the authorized authorities, the terms were postponed and prolonged almost for 10 years. Initially, the term was postponed until the 1st of July, 2006, then until 2008, 2010-2011 and finally the term approved as the deadline for extinguishing of all flares and putting into effect the prohibition for flaring of associated gas – this is 2015. This term is indicated in the frames of amendments and supplements implemented into some legislative acts of the RK on the issues of energy saving and increasing energy efficiency.

Actually the last 7 years the situation with APG utilization developed as follows: subsoil users divided into two groups, those who at the moment of introduction of the prohibition did not have any technologies on utilization and those that had, but their volumes of gas production exceeded their current possibilities of its utilization (Christen, 2004; Ismail & Umukoro, 2012; Weyant et al., 2016). Urgently solving the problem, mainly with the purpose was to reduce penalty sanctions, some companies tried to minimize flared volumes by increasing of APG volumes injected into formations for pressure maintenance, that is went to "gas conservation", some tried to increase the capacity of the existing utilization facilities. Particularly it should be noticed that several large companies made capital expenditure and started to solve this problem completely, here the "Tengizchevroil" Company should be mentioned.

In our opinion, within the reform implementation directed for prohibition of APG flaring, the state made two strategic mistakes: First – this is an absence (non provision) of an officially approved transition period, that is after introduction of a legislative prohibition for flaring, it was necessary to postpone its coming into effect and stipulate the transition period of about 5-7 years, which afterward were provided by periodical terms prolongation. Second – this is prohibition of APG flaring that was necessary to introduce in relation to the stages of implementation of the program on development to the national oil and gas machinery, then the major part of subsoil users could be invested to the economy of Kazakhstan and strengthen of positions of the national producers of equipment.

As these things developed in different directions, at the first stage of execution of APG utilization program – subsoil users have purchased foreign equipment for milliards of dollars (Bashkin, 2007; Deutsch, 2011; Gerner, Svensson, & Djumena, 2004). Thus, in during unconsidered and non-system approach to solving the APG utilization problems and national machinery development – we almost threw away from the economy of the country milliards of dollars and invested them into the economy of other countries. The main importers of oil and gas equipment during the considered period became Russia, China, USA, and others.

Without a provision to subsoil users of the legislative period for gradual implementation of the APG utilization projects we almost forced them to purchase hurriedly foreign equipment enriching foreign producers and intermediate companies that came to our market. A total amount of financial investments was spent on imported products, in my opinion, practically is not possible to estimate.

Only in 2007, the volume of the market of oil and gas equipment according to the expert valuation made 4-5 billion US Dollars, when the demand for these products was satisfied by national producers only for 3.1%, or for 65 million US dollars (Kalmenova, 2014). Within following years demand is decreasing, and nevertheless, in 2012 it comprised 1.4 billion Dollars. But in 2012 the situation with the production of oil and gas equipment was significantly better, more than 53 Kazakh plants produce the major part of the required by subsoil users equipment and it is competitive. These are figures from official statistics that are significantly less than those estimated by independent expert organizations but a low level of satisfying the general demand by domestic products could be observed, “according to the data of the Ministry of Oil and Gas of the RK in 2008, when a total volume of the market was 168 billion tenges, the demand for oil and gas equipment for 150 billion tenges was satisfied by import, and consequently, sales of domestic products from the total volume comprised 12%” (Decree of the Government, 2010a). Statistics says for itself.

Unfortunately, not all oil refineries in Kazakhstan comply with environmental standards, and invest in the recycling and disposal of hazardous waste. In addition, in the process of oil and gas production, according to soil chemical analyses, the adverse impact of oil and oil products on it has been identified, which leads to erosion, deflation, soil contamination, its transformation into technologically saline soils, and salt marshes.

When flaring associated gas, a high thermal background is formed. Despite the fact that the oil and gas industry ranks first among industries in terms of investment, in the Atyrau and Mangystau regions (the main areas of oil and gas production and refining), production is carried out using backward technologies and outdated equipment, which leads to accidents and oil leaks. As a result, the total area of oil pollution in Western Kazakhstan is 194 thousand hectares, and the volume of spilled oil is more than 5 million tons.

At new refineries, the content of these emissions is much higher, and respectively, the proportion of damage is higher. Currently, the priority task for the development of enterprises in the oil and gas sector should be environmental-oriented activities. The cost of projects due to environmental impact assessment pays off during 5-7 years on average. The implementation of environmental protection technologies and equipment at the pre-investment stage of projects costs 3-4 times cheaper than the subsequent installation of additional environmental protection equipment (Yedilbayeva, 2009; Yakovlev & Nikulina, 2013). Nevertheless, the cost of eliminating the possible consequences of the use of "dirty technologies" is 30-35 times higher than the costs of developing clean technology and using environmentally advanced equipment (Nikolayeva et al., 2014; Mynbayev, 2008). The modernization of the processes of extraction and treatment of oil and gas products with environmental protection costs of 1-2% of the total investment can prevent losses of 3-5% of the gross national product, as well as to reduce emissions to the atmosphere (Yegorov, Chigarkina, & Baymukanov, 2003; Kenzhegaliyev & Bekmukhanov 2010).

CONCLUSION

The authors' opinion is that the most important decision is the requirement towards mining companies to implement only environmentally friendly production. To this end, measures are being actively developed for the creation and implementation of a mechanism for promoting the use of renewable energy sources and environmentally friendly technologies.

Another new direction influencing the development of a "green economy" in Kazakhstan is the creation of a strategic "reserve" of hydrocarbons. An analysis of world practice shows that economically developed countries, in order to ensure the smooth operation of economic facilities and for future generations, create strategic reserves of raw materials and, above all, oil (Drouvot, M., Drouvot, H., & Perluss, 2014; Thomas & Dawe, 2003). For example, the United States, producing oil in the Gulf of Mexico, practically does not use it but is pumping it into reservoirs for long-term storage. For its own needs, the country uses imported oil from other countries. Thus, in the oil and gas sector of Kazakhstan, at present, the most relevant principle is greening the economy in order to minimize the negative impact on the environment, i.e. application and implementation of a set of managerial (organizational), technological, financial and economic measures aimed at reducing the pressure on the environment by enterprises while maintaining the industry goals of making a profit at sufficient rates of economic development and ensuring the ongoing development of the human community.

After analyzing the problem, it is worth to transfer to the perspectives, proposals to improve the situation. In this context, we think that it is necessary to consider the world experience in stimulating entrepreneurs' initiatives and to develop the APG market, providing to the entrepreneurs the maximum amount of preferences, and measures of support.

1) The State support could be provided through roadmaps by the business support of the Fund "Damu", the Group of KazMunaiGas Companies etc. In

the frame of this project, it is possible to establish several programs separately for small, remote from transport infrastructure and medium subsoil users who have some difficulties with APG utilization program financing. For those entrepreneurs or companies who are agree and wish to work with the APG processing projects int5o the ready-made products and organization of its realization or export.

2) During the APG processing, the appropriate technologies implementation is possible to receive several types of hydrocarbons ready for sale condition. It can be as a dry stripped gas or pentane-hexane fraction, butane, BFLH (broad fraction of light hydrocarbons) etc. All these APG components are processed until a ready-made marketable condition is in strong demand in the RK and in countries near and far abroad, especially in the petrochemical industry developing in our country.

3) The State might assist in the frames of a specially created company or one of the subsidiary companies of the NWF Samruk-Kazyna, through solving the issues of transport infrastructure (connection of gas pipelines, networks with the production sites), organizing an appropriate sales market for the received in the course of processing products, try to provide the required domestic equipment in exchange for participating in an enterprise (sharing capital), or long-term obligations for purchase of raw materials etc. In thousands of agreements' varieties, in each concrete case, under a concrete project the acceptable conditions could be established. It is not a fact that the majority of subsoil users or entrepreneurs could make this step, but the fact of availability of such perspective would be evidence that the State is implementing not only punitive but also an incentive and support measures in this issue.

4) Having provided such incentive, supporting mechanisms on the issues of APG utilization, the state would solve three problems at once: reduction of volumes of APG flaring, ecological environment improvement and business support, initiatives of entrepreneurs. Definitely, availability of stimulating measures does not mean cancellation or containment of punitive measures for unauthorized APG flaring or non-compliance legislation requirements. However, an application of method "carrot and stick" not once proved its efficiency, when until the present time, the main instrument, used by the state in this direction is a punitive method stipulating sanctions, penalties etc.

All these issues should not be removed from the agenda of the day. As at the present time subsoil users still have a lot of problems, for example, after installation of gas-turbine power stations, gas dehydration units – most of them are not able to find the selling market of the produced power energy or gas and this is taking into consideration their technological needs and requirements satisfaction This is the result of undeveloped infrastructure of power and gas distribution networks, immaturity of sales market and consumption of marketable products received after recycling APG etc. Taking into consideration a large quantitative index of problems connected with APG recycling or disposal, it is necessary to devote a separate article for the consideration of the mechanisms for its solving.

REFERENCES

Abrosimov, A.A., Dolomatova, M.Y., & Telyasheva E.G. (2002). *Ecology of hydrocarbon systems processing.* Moscow: Khimiya. pp. 70-81.

Bashkin, V.N. (2007). *Environmental risks: calculation, management, insurance.* Moscow: Vysshaya shkola.

Burnham, A., Han, J., Clark, C.E., Wang, M. (2011). *Life-cycle greenhouse gas emissions of shale gas, natural gas, coal, and petroleum*. Science & Technology. ACS Publications.

Christen, K. (2004). *Environmental impacts of gas flaring, venting add up*. ACS Publications.

Decree of the Government of the Republic of Kazakhstan No. 1002 of 30.09.2010. (2010a). 'Paragraph' information system.

Decree of the Government of the Republic of Kazakhstan No. 1135 of 29.10.2010. (2010b). 'Paragraph' information system.

Deutsch, J. (2011). The Good News about Gas: The Natural Gas Revolution and its Consequences. *Foreign Affairs, 90*(1), 82-93.

Diarov M.D. (2003). *Ecology and oil and gas industry.* Almaty.

Drouvot, M., Drouvot, H., & Perluss, P. (2014). Green house gas reduction through social inclusion in Brazil. *International Journal of Sustainable Development, 17*(1), 89-102.

Gerner, F., Svensson, B., & Djumena, S. (2004). *Gas flaring and venting: A regulatory framework and incentives for gas utilization. Viewpoint*. Washington, DC: World Bank.

Gervet, B. (2007). *Gas flaring emission contributes to global warming*. Renewable Energy Research Group, Lulea University.

Hartman, F. T. (2003). *The Ten Commandments of Better Contracting: A Practical Guide to Adding Value to an Enterprise through More Effective Smart Contracting*. ASCE Publications, 69–71.

Ismail, O. S., & Umukoro, G. E. (2012). Global Impact of Gas Flaring. *Energy and Power Engineering, 4*, 290-302.

Kalmenova, M.T. (2014). Solution of the Ecological and Economical Problems of the Oil and Gas Sector of Kazakhstan within the Development of "Green Economy. *Kazeu newspaper*, *2*(98), 62-72.

Kenzhegaliyev, A., & Bekmukhanov, K.Z. (2010). Deep processing of oil and environmental protection. *Oil and gas, 2*(56), 135-137.

Law of the Republic of Kazakhstan 'About the state property' No, 413-IV of 1.03.2011 (with amendments and additions as of 21.07.2015). (2015). 'Paragraph' information system.

Mynbayev, S. (2008). Wearing-out of the main equipment of power stations in Kazakhstan reached 70%. *Information agents "Kazakhstan Today"*.

Nazarbayev N.A. (2012). Strategy "Kazakhstan - 2050": a new political course of the established State. *Astana: Akorda.*

Nazarbayev, N.A. (2013). *Concept for the transition of the Republic of Kazakhstan to a green economy.* Astana: Akorda.

Nazarbayev, N.A. (2012). Socio-economic modernization is the main vector of development of Kazakhstan. *Evening Almaty*.

Nikolayeva, M., Grigorevich, L.V., Arkadyeva, L.A., Mikhaylova, M.L., & Nikolayeva, E.S. (2014). The economic assessment of harm to the arctic ecosystems at the development of oil and gas resources. *Economy of Region, 1*, 102-111.

Podavalov, Y.A. (2010). *Ecology of oil and gas production.* Moscow: Infra-Engineering, 134-146.

Roadmap for Business 2020. (2011). 'Paragraph' information system.

Tengizchevroil LLC. (2016). *TCO 2015-16 Corporate Responsibility Report*. Retrieved from http://www.tengizchevroil.com/docs/default-source/publications/eng/tco_2015_2016_corporate-responsibility-report_e.pdf?sfvrsn=6

Thomas, S., & Dawe, R.A. (2003). *Review of ways to transport natural gas energy from countries which do not need the gas for domestic use*. Elsevier.

Weyant, C.L., Shepson, P.B., & Subramanian, R. (2016). Black Carbon Emissions from Associated Natural Gas Flaring. *Environ. Sci. Technol., 50*(4), 2075–2081.

Yakovlev, S., & Nikulina, Y.G. (2013). Ecological rating of the allowable residual oil content in soils of different land uses. *Eurasian Soil Science, 46*(2), 212-216.

Yedilbayeva, G. (2009). *Development of legislation on the regulation of environmental management in the context of the industrial development of Kazakhstan.* Almaty: Gylym.

Yegorov, A.I., Chigarkina, A.O., & Baymukanov, A.S. (2003). *Oil and gas industry: problems of development and effective functioning.* Almaty: Atamura.