Analysing oil and gas production facilities impact on atmospheric air of Potochnoye field

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Abstract. Environmental issues are always relevant. Nature is subject to constant human intervention. At the same time, associated institutions are being created to solve the tasks of reducing the level of harmful effects and the full restoration of environment. In this article, we assess the level of harmful emissions and wastes of oil and gas complex facilities during drilling, construction of facilities for field development and their operation, and present basic measures to reduce their impact on the air in Potochnoye field. We have examined the amount of emissions and waste from stationary and mobile sources. During wells drilling and facilities construction, the average annual evidence of pollutant emissions into the atmosphere caused by stationary sources will amount to 141.29 tons per year while the pollutant emissions caused by road and construction equipment and vehicles will be equal to 200.8 tons per year. Every year the amount of emissions into the atmosphere caused by the maintenance of the designed facilities will be 13730.9 tons per year, emissions from vehicles will be 47.1 tons per year. During field development, all work on the field should be carried out in compliance with the standards of the legislation of the Russian Federation. Having analyzed the amount of estimated emissions, a set of measures has been drawn up with the objective to reduce the impact of oil and gas complex on atmospheric air.

1. Introduction

Oil and gas complex expands the territory of field development every year. The number of drilled wells is growing, and the impact on nature is growing as well. In order to equip an oil field, the construction of areal and linear objects (communications) of oil and gas production for various purposes is required. The main task is to bring the field to the planned volumes of oil production. Environmental support on the field aims to regulate the interaction of an enterprise with the environment by means of standardization of impacts [1].

The modern system of field development is distinguished by such stages as hydrocarbon raw materials: exploration and search for deposits, construction (drilling) of exploration and prospecting wells, exploitation and development of explored fields.

Harmful emissions and waste from operations are generated at all stages of field development [2].
Environmental impact associated with well drilling, arrangement of well clusters and routes of communication corridors to them will be formed during Potochnoye field development. Next, we consider in detail the amount of emissions during field operations and measures to reduce them.

2. Materials and methods

The development of hydrocarbon deposits has a permissive order, specifically, it requires prior permission to operate from relevant state bodies, and is regulated by a package of existing regulatory, methodological and legislative documents [3].

Potential emissions (pollution) into the atmosphere are justified during the environmental impact assessment procedure.

Environmental impact assessment (EIA) is a mandatory part of the design documentation [4]. Such a procedure is organized before the start of the project. An EIA is carried out after assessing the current state of the environment, taking into account the environmental protection measures plan (EPMP). This document contains information on emissions and other negative environmental impacts.

All calculations of quantitative indicators in assessing the environmental impact of facilities were carried out on the basis of consolidated standards calculated for similar projects.

3. Results

This section covers the impact of construction work with the maximum volumes on atmospheric air during the further maintenance of Potochnoye field.

With the further development of Potochnoye field, an additional environmental impact associated with well drilling, arrangement of well clusters and routes of communication corridors to them will be formed.

Potential sources, impact volumes and environmental protection measures of development are considered separately for the components of the natural environment at the stages of well drilling, construction of facilities for field development and their operation [5].

During construction and installation works, the sources of pollutants emission are as follows:
- boiling room operating during drilling operations;
- diesel power plant operating during construction and installation works;
- emissions from car engines and construction equipment operation;
- manipulations with welding equipment;
- molar work;
- pouring work;
- fuel stations;
- mud mixing system [6].

In the operating mode of facilities management, the main sources of emitting harmful substances into the air during oil production are as follows:
- flanges in pipe fittings are loosely connected;
- sealants of movable joints of pumping equipment;
- breather valves of containers;
- air ducts of chemical input unit [7].

When constructing facilities for calculations, the following norms are accepted:
- the norm of pollutant emissions into the atmosphere is per 1 well cluster under construction;
- the norm of waste generation, water consumption, water disposal per one drilled well;
- the amount of rainwater calculated on the average annual runoff from the surface and the area of rainwater harvesting.

When operating the designed facilities, the calculations of the following aspects were carried out:
- atmospheric emissions from processing facilities installed at sites;
- air emissions from mobile vehicles in compliance with the standard for emissions of each pollutant per 1 wellbore;
- production waste in compliance with the norm of industrial waste generation (containers, packaging, etc.) per 1 working production well;
- oily waste in compliance with the standard for the formation of products for oilfield equipment cleaning per 1 ton of produced fluid;
- volumes of produced water in compliance with the indicators of field development.

The mass of harmful substances emitted from stationary and mobile sources during well drilling, construction of facilities and their operation are shown in table 1.

**Table 1.** The amount of harmful emissions into the atmosphere

| Name of the process and sources of emissions | Name of harmful substance | Emission mass, tons per year |
|---------------------------------------------|---------------------------|-----------------------------|
| **1. Well drilling**                        |                           |                             |
| 1.1. Stationary source                      | Nitrogen oxides           | 20.7                        |
|                                              | Soot                      | 0.4                         |
|                                              | Carbon oxide              | 14.8                        |
|                                              | Fuel oil ash              | 0.5                         |
|                                              | Hydrocarbons              | 67.7                        |
|                                              | Sulphurous anhydride      | 35.1                        |
|                                              | Manganese and its compounds | 0.00018             |
|                                              | Iron oxide                | 0.007                       |
| 1.2. Vehicles                               | Carbon oxide              | 95.2                        |
|                                              | Nitrogen oxides           | 55.6                        |
|                                              | Hydrocarbons              | 20.2                        |
|                                              | Soot                      | 7.5                         |
|                                              | Lead                      | 0.07                        |
|                                              | Sulphurous anhydride      | 7.5                         |
| **2. Facilities construction**              |                           |                             |
| 2.1. Stationary sources                     | Nitrogen oxides           | 0.18                        |
|                                              | Carbon oxide              | 0.88                        |
|                                              | Welding spray             | 1.05                        |
|                                              | Solvents                  | 0.02                        |
| 2.2. Vehicles                               | Nitrogen oxides           | 0.4                         |
|                                              | Carbon oxide              | 12.4                        |
|                                              | Hydrocarbons              | 1.7                         |
|                                              | Soot                      | 0.07                        |
|                                              | Lead                      | 0.02                        |
|                                              | Sulphurous anhydride      | 0.05                        |
| **3. Facilities operation**                 |                           |                             |
| 3.1. Stationary sources                     | Nitrogen oxides           | 9.4                         |
|                                              | Carbon oxide              | 299.1                       |
|                                              | Hydrocarbons              | 13421.9                     |
|                                              | Soot                      | 0.0                         |
|                                              | Chemicals (methanol)      | 0.54                        |
|                                              | Benz a pyrene             | 0.0000001                   |
| 3.2. Vehicles                               | Nitrogen oxides           | 1.8                         |
|                                              | Carbon oxide              | 38.6                        |
|                                              | Hydrocarbons              | 6.1                         |
|                                              | Soot                      | 0.17                        |
|                                              | Lead                      | 0.036                       |
|                                              | Sulphurous anhydride      | 0.44                        |
4. Discussion
Drilling of wells using drilling rigs with an electric drive was adopted with the objective to calculate emissions.

During the construction of well facilities and drilling facilities, the average annual emissions of polluting substances into the atmosphere caused by stationary sources will amount to 141.29 tons per year and the ones caused by road and construction equipment and vehicles will be 200.8 tons per year.

In the operating mode of project facilities management, pollutants from stationary sources will be released into the atmosphere every year in the amount of 13730.9 tons per year, emissions from vehicles will be 47.1 tons per year.

5. Conclusion
In order to prevent air pollution at an enterprise, the following measures should be taken to reduce the harmful effects:

- complete sealing of equipment: wellheads, systems for receiving and measuring formation fluids coming from testing wells, circulating systems, valves and pipelines, eliminating constant emissions [8];
- selection of equipment taking into account explosiveness, fire hazard and toxicity of products;
- fuels and lubricants must be delivered and stored in sealed containers, it is required to keep a record of spent and consumed fuel and lubricants;
- the process of burning fuel in boiling rooms and heaters is optimized according to regime maps;
- equipping the apparatus (where pressure that exceeds the calculated one may arise) with safety valves in compliance with the requirements of the “Rules for the Construction and Safe Operation of Pressure Vessels”;
- pumping oil from the apparatus and drainage during equipment repair, oil and gas discharge from the safety valves into emergency tanks;
- posing control over air pollution [9].

The use of associated and natural petroleum gas should be reflected in projects for a field development [10]. The level of utilizing associated produced gas during the field’s operation should be at least 97.5%.

For oil and gas production facilities that have been commissioned at the Potochnoye field, it is necessary to establish standards for harmful emissions into the atmospheric air from each type of equipment located at industrial sites and issue a permit for the emission of pollutants into the atmospheric air in the prescribed manner.

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