 ISSN NO: 2770-4491
Date of Publication:30-06-2022

Creation of an algorithm for the optimal functioning of an underground gas storage station

B.U.Shomirzaev
Department of Information Technologies, Andijan State University, Uzbekistan, Address: University, 129, 170100, Andijan city, Republic of
Uzbekistan E-mail: [2] shobabur@mail.ru

Abstract: The article deals with the creation of an algorithm optimal control of the technological parameters of an underground gas storage station, the relevance of solving the problem of creating automatic control systems for automating the control and management of technological parameters. According to the author's conclusion, the use of the optimal control algorithm for an underground gas storage station improves station performance.

Keywords: gas pipeline, injection, regulation, underground gas storage , pressure , flow rate, gas transportation .

Introduction

Optimal management of any technological object is associated with finding the optimal mode of its operation according to some selected criterion within the framework of the technological regulation and maintaining this mode. The solution of this problem requires the use of mathematical models that are adequate to the controlled process, allowing one to evaluate the optimality criterion for any admissible mode, as well as sufficiently high computing resources of the applied computer complex.

Material

Underground gas storage stations (UGS) are designed to regulate the unevenness of gas consumption associated with seasonal fluctuations in demand for natural gas, as well as to form operational and strategic reserve reserves in the main gas- consuming areas to maintain the stability of gas supplies, incl . export.

Optimal operation of UGS facilities ensures uninterrupted execution of technological processes of gas injection, storage and withdrawal.

UGS facilities include a complex of industrial buildings of large-sized installations; one or more GPA shops, a gas field with gas collection points, infield pipelines and a complex of wells with underground and wellhead equipment; gas treatment plants, with distribution, measuring and control devices, gas pipeline for connection to the main gas pipeline (MG); systems for automatic control, protection and control; heating , chemical and other auxiliary facilities.

Consider the technological scheme of gas injection into an underground gas storage (Figure 1)

ISSN NO: 2770-4491
Date of Publication:30-06-2022

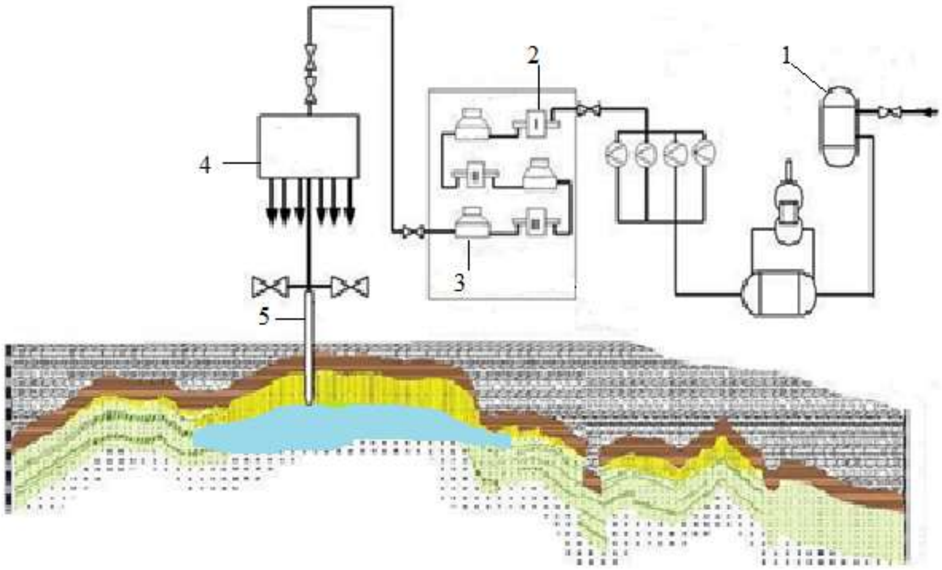


Figure 1—Technological scheme of gas injection

As mentioned above, the underground storage includes compressor shops, gas treatment units and gas collection points (GSP). At gas collection points, individual metering of injected and withdrawn gas from wells is carried out, as well as gas purification during extraction. Gas purification is carried out in gas separators, which are installed in open areas. In a special room, flow meters and valves are mounted on each well. When pumping, gas with a pressure of 2-2.5 MPa is supplied through the outlet from the main gas pipeline, cleaned in the dust cleaning system 1 and sent to the compressor shops 2 for compression to a pressure of 14-18 MPa. With such a large compression of the gas, its temperature rises sharply and therefore the gas is cooled in air coolers 3 or cooling towers. After that, the gas is sent for purification from compressor oil, which enters during compression . Oil removal is carried out in several stages: cyclone separators (usually two stages), carbon adsorbers and finally ceramic filters **.** In the first stage of cyclone separators, condensed heavy hydrocarbons and oil are captured, in the second stage, condensed light hydrocarbons and coagulated oil particles. Smaller oil particles (diameter 20-30 microns) are captured in coal adsorbers.

Used as a sorbent in the form of cylinders with a diameter of 3-4 mm and a length of 8 mm. The sorbent is regenerated by steam. Fine cleaning of oil dust is carried out in ceramic filters, consisting of tubes made of filter materials, one end of which is closed. The gas, having passed all stages of purification, contains 0.4-0.5 g of compressor oil per 1000 m $^{3\ of}$ gas. The need for these processes is caused by the danger of clogging of gas paths with hydrates at positive temperatures (288 K) and a decrease in permeability to ditch channels at the bottom of the well due to the ingress of oil particles into them, which leads to the need to increase the injection pressure and, at the same time, to a decrease in productivity with an increase in energy costs. Therefore, it is advisable to use reciprocating compressors without cylinder lubrication, i.e., the same gas engine compressors or compressors with an electric drive, but equipped with graphite-filled fluoroplastic rings, or using high-pressure centrifugal blowers driven by gas turbine engines.

4 through the gas collection manifold **,** where it is sent through separate loops to the UGS wells 5 with a preliminary measurement of the amount of gas injected into each injection and production well and accumulates in porous structures, pushing water to the edges of the structure. UGS facilities in depleted deposits are subject to flooding as a result of pressure drawdown, but flooding can play a positive role, as it reduces the buffer volume of gas in UGSFs. Therefore, during operation, the properties of the reservoir are systematically examined through gas and observation wells. During storage, the gas is saturated with water vapor, so when it is released, which occurs with a decrease in gas temperature, and it is cooled, it must be introduced into wells in plumes and plumes hydrate inhibitors.

ISSN NO: 2770-4491
Date of Publication:30-06-2022

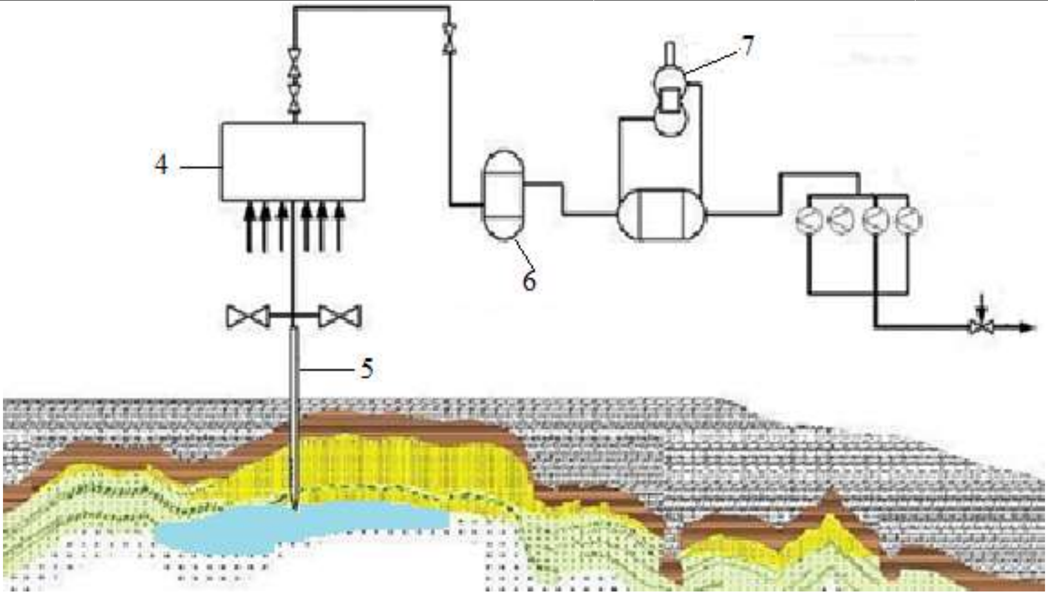


Figure 2. Technological scheme of gas sampling

When withdrawing gas from production wells, it enters the GSP through individual pipelines. Reduce gas pressure with reducing fittings**.** The gas from the wells entering the GSP through individual loops carries sand and moisture with it, which are separated in the first stage separators 6 , installed before the choke in the direction of gas flow, and in the second stage separators installed after the choke. After the separators, the gas is fed to the drying unit **7** , from where it is sent to the main gas pipeline at the dew point temperature. The pelvis is dried with diethylene glycol .

Results

Among the parameters that provide Optimal operation of UGS facilities There are two parameters that are difficult to control.

The flow of natural gas in the UGS pipeline is described by the following system of differential equations:

$$\begin{cases} \frac{\partial P}{\partial x} + \rho\alpha\frac{\partial}{\partial x}\left(\frac{\omega^2}{2}\right) + \frac{\lambda\omega^2}{2D}\rho + \frac{\partial(\rho\omega)}{\partial t} = 0, \\ \frac{\partial(\rho\omega)}{\partial x} + \frac{1}{c^2}\frac{\partial P}{\partial t} = 0. \end{cases}.$$

For the normal operation of an underground gas storage station, it is necessary to solve an equation that fulfills the following conditions:

$0 \le Q^{+}_{EOGO}(t) \le min\{maxQ_{ol}; Q^{0}_{EOGO}\}$,

$0 \le Q^{-}_{\text{E}EOGO}(t) \le min\{maxQ_{yub}; V_{EOGO} - Q^{0}_{EOGO}\}$,

where V_{EOGO} – UGS capacity, Q^{0}_{EOGO} – initial gas stock in UGS, $Q^{+}_{EOGO}, Q^{-}_{\text{E}EOGO}$ –current volume of gas injection and withdrawal, $maxQ_{ol} - maxQ_{yub}$ –maximum gas withdrawal, maximum gas injection.

The main task of gas transportation is expressed in the following form:

$P^2_b(t) - P^2_{\text{o}}(t) = AQ^2_{tq}(t)$,

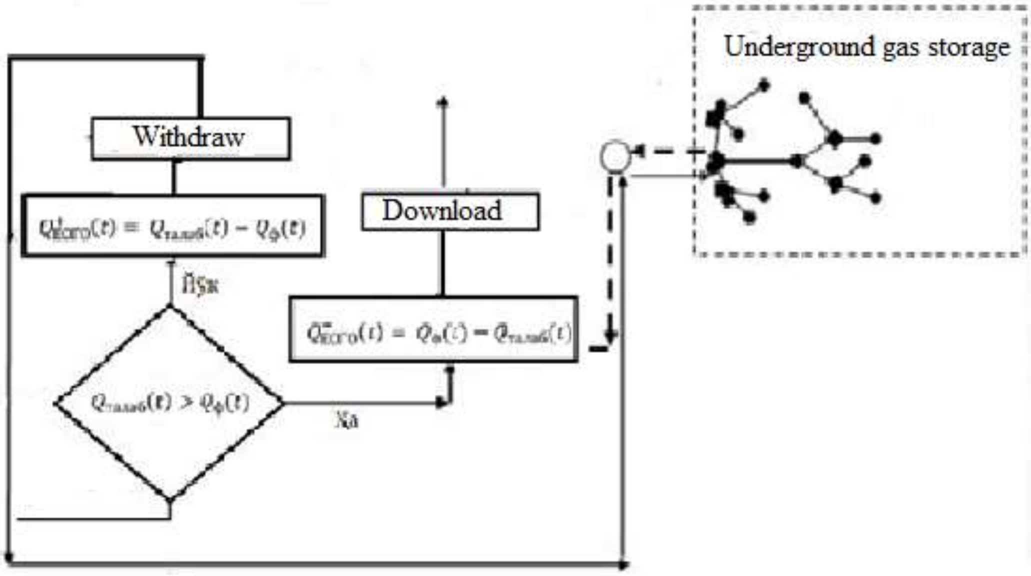
where, Q_{tq} - required gas flow, P_b , P_o - pressure values at the end and at the beginning of the pipeline, A is the overall drag coefficient.

For the normal functioning of the transportation of natural gas extracted from underground storage facilities, the following conditions must be met:

$P_{min} \le P_{b,\text{o}}(t) \le P_{max}$,$Q_{\text{тq}}(t) \le Q_{max}$

where P_{max} , P_{min} are the maximum and minimum pressures, Qmax is the maximum capacity of the gas transmission system.

ISSN NO: 2770-4491
Date of Publication:30-06-2022



Based on the above data, it is possible to draw up an algorithm for the injection, withdrawal and normal functioning of the transportation of natural gas extracted from underground storage facilities

Conclusion

The created algorithm for the operational calculation of UGS technological parameters will qualitatively improve the connoll and control of gas injection and withdrawal processes at UGS facilities, evaluate the maximum possible gas withdrawals in extreme situations, deviation from predicted modes and their consequences, as well as improve the operation of UGS facilities.

References

1. Kulik V.S. Optimizatsiya rejimov transportirovki prirodnogo gaza po sistemam magistralnix gazoprovodov v usloviyax neopredelyonnosti isxodnix dannix: Dissertatsiya kandidata texnicheskix nauk: 05-13-18. – M., 2015
2. Siddikov I.X., Shomirzaev B. U. Gas Pressure and Flow Control Algorithm in Main Gas Pipelines Using the Fuzzy Logic Apparatus // International journal of advanced research in science, Engineering and technology. India 2019, Vol. 6, Issue 8, August 2019.
3. Zibert G.K., Sedix A.D., i dr. Podgotovka i pererabotka uglevodorodnix gazov i kondensata. Texnologii i oborudovanie. Spravochnoe posobie- M.: OAO "Nedra-Biznessentr", 2001. - 316 s.
4. Siddikov I.X., Shomirzaev B. U. Dvuxurovnevaya sxema nechetkogo adaptivnogo regulirovaniya dinamicheskix ob'ektov // Ximicheskaya texnologiya. Kontrol i upravlenie. Tashkent, – №6. – 2018, – S.41-46.
5. Maksimov Yu.I. Imitatsionnie modeli operativnogo planirovaniya i upravleniya magistralnim transportom gaza. – Novosibirsk: Nauka, 1982.
6. Siddikov IX, Shomirzaev BU Sozdanie dinamicheskix modeley texnologicheskix protsessov dlya podzemnix xranilish gas // Vestnik TashGTU . Tashkent , - No. 1. – 2019, – S.9-13.
7. Kravsov A.V., Usheva N.V., Beshagina Ye.V. Texnologicheskie osnovi i modelirovanie protsessov promislovoy podgotovki nefti i gaza. Uchebnoe posobie. - Tomsk: Izd-vo Tomskogo Politex. Univer.2012. - 128 s.
8. Murin V.I., Kislenko N.N. i dr. (red.) Texnologiya pererabotki prirodnogo gaza i kondensata. Spravochnik: V 2-x ch. -M.: OOO "NedraBiznessentr", 2002. - 4.1 - 517s.