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USSR Report

ENERGY

(FOUO 5/81)

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ENERGY

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CONTENTS

ELECTRIC POWER

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PUMPED-STORAGE POWER PLANTS

Moscow GIDROAKKUMULIRUYUSHCHIYE ELEKTROSTANTSII in Russian 1978 (signed to press 1 Nov 78) pp 1-4, 182-184

[Annotation, foreword and table of contents from book "Pumped-Storage Power Plants", by Boris Leonidovich Baburin, Moisey Davidovich Glezin, Mikhail Fedorovich Krasil'nikov and Leonid Borisovich Sheynman, edited by Sheynman, Izdatel'stvo "Energiya", 2000 copies, 184 pages]

[Text] Annotation. Pumped-storage power plants (GAES) are a new source of maneuverable electric power for USSR power systems. This book is a first attempt to generalize experience in planning and building GAES's in our country and abroad. It describes schematic diagrams for pumped-storage power plants (GAES), GAES configurations and designs and basic equipment. The economics of building and the prospects of developing pumped storage in the USSR are analyzed. Examples are given of various designs of GAES's in operation, under construction or being planned. The book is intended for hydraulic engineers and hydroelectric power engineers and can also be useful to VUZ students in corresponding specialties.

Foreword. Hydroelectric power plants have in recent years taken on increasing importance in power systems of the European portion of the Soviet Union as sources of maneuverable power, integrally combined as they are with the nuclear power plants used extensively here. The availability of maneuverable power and a flexible reserve in the power systems determines the power supply, that is, the possibility of meeting more reliably and economically the power consumption schedules at times of peak demand and in various emergency situations.

However, the most efficient hydroelectric power resources in the European part of the USSR have in considerable measure been exhausted. Pumped storage has therefore taken on particular importance here, as it is not associated with the need for large rivers and as it requires the withdrawal of considerably less land from other use than do river GES's.

The importance of pumped-storage power plants in improving the technical-economic indicators of power equipment operation was noted in the "Basic Directions of USSR National Economic Development in 1976-1980."

Our country has now overcome the previous negative attitude towards GAES construction which resulted from inadequate economic substantiation. It should be noted that GAES's ensure a significant savings in fuel as compared with thermal maneuverable electric

power sources -- gas-turbine and semipeak steam-turbine power plants. They are successfully inserted into the environment, since they use favorable natural factors and do not disturb the ecological conditions which have already evolved. In a number of instances, GAES basins can be used as multiple-use reservoirs. This is of special importance in light of the theses expressed by CPSU Central Committee General Secretary L. I. Brezhnev in the Accountability Report to the 25th CPSU Congress: "...nature can be used in various ways. We can, as human history shows us with many examples, leave behind us a space which is infertile, lifeless and hazardous to man. But we can also, and we must, comrades, ennoble nature and help it reveal more fully its vital forces."

In connection with the forthcoming unfolding of GAES construction in the USSR, the question of standardizing facilities has acquired special significance. We can first of all standardize pumped-storage power plants for heads of 80-120 meters. At present, we are working to standardize components for upper basin enclosures, water intakes, GAES buildings and pipes.

Initial experience in planning and building pumped-storage power plants in the USSR has disclosed that they are superior to river GES's in a number of specific features.

In view of the ever-expanding amount of GAES planning in the USSR, we need to generalize and analyze domestic and foreign experience in the field of pumped-storage electric power (pumped storage), as well as the scientific research and development done in recent years by the Ukrainian and Leningrad departments of Gidroproyekt Institute imeni S. Ya. Zhuk, its Moscow departments and Scientific Research Sector. The book analyzes the schematic configurations and structural resolutions of the facilities, as well as GAES equipment, and that analysis is the basis for recommendations on developing economical GAES plans for various natural conditions. The recommendations on methods of calculating GAES economic effectiveness enable us to take into account the systems and comprehensive national economic impact of their operation. The book does not examine GAES hydromechanical equipment, inasmuch as it does not differ fundamentally from similar hydroelectric power plant equipment.

Inasmuch as there is little experience in operating GAES facilities in the USSR and the foreign literature contains very limited information on this problem, the book describes only a few GAES equipment operating features.

The authors express their profound gratitude to Professor G. I. Krivchenko and engineer A. K. Vakhrameyev, who made a number of useful observations on the manuscript, which were then taken into account by the authors when preparing the book for publication.

Chapter 1 was written by B. L. Baburin, Chapter 5 by M. F. Krasil'nikov. The remaining chapters were written jointly by L. B. Sheynman and M. D. Glezin.

This publication is an initial attempt to create a book devoted to pumped-storage power plants, and it is therefore unquestionably not free of shortcomings. The authors would gratefully accept observations and advice on the book, which they request be sent to: 113114, Moscow, M-114, Shlyuzovaya nab., 10, izd-vo "Energiya."

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ECONOMIC EFFECTIVENESS OF OIL, GAS EXPLORATION EVALUATED

Moscow EKONOMICHESKAYA EFFEKTIVNOST' GEOLOGORAZVEDOCHNYKH RABOT NA NEFT' I GAZ in Russian 1980 (signed to press 13 Aug 80) pp 1-6, 214-216

[Annotation, introduction and table of contents from the book "Economic Effectiveness of Geological Exploration for Oil and Gas", edited by N. I. Buyalov and S. Ya. Kaganovich, Nedra, 1750 copies, 216 pages]

[Text] This book shows the value of geological exploration in setting up a raw material base for the oil and gas extracting industry. It examines the methodological principles for determining the economic effectiveness of work, methods of calculation and analysis of the efficiency indicators for geological exploration with regard for the stages and complexity of its practical implementation. It demonstrates the role of natural and organizational-method factors. An examination is made of the features of the active system of current and long-term planning. Based on an analysis of the extant evaluation system, it formulates a geological and economic evaluation of the oil and gas fields. It plans ways to increase the efficiency of geological exploration for oil and gas.

The book is designed for workers in the oil and gas industry, geologists, engineers and economists, scientists and planners.

Introduction

The topic of this book is determined by the key importance of increasing efficiency and quality as the decisive factor of our country's economic and social development for many years. L. I. Brezhnev stated: "The future of our economy lies in increasing efficiency. There is no other way to guarantee the successful and dynamic development of the national economy. This is precisely why the party will hold a steady line to accelerate scientific and technical progress, and to perfect planning and control..." [1].

Among the main questions of the national economic development of the Soviet Union, especial importance is attached to setting up a powerful fuel and energy complex. A. N. Kosygin in his report at the meeting with worker representatives of the Moscow city okrug stated: "In the new five-year plan it remains to implement major measures for the further development of the fuel and energy complex. Now, when many capitalist countries are experiencing growing concern with satisfaction of their energy needs, we are confidently looking to the future. In our plans we envisage a stable growth in the country's energy for many years ahead " [6].

Radical changes have taken place in the development of the Soviet Union's oil and gas industry in recent five-year plans. They were expressed in the organization and development of extraction in many economic regions of the country: northwest Volga-Urals, North Caucasus, within the Ukrainian SSR, Belorussian SSR, in the Transcaucasus, republics of Central Asia and Kazakhstan, in West Siberia and the Far East. This significantly promoted the development of productive forces of the country and influenced the complex development of the economy in major economic regions of the country.

The chief role for the oil and gas industry that develops intensively from year to year is played by expanding the strong raw material base. This is done by using the current advances of science and technology.

The Basic Directions for Development of the USSR National Economy for 1976-1980 that were adopted by the 25th CPSU Congress set the task of significantly expanding geological exploration and improving its economic effectiveness and the quality of preparation of the mineral reserves. It stresses the need to intensify exploration and prospecting for oil and gas fields. The main directions of oil and gas exploration and prospecting are indicated [3,6].

The results of geological exploration in 1955-1975 guaranteed that the USSR would attain high rates of development and absolute level of oil extraction. At the same time, the need for a leading increment in explored reserves under more complicated natural conditions of exploration and prospecting of new fields requires greater efforts and allocations. The problem of increasing the economic effectiveness of geological exploration is therefore becoming more urgent.

Increasing economic effectiveness of geological exploration is a complex scientific and practical problem. Geological, technical and economic aspects can be isolated in it. The USSR Minister of Geology Ye. A. Kozlovskiy has repeatedly indicated the lagging of research in the economics of mineral raw material and geological exploration. In 1975 he wrote: "The outlook for the development of economic research in the sector is inseparably linked with the need to solve such basic problems as developing the primary indicators for evaluating the efficiency of geological exploration and a system of economic factors where all the indicators of production and financial activity of the enterprises must be directly dependent on the increase in reserves and improvement in effectiveness of geological exploration" [43]. He later noted: "The main indicators have still not been formulated for evaluating the economic effectiveness of geological exploration. There are serious shortcomings in the active system of planning and economic stimulation. Work on complex programs is being slowly introduced into practice" [44].

The decree of the CPSU Central Committee and USSR Council of Ministers "On Improving Planning and Intensifying the Effect of the Economic Mechanism on Improved Efficiency of Production and Quality of Work" that was adopted in July 1979 is very important for the geological exploration sector. The requirements for limited unification of annual, five-year plans, the basic directions of economic and social development for 10 years, and the programs of scientific and technical development for 20 years agree well with the duration of the complete geological exploration cycle. The selection of the most effective means of attaining the final national economic results, detection and exploration of mobile oil and gas reserves, is no less important and significant for the multiple-stage process of

geological exploration. The need to perfect the intra- and interbranch cost accounting relationships is especially acute.

The great and serious tasks that face geological-economic research, especially in the area of increasing the economic effectivness of geological exploration for oil and gas, are evident.

The authors have attempted to condense the circle of unsolved economic problems of geological exploration for oil and gas that include perfection of planning, increase in economic effectiveness, improvement in technical and economic indicators of deep drilling, analysis of the structure of expenditures and ways to reduce the cost of operations, improvement in labor productivity, etc. The scientific-method resolution of these complicated problems clearly does not correspond to practical needs. The lack of resolution of many economic questions has an unfavorable effect on the effective development of geological exploration for oil and gas.

This book presents the chief results of many years of research on increasing the economic effectiveness of geological exploration for oil and gas. Special attention was focused on studying methodological and method questions.

The authors hope that their modest work will be useful in solving the complex problem of improving the economic effectiveness of geological exploration for oil and gas in the USSR.

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FUELS

FUEL CONSERVATION WITH SPECIAL REFERENCE TO MILITARY EQUIPMENT

Moscow EKONOMIYA GORYUCHEGO in Russi .. 1980 (signed to press 11 Jun 80) pp 1-4, 143-144

[Annotation, foreword and table of contents from the book "Fuel Conservation", edited by Candidate of Technical Sciences Ye. P. Seregin, Order of the Red Banner of Labor Voyennoye Izdatel'stvo of the USSR Ministry of Defense, 19,000 copies, 144 pages]

[Text] This book generalizes the domestic and foreign experience of conserving vehicle fuel. It examines the effect of the design features of the engines and chassis, the operating properties of the fuel, the vehicle driving technique, and the organization of hauling on the consumption of fuel. Suggestions are made to contend with fuel losses during its transporting, storage and filling of the vehicle equipment. Current views are presented regarding the possible use of petroleum product substitutes.

This book is designed for individuals involved with operating vehicles and other military equipment, transporting, storage and use of fuel.

Foreword

The Communist Party and the Soviet government are concentrating a lot of attention on improving the efficiency of all economic activity, including the conservation, and economical and efficient use of material resources.

General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet, Comrade L. I. Brezhnev noted at the 25th Party Congress: "No matter how the wealth of our society grows, the most stringent conservation and economy remain the most important condition for development of the national economy and increase in the people's welfare."*

A patriotic movement for the efficient consumption of fuel and energy is currently sweeping the country.

A special science, chemotology, is studying the efficient use of fuel and lubricants in equipment. It investigates a broad circle of questions that develop in the system: fuel-lubricants-engines, mechanisms-operation.

*"Materialy XXV s'yezda KPSS" [Materials of 25th CPSU Congress], Moscow, Politizdat, 1976, p 45.

The book "Fuel Conservation" examines conservation of fuel when piston engines are used, as well as fuel conservation during transporting and storage in warehouses.

It shows the complex interrelationship between the design of engines and transportation vehicles, the quality of the employed fuel, lubricants and special fluids, the technical condition and operating conditions of the equipment, and the problem of employing future energy sources.

The book "Fuel Conservation" can be a valuable manual for further, intensified work on conservation of fuel used in military equipment. It will also be of benefit to all readers associated with fuel use.

V. V. Nikitin

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FUELS

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TYUMENSKAYA OBLAST OIL WELL SERVICING EXPENDITURES, BY METHOD OF WELL OPERATION

Moscow NEFTYANAYA PROMYSHLENNOST': SERIYA "EKONOMIKA" in Russian No 11, Nov 80 pp 23-26

[Article by A. N. Yanin, Siberian Scientific Research Institute of Petroleum Industry (SibNIINP): "Influence of Method of Petroleum Extraction on Amount of Expenditures to Service Wells in Tyumenskaya Oblast Deposits"]

[Text] One characteristic feature of the current stage of development of Tyumenskaya Oblast petroleum extraction industry is the large-scale changeover of wells to mechanized operation. Mechanized well operating indicators are beginning to exert a great influence on the technical-economic indicators of petroleum extraction for the region as a whole. The method of well operation has a significant influence on the level of capital investments to outfit the wells, on the petroleum extraction operating expenditures and on the number of servicing personnel. In this connection, the problem has arisen of choosing an optimum method of operating wells which takes into account the specific conditions under which the deposits of Tyumenskaya Oblast are being utilized, a method which ensures high technical-economic indicators for petroleum extraction.

The indicator of level of well servicing expenditures is given important significance in choosing a method of petroleum extraction. Wells are the primary element in the production assets of petroleum extraction enterprises. The number of wells varies from a few units to several thousand; they are scattered about a large area, in which connection there are considerable difficulties associated with servicing them. In the deposits of Tyumenskaya Oblast, with its severe marshiness and flooding and low winter air temperatures, and given inadequate roads, expenditures on maintaining wells in good operating condition are especially high.

One of the main criteria in choosing a method of petroleum extraction is minimum expenditures on servicing wells. The composition of well servicing expenditures is not regulated by the instructions now in effect in the branch. In this work, they will include expenditures on work done at the wells: expenditures on basic and supplemental wages, with social insurance deductions for workers directly employed in petroleum extraction (subsequently, all three lines of expenditures will be combined under the title "Wages of Workers in Petroleum Extraction Shops"), as well as expenditures on routine subsurface oil well maintenance.

The well operating experience accumulated in the branch demonstrates that the lowest servicing expenditures are typical of the gusher method of petroleum extraction.

It is of interest to reveal the influence of method of operation on the amount of well-servicing expenditures for the specific conditions of Tyumenskaya Oblast based on an analysis of actual data.

All the basic methods of petroleum extraction are being used at the deposits of Tyumenskaya Oblast. In 1978, the gusher method of operation was being used at all deposits, accounting for 13 to 100 percent of their wells. Electric rotary pumps were installed at 19 deposits and sucker-rod pumps at 12. A large compressor gas-lift petroleum extraction complex was being operated at the Pravdinskiy deposit. A compressorless gas lift using high-pressure gas drawn from the gas caprock of producing strata was being used at the Samotlorskiy deposit to bring up liquids from several dozen wells. For Tyumenskaya Oblast as a whole, gushers comprised 72.9 percent of the average total number of operating wells, wells with electric rotary pumps -- 13.8 percent, wells with sucker-rod pumps -- 7.5 percent and gas-lift wells -- 5.8 percent, including 5.3 percent with compressor gas lifts. Given the simultaneous use of several methods of extracting petroleum, we determined the influence of method of operation on amount of expenditures on servicing wells on the basis of actual data. Of greatest interest are indicators for the "Yugansknefteaz" association, in which all methods of operation except for the compressorless gas lift are used under approximately identical conditions.

It is not possible to reveal the influence of petroleum extraction method on level of petroleum extraction shop worker wages directly using the reporting data from petroleum and gas extraction administrations (Table 1).

Table 1. Petroleum Extraction Shop Worker Wage Expenditures for Various Combinations of Methods of Operation

enterprise	proportion of methods of operation, %				worker wages, in 1,000 rubles per well
	gusher	electric-rotary pump	sucker-rod pump	gas-lift	
"Nizhnevartovsk-neftegaz"	90.6	7.4	0.9	1.1	0.62
"Surgutneftegaz"	76.6	15.8	7.4	--	1.10
"Yugansknefteaz"	46.1	27.6	4.2	22.0	0.72
including these petroleum-gas extraction administrations:					
"Yuganskneft'"	41.8	46.8	11.4	--	0.79
"Mamontovneft'"	73.3	26.4	0.3	--	0.63
"Pravdinskneft'"	11.5	0.3	--	88.2	0.79
"Urayneftegaz"	48.0	8.9	43.0	--	0.63
total	72.9	13.8	7.5	5.8	0.72

Expenditure data are recorded for the shop as a whole, but each shop is generally servicing a group of wells with different methods of operation. Workers of a single shop often monitor the operation of wells at two or more deposits. Moreover, the production functions of shop workers are not always of the same type in all instances. At deposits just beginning to be developed, which have a small number of operating wells, petroleum extraction shop personnel are instructed, in a number of instances,

to do jobs which are the province of the petroleum pumping shop. As a consequence of this, the reporting indicators of expenditures at new deposits are not comparable with indicators relating to old deposits with a full complement of shops. Factors not associated with method of petroleum extraction -- availability of roads, possibility of moving about the deposit, distance to production centers, and so on -- exert a considerable influence on the amount of expenditures for this item. As a consequence of the simultaneous influence of a large number of factors on amount of shop worker labor expenditures, we have not succeeded in revealing the influence of method of operation on the value of this indicator in "pure" form. That is possible only on the basis of special statistical analysis and only if other factors are excluded. To do this, reporting indicators were worked out for petroleum and gas extracting administrations for 1976-1978 and the following equation was set up:

$$C = C_g N_g + C_e N_e + C_s N_s + C_{gl} N_{gl},$$

where C is petroleum extraction shop worker wage expenditures, in 1,000 rubles;

N_g, N_e, N_s, N_{gl} are the average number of gusher, electric rotary pump, sucker-rod pump and gas-lift wells in operation;

C_g, C_e, C_s, C_{gl} are the shop worker wage expenditures per gusher, electric rotary pump, sucker-rod pump and gas-lift well, respectively, in 1,000 rubles.

Using standard methods to solve the equation, we obtained the following values for expenditure coefficients: gusher operation -- 570 rubles per well, electric rotary pump wells -- 920 rubles per well, sucker-rod pump wells -- 1,030 rubles per well and gas-lift method -- 800 rubles per well. These indicators reflect the average actual level of expenditures on petroleum extraction shop worker labor which had evolved at deposits of Tyumenskaya Oblast. Actual expenditures at each specific deposit might differ from those calculated using data from average coefficients, due to the influence of a large number of incidental factors.

Thus, the lowest petroleum extraction shop worker labor expenditures occurred with the gas-lift method of operation (among mechanized methods of petroleum extraction). These expenditures were somewhat higher when electric rotary pumps were used and were highest when sucker-rod pumps were used. However, the difference in level of expenditures for all the methods of mechanized extraction being examined was slight, on the order of 100-200 rubles per well per year.

Routine subsurface maintenance expenditures account for a large proportion of well-servicing expenditures. The amount of the routine subsurface oil well maintenance expenditures is determined for each method of operation by the following two factors: number of repairs per average operating well and average repair cost. Actual data on well subsurface maintenance expenditures on average for 1976-1978 at Tyumenskaya Oblast deposits are given in Table 2 [following page], by method of petroleum extraction. Well depth has a great influence on the amount of routine well subsurface maintenance expenditures, so all indicators are examined separately for two groups of deposits: Shaimskiy Rayon, where well depths are 1,600 to 1,800 meters, and the central Ob' region, where well depths are 2,200 to 2,400 meters.

The lowest routine well subsurface maintenance expenditures are characteristic of the gusher method of petroleum extraction, in which the number of repairs per well and

Table 2. Expenditures on Routine Well Subsurface Maintenance (actual data)

	method of operation					
	gusher	electric-rotary pump	sucker-rod pump	compressor gas lift, total	including cable	other
well depth of 1,600 to 1,800 meters						
number of repairs per well per year	0.34	4.11	2.71	--	--	--
average repair cost, 1,000 rubles	1.40	2.26	1.98	--	--	--
maintenance expenditures per well per year, 1,000 rubles	0.47	9.32	5.37	--	--	--
well depth of 2,200 to 2,400 meters						
number of repairs per well per year	0.26	2.64	1.96	1.79	1.45	0.34
average repair cost, 1,000 rubles	3.56	5.61	5.01	1.58	1.02	3.97
maintenance expenditures per well per year, 1,000 rubles	0.92	14.80	9.82	2.83	1.48	1.34

the average cost per repair are significantly lower than in mechanized operation. Annual expenditures per well are 10- to 20-fold lower than with a compressor gas lift. The lowest mechanized well subsurface maintenance expenditures were achieved at the Pravdinskiy deposit, which uses the most progressive equipment and compressor gas-lift technology: the number of repairs per gas-lift well is 1.1- to 1.5-fold lower than when pumping methods of petroleum extraction are used and the average repair cost is 3.2- to 3.6-fold lower. The significant reduction in gas-lift well routine subsurface maintenance expenditures was achieved through the broad application of cable work methods.

Upwards of 80 percent of all gas-lift well repairs were performed by the cable method in 1976-1978. In this regard, the average cost per repair was 3.9-fold lower than with ordinary repair technology.

Consequently, the amount of routine well subsurface maintenance expenditures at deposits of Tyumenskaya Oblast differ significantly, based on method of operation. Given well depths of 2,200 to 2,400 meters, expenditures for all methods of operation are 1.6- to two-fold greater than for well depths of 1,600 to 1,800 meters. However, the number of repairs per gusher well at deposits of the central Ob' region is somewhat lower than in Shaimskiy Rayon, due to the lower average service life of the wells.

One important factor influencing the amount of expenditures on routine well subsurface maintenance is well productivity. As productivity increases, so does the diameter of the pump-compressor pipe and sucker rod, and the size and weight of the

power and pump equipment increase. In this connection, time spent on maintenance and the cost of maintenance increase substantially. Therefore, when comparing expenditures on servicing wells for different methods of petroleum extraction, consideration must be given to the flow rate of the wells. Indicators given in Table 2 are not fully comparable, since they correspond to actual well flow rates, which vary within broad limits. Thus, if the 1978 gusher flow rate is taken to be 100 percent, the electric rotary pump well flow rate would be 129 percent, the sucker-rod pump well flow rate would be 13 percent, and the compressor well flow rate would be 49 percent. Thus, the average flow rate of wells with rotary pumps was nearly 10 times higher than that for wells with sucker-rod pumps. Consequently, the actual indicators to make them comparable must be recalculated for identical well flow rates.

A statistical analysis revealed the empirical functions of routine subsurface maintenance expenditures to well flow rate for each method of operation, which take the following form:

$$R_g = 0.42 + 0.003\ q;$$
$$R_e = 8.25 + 0.030\ q;$$
$$R_s = 5.02 + 0.115\ q;$$
$$R_{gl} = 1.52 + 0.017\ q,$$

where R_g, R_e, R_s, R_{gl} are routine well subsurface maintenance expenditures for gusher, electric rotary-pump, sucker-rod pump and gas-lift operation, respectively, in 1,000 rubles per well.

The results of calculations of routine subsurface maintenance and well-servicing expenditures, given flow rates of 30, 60, 90 and 150 tons per 24-hour period, are given in Table 3. Petroleum extraction shop worker wage expenditures are assumed to be constant for each method of operation for all flow-rate values. [Table 3 on following page.]

In all the cases examined, the gusher method of operation is the most economical. Among the mechanized methods of extraction, the lowest servicing expenditures are characteristic of the compressor gas lift.

Well-servicing expenditures increase as well flow rates increase for all methods of operation. In the gusher method of extraction, the increase in expenditures is comparatively slight; it is more significant for the compressor gas lift and when electric rotary pumps are used. Well-servicing expenditures increase fastest as a function of increasing flow rates for the sucker-rod pump method of petroleum extraction.

The well-servicing expenditure values obtained on the basis of an analysis of actual indicators for deposits of Tyumenskaya Oblast could be used in the technical-economic substantiation of petroleum extraction methods at deposits of this region.

Table 3. Calculated Well-Servicing Expenditures, Given Comparable Flow Rates, in 1,000 rubles per well

indicators	method of operation			
	gusher	electric rotary pump	sucker-rod pump	gas-lift
flow rate of 30 tons per day				
wages, with deductions	0.57	0.92	1.03	0.80
routine well maintenance	0.51	9.15	8.47	2.03
total	1.08	10.07	9.50	2.83
flow rate of 60 tons per day				
wages, with deductions	0.57	0.92	1.03	0.80
routine well maintenance	0.60	10.05	11.92	2.54
total	1.17	10.97	12.95	3.34
flow rate of 90 tons per day				
wages, with deductions	0.57	0.92	--	0.80
routine well maintenance	0.69	10.95	--	3.05
total	1.26	11.87	--	3.85
flow rate of 150 tons per day				
wages, with deductions	0.57	0.92	--	0.80
routine well maintenance	0.87	12.75	--	4.07
total	1.44	13.67	--	4.87

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