

THE USING ENERGY FOR HEAT AND POWER SUPPLY

A.B. Alkhasov, R.M. Aliyev, I.M. Abdulagatov

The Institute for Geothermal Problems
of the **Daghestan** Scientific Centre of the RAS

Kalinina, 39a, Makhachkala, Daghestan, 367030, Russia

ABSTRACT

In given paper the present day state of geothermal power engineering of Daghestan and prospects of its further development are considered. Grounds of unsatisfactory use of geothermal recourses in national economy are analyzed.

To improve the profitability of geothermal production, number of prospective technologies are suggested, that kind as the heat-pumping systems of heat supply with attraction of low-potential thermal waters, combined-separate extraction of fresh low-potential and salt middle-potential waters from the same well and combined production of electrical energy and heat with inclusion of heat pump cycle mbicontour system.

Republic of **Daghestan** is the most prospective region of Russia for geothermal power development. Resources for geothermal power engineering are rather great. In sedimentary section of Daghestan foothills and plain three structural hydrogeothermal stages are distinguished represented by series of thick regional aquifers, where enormous resources of low-potential (30-60 °C), middle-potential (60-120 °C) and high-potential (>120 °C) thermal waters were explored.

On the basis of thermal water utilization low-potential geothermal power engineering, the health resorts and balneology organizations are developed and there are real mine and geological prerequisites for high-potential geothermal power engineering and rare metal chemical industry development.

During many years the geothermal water fields Makhachkala, Kislar, Isberbash are exploited. Production of these fields is used for heating and hot water supply of municipal, administrative, rural and industrial installations. Annual realization of thermal water is more than 7 mln m³/year, that is equal to substitution about 50 thous. tn. of standard fuel.

Exploitation of the fields is carried out at a low level. Utilization rate of recoverable reserves in quantity and heat are equal respectively to 0,34 and 0,18 [1]. Daghestan is the region of high thermal stress, where the local thermoabnormal zones with thermal gradient, exceeding 0,04 °C/m, are wide spread. In separate fields the temperature 200 °C and more is

registered at depth about 5000m on bottomless Forecast reserves of thermal water, containing in water-bearing senes, at depth up to 5500m are more than 2,5 mln m³/day [2]

The low level of fields exploitation and enormous dispropotion between significant reserves of geothermal power and infinitesimal its using part is due to some specific factors, characterizing this power and also technology of its extraction and utilization

That kind of factors are the high cost of well drilling and technologies, appreciated in thermal water production, low transportability of geothermal energy, comparatively low concentration of geothermal power in formation and thermal water, necessity of reinjection of waste water, i.e. application of underground circulating systems (USC) and large expenses to their preparation, impossibility of thermal energy accumulation for a long period, corrosion aggressive properhes of thermal waters at large depth and so on

Because of anumerated negative factors the scientific and technological problems have sprigged up, the main fm which are reducbon of capital investments in well drilling with simultaneous reduction of periods of penetrabon and bringing into service, design of wells construction, permitting to increase their flow rate and intake rate and to reduce heat losses along brothel, development of technology of UCS creation, elaborabon of effective methods of corrosion and salt sedimentation prevention, elaborabon of profitable bi-contour systems of geothermal energy supply on the basis of cheap corrosion resistant heatexchangers, working out and serial production of module equipment for geothermal power stations, selection of rational technologies of deep heat consumption, discovering of energy capable economically justified consumers and so on

Solution of these problems is connected with involving of enormous financial, productive and scientific-technical resources and coordination of power of many Ministries and Departments in a scale of the whole Russia At the same tune Republic of **Daghestan** may become a proving ground for solution number of problems, that kind as

development the technology of **UCS**, building of **two-contour** geothermal power stations, creation of combined geothermal-pumping station and so on.

Low thermal fresh waters of Pliocene hydrogeothermal stage have **exploited** extremely unsatisfactorily. On Northern Daghestan plain quantity of artesian wells, drilled to this waters, exceeds 1500. About **10%** of water is appreciated with profit, the remain part of water does large damage to adjoined **lands**, salting and making them **boggy**. To prevent the leakage it is necessary wells to transfer to cock-diaphragm production conditions. The very effective **direction** of fresh low-potential water **using in national economy** is inculcation of technologies with application of heat pumps. The most wide the heat pumping plants (HPP) may be used in heat supply, one of energy capacious consumers now.

The most effective region of inculcation of heat pumping systems of heat supply is heat supply of the great number of small and middle decentralized consumers, springing up in last years in connection to transition to market economy, and heat supply of rural consumers.

The further transition to market relations **will** lead to reduction of role of the state in systematic forming of towns and populated areas, individual building will be increase in them, the process of population **outflow from towns** to ecologically pure small populated areas will **begin**, that will lead to gradual reduction of thermal **loading** concentration extent their density, that in their turn will aid development of heat pumping systems of heat supply (HSH).

HSH are prospective for heat supply of energy biological complexes (EBC). Building of EBC with heat utilizing **units**, such as hot-houses, fish-production unit of **open** thermal heating of ground **will** rise the profitableness of geothermal production by involving of significant volumes of low-potential thermal water, will create additional working places, **will** improve infrastructure and population leaving standard.

Present time in **Russia** there isn't **mass** production of heat pumps, although **significant** experience is accumulated of schematic solutions of HSH. The most effective **HSH** are those, which simultaneously solve the problems of heating, hot water supply and municipal water supply, that is especially important in such a waterless region as Northern **Daghestan plain**, where the problem of **fresh high quality** water for water supply of **populating** areas and objects of national economy is **sharp**.

The combined solar-wind-thermal and heat pumping plants are of considerable interest in that regions, where there are the favorable conditions. Solar and

wind plants may be used for drive of compressors of heat pumps. **Mass** productions of heat pumps may be organized on plants of the Republic, which are shut down.

Daghestan may become the demonstration zone of wide inculcation of **HPP** and transfer on this basis the Republic economy to energy **saving** development way.

The basic function of middlepotential thermal water - heat supply of different purpose objects. Further development of middlepotential geothermal power **engineering** is connected with development of **new** technologies of extraction and utilization of that kind of waters.

Technology of simultaneously - separate obtaining of **fresh** low-thermal and **mineral** thermal waters by wells-heat exchangers is developed, which is given in **Fig.1**.

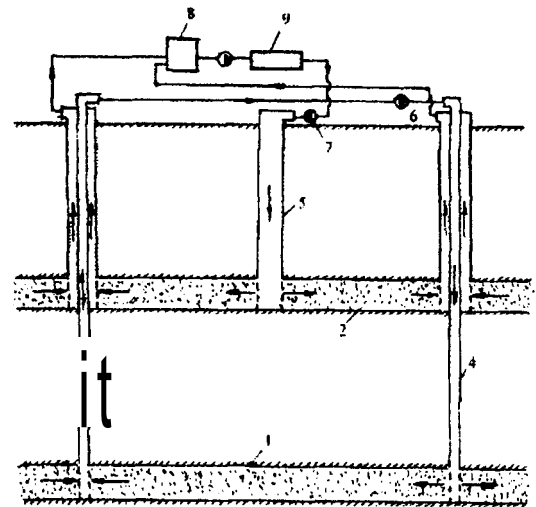


Fig. 1. Method of simultaneously-separate extraction of fresh low thermal and salt thermal water.

1,2- lower and upper **aquifers**; 3- producing well; 4- producing and injection wells; 5- injection well; 6,7- injection pumps; 8- thermoisolated tank, accumulator; 9- heat user.

Construction of geothermal circulating system consisting of 2 wells-heat exchangers will permit to transfer heat of thermal water, **lifting** from lower aquifer to **fresh low thermal** water of upper horizon the most completely. In such a technological scheme thermal water of lower horizon circulates by closed contour "stratum - productive well - surface piping - pump - injection well - stratum" Fresh low thermal water from upper aquifer **lifts** through annulus both producing and injection wells. For all this, part of well from bottom of upper stratum to wellhead in producing well serves by double-pipe heat exchanges, but in injection well - countercurrent heat exchanger.

Existing of favorable hydrogeological conditions all over the territory of flat Dagestan at simultaneous availability of problems of fresh water and utilization of deep heat of the Earth permit to develop that kind of production technology. Transfer of heat from, as a rule, high salt aggressive thermal water to fresh "cool" water is an important factor., leading to positive change of conditions and character of thermal water utilization as result of combined production of thermal and fresh water. Discussing possibility of transfer of thermal energy to fresh water direct in a well save from necessity of building of heat exchangers on surface, to increase effectivity of heat transfer because of significant extent of combined part of well reduces losses and probability of contact with oxygen medium and so on.

One of a high effective form of using of combined wells production is heat supply of agricultural and industrial complexes, where forms and scales of geothermal heat utilization occur unlimited. Building of winterized stock breeding complexes, heat supply and hot water supply of houses and factories with account for the great number. of labour resources, may be carried out on the basis of wells. simultaneously obtaining fresh low thermal and salt thermal waters

Using that kind of technology is very prospective in oil production when developing the fields with high viscous and wax-bearing crude oil. Development of that sort of fields without application of thermal methods leads to low oil recovery, complication of exploitation of wells by possible wax sedimentation in pump-compressor pipes flow lines, gathering lines and other oil-field equipment. Meanwhile many oil fields is spread by high temperature thermal aquifers. Construction of well-heat exchangers for combined-separate extraction of thermal water and oil will permit to do simultaneous heating of oil, lifting through annulus, that permit to prevent wax deposition from oil and to decrease its viscosity considerable.

Overheated high salt waters of mesozoic structural-hydrogeothermal stage are prospective for electric power production. with using of bicontour technological diagrams with low boiling working medium.

Number of technological schemes of geothermal power stations with downhole heat exchangers-evaporators have been elaborated [3].

In Fig.2 the technological diagram of combined steam turbine plant for electrical power and heat production is presented, which includes a geothermal circulating system, a system of secondary heat carrier and a cycle of heat pump.

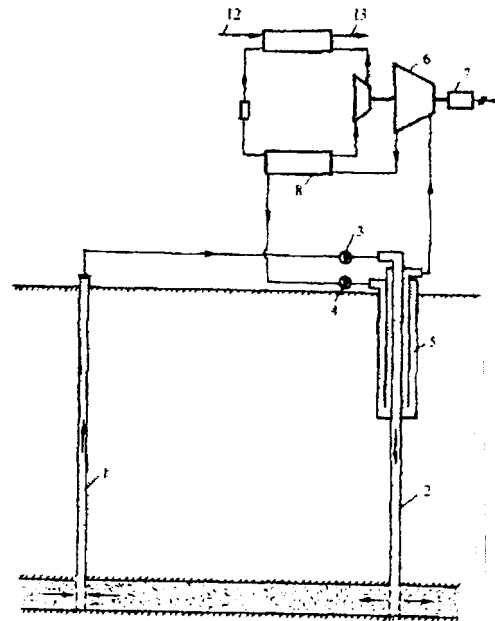


Fig 2 Combined steam turbine plant for electrical energy and heat production

1- producing well, 2- injection well. 3- injection pump of primary contour, 5- downhole heat exchanger, 6- turbine, 7- generator, 8- condenser-evaporator, 9- compressor, 10- condenser of a heat pump, 11- throttle valve, 12- admission of cool water, 13- tapping of hot water to consumers removal

High temperature thermal water, which is lifted through string of producing well to its wellhead, on surface through pipeline is brought up to injection pump and is reinjected through string of injection well back in the stratum. In the upper part of injection well the downhole double-pipe heat-exchanger is built in, where the waste heat-carrier from a turbine flows through the pipe, lowering in heat-exchanger annulus to its bottom from condenser of secondary heat carrier

When lifting through annulus the heat carrier is heated, evaporated and overheated. The overheated steam on the surface is brought up to the turbine, where, expanding, rotates the turbine, which, in its turn, puts generator and compressor of the heat pump, installed on the same shaft, into operation.

Condenser of the system of secondary heat carrier serves simultaneously as an evaporator for the heat pump. Low boiling refrigerant, circulating in closed contour of the heat pump, evaporating in the condenser, absorbs low potential heat of used in turbine steam. Compression of evaporated steam - refrigerant and increasing of its temperature occurs in compressor. Condensation of steam with removing of heat at high temperature occurs in condenser of heat pump, where the cool water is put in and heated

water is removed to consumer. After condensator of heat pump, refrigerant, moving through throttle valve reaches condensator-evaporator of the system of secondary heat carrier.

The important feature when building the geothermal power plant is selection of **working** medium in a secondary contour, which must combine favorable chemical physical and exploitation properties at given conditions of work, i.e. be stable, noncombustible, nontoxic, **inert** in respect to construction materials, and cheap. It is desirable to select the **working** medium with more low dynamic viscosity coefficient (hydraulic losses are less), **more** high thermal conductivity factor (heat exchange is improved). **All** these requirements is practically impossible to satisfy simultaneously, therefore selection one or another **working** medium it needs always to optimize. The most optimal among **known agents is isobutane and R-142b**.

Calculation analysis of cycles **with** using of different heat carriers in the secondary contour testify, **that** the supercritical cycles are the most **optimal**, to raise turbine capacity and cycle efficiency, to improve transportable properties of heat carrier and more completely using of the temperature of **initial** thermal water circulating in primary contour of the geothermal power station.

Evaluating calculations show that prognostic resources of high parametrical thermal waters of the Northern Daghestan plain are sufficient for building of thermal power plant with total capacity more than 1000 MWt.

Especial attention the geotechnological complex of high salt, high potential thermal water utilization deserves, including unit of **chemical** elements and mineral salt extraction, **and** unit of transformation of the thermal power in electrical, where electrical energy is used for own needs.

Rational integrated utilization of **high** potential brine thermal waters will beneficially influence economical indices of geothermal production and will raise essentially its competitiveness with other sources of raw materials and power.

Thus, widescale involving of low potential fresh, **middle** potential salt and high potential brine **thermal** water for satisfaction of Republic national economy requirements will lead to sharp change of structure of energy equilibrium and to improvement of ecological circumstance in the region, will permit to satisfy requirements of significant number of power users, will turn Daghestan in show region of **high** power efficiency.

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