TECHNOLOGY OF UTILIZE DESALINATION OF SEAWATER

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ABSTRACT

The technological schema of seawater desalination in two stages (reverse osmosis and thermal distillation) is offered and investigated. At a distillation stage it is offered to utilize waste heat of gas turbines plants. For prevention scale formation at desalination the method Na - cationite softening of seawater is used. Thus the cationite regeneration will be carried only by concentrate of a desalination stage. The accounts are executed on an example of gas turbines plant of a oilfield « Нефт Дашлары ». It is established, that all quantity of technical fresh water, which now is transported from a coast can be replaced on desalination water - distillate and permeate. It creates conditions for development of new manufactures and construction of thermal electrical station on the given object.

Keywords: desalination, seawater, technological schema, distillate, permeate

I.INTRODUCTION

Thermal desalination is one of the most effective widespread methods of preparation of additional water at thermal electrical stations. The experience of operation of thermal desalination plants is shown, what with the large share of the operational charges (~ up to 30- 40 %) are necessary on a heat component. A rise in prices on fuel and the natural decrease of its stocks limits an opportunity of increase of process efficiency thermal distillation. In these conditions become a actual problem of the maximal utilization of secondary power resources in the thermal schema of desalination. Agrees [1] specific power expenses of utilize desalination are estimated at 20-30 doll/MG. It approximately in 3 times is lower, than at desalination by reverse osmosis and 5,2 times - at dual-purpose thermal desalination. In power as secondary power resources represent practical interest emissions of combustion products of gas turbines, power boiler and systems of cooling of the power equipment.

The present work is devoted to investigate technology of thermal desalination of the Caspian seawater with utilization heat of gas turbines (GT) plants. The work is executed on an example of electrical GT station. Such station includes four GT plants and now is maintained on a oilfield « Neft Dashlari » of the Azerbaijan Republic

This oilfield in the sea and it is on some tens kilometers from coast. Existing desalination plant has low productivity and does not provide all needs for technical water. Therefore it is necessary to use significant quantity of fresh water, which transport from a coast by special tankers. The expenses for transportation of water are very high. The building of thermal electrical station on the given object also requires the decision of water problem.

II. BODY OF THE TEXT

The set of the specified circumstances makes actual creation of plant multi-purpose desalination complex with utilization of heat working gas turbines. The real preconditions for the decision of this problem are caused by that each of four gas turbines is equipped with the boiler - utilizes (BU), allowing to heat up water to 150-160 ^{o}C. However, because of absence of the thermal consumers of low potential, one BU practically is used only. In other BU combustion products with temperature 450 ^{o}C act and with same temperature leave it. These three boilers also can be used in the schema of utilize desalination of seawater. The accounts show, that the losses of heat with leaving gases on each boiler reach 38 %, and appropriate charge of waste heat - 6,7 MVt.

On considered object there is a need for technical fresh water, softening water, and distillate. The basic multi-purpose technological schema of desalination therefore is offered which is based on the following principles and processes:

- combination of stages thermal and reverse osmosis desalination with use of a residual concentrate of a stage reverse osmosis (RO) desalination for a feed of a stage thermal desalination (TD);
- organization of a circulating contour including the BU and flash evaporators at a stage TD;
- prevention scale formation on the surfaces of BU and membranes RO modules by preliminary Na-cationization softening of sea water. Regeneration Na-cationite

exchange of filters only own salt component of initial sea water (without using reagents).

According to the given schema the combustion products (2) of gas-air mix (1) after GT act with temperature 450 ^{o}C in the BU. Here temperature of gases is reduced up to 170-180 ^{o}C. From heater water in адиабатном evaporator it turns in the steam. The condensation of this stem is carried out in the special condenser, which is cooled by sea water on a line (3-4). Received distillate (5) is allocated as one of purpose product. The part of sea water acts on Na-cationite exchange softening. The preliminary clearing of sea water of mechanical impurity with input coagulant (6) in a line is provided. The part of softened water (7) is a purpose product and is directed on the technical needs. Other part of softened water acts on a feed RO module. Permeate of a RO stage (9) is the third purpose product. As it is visible from the schema a feed of circulating contour of thermal stage desalination is carried out by a concentrate of a RO stage. The opportunity of a feed of this contour by a mix of a concentrate and softened water (dashed line) is provided also. In a circulating contour (BU- flash evaporator) is supported salt concentrate ($NaCl+Na_2SO_4$) 80-120 g/l. It provides effective cationite regeneration with a solution, which is blown from this contour and is directed on Na-cationite exchange filter. For prevention organic deposits on RO membranes are used inhibitors (8). Inhibitors (10) are applied to maintenance of allowable values of metal corrosion speed on the TD.

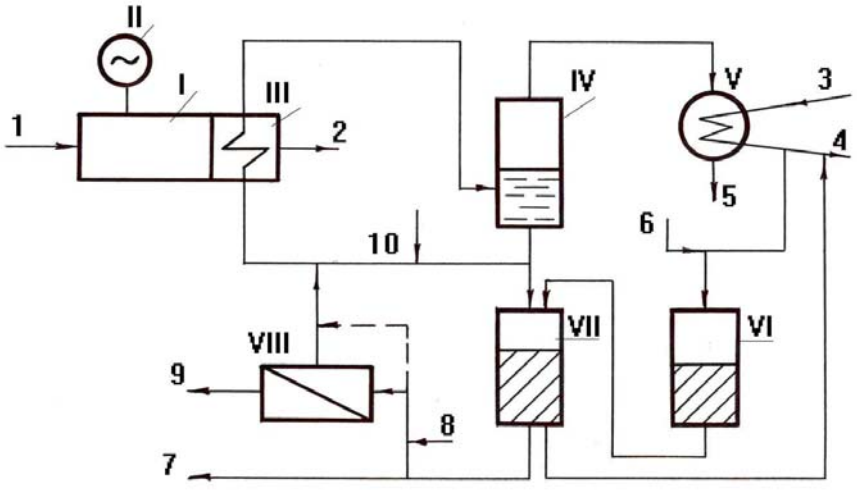
One of the main features of the offered technological schema consists in Na-cationization softening of sea water before desalination. This technology passed industrial application on one of thermal electrical stations of Azerbaijan Republic. The new method of cationite regeneration is developed. It allows carrying out effective regeneration using only 70-80 % of available salt (concentrate of process desalination) [2]. It is equivalent opportunities of a conclusion 20-30% of softening water on the technical purposes (on a line 7 agrees the scheme).

Mathematical model of the offered scheme is developed and investigated. Thus the following characteristics BU are taken into account:

- surface of heating - 550 м^2 ;
- recommended range of change of temperature of heating of water in the BU 140-160 ^{o}C;
- recommended range of change of the charge circulating waters 40-60 t/h (ton/hour).

In accounts the following initial data are used:

- ion content of water of the Caspian sea (mg-ekv/l): Sodium- 138; calcium - 16; magnesium - 60; chloride - 142; sulfate - 68; bicarbonate - 4; salt concentration ~ 12,8 g/l
- salt concentration of water in a circulating contour - 100 g/l;
- one-step schema RO module at selectivity of membranes 99 %;
- output of water desalination (conversion) at a RO stage 70 %;
- own needs of a mechanical clearing and softening stages of seawater 10 %.



The basic technological schema of multi-purpose plant desalination of sea water.
I - gas turbine; II - electrical generator; III - BU; IV-flash evaporator; V - condenser; VI - mechanical filter; VII - Na-cationite exchanger; VIII - RO module

In the table 1 the results of accounts of the technological schema are given. The accounts are executed for the minimal and maximal values of the charges of water in a circulating contour: 120 and 180 t/h (use of three BU) is provided. The variant of a circulating contour feed only by concentrate of a RO stage of the softening seawater is considered. As it is visible from the received results from 6,7 MVt be heat on each BU can utilized about 50 % (9,3:3). It allows to lower temperature of gases from 450 ^{o}C up to 170 ^{o}C. Thus the development

distillate will make about 9000 m^3 per month that completely will ensure modern needs of an oilfield for technical fresh water.

According to results of accounts the offered way of a stage combination RO and thermal desalination allows to receive permeate in quantity considerably exceeding distillate. It creates an opportunity for development new manufactures, including construction of thermal electrical station.

It is important to note, that the offered technological schema is rather floppy and allows at the maximal utilization of heat of gas turbines in a wide range to change the charge permeate. For this purpose it is enough to carry out feed of a circulating contour by a mix of a concentrate RO stage and softening water. By change a number of BU for the necessary practical purposes charges of all three products can be received.

In the table 2 the results of accounts of the technological schema for various ratios of a concentrate and softening water in feed water of thermal stage desalination are given. The account is executed for a case of using two BU. How it is visible from the received results by change α it is possible in a wide range to change the charges permeate and softening seawater. Thus the distillate charge remains constant of a condition of the maximal utilization of heat waste gases.

Table 1.Results of accounts of the technological schema multi-purpose utilize desalination of seawater

№	Parameters	Dimension	The charge of circulating water, t/h	
			120	180
1	Temperature of gases after utilization	^{0}C	183	170
2	The charge of utilization heat	MVt	9,3	9,8
3	Temperature of water after the BU	^{0}C	157	137
4	Temperature of water acting in the BU	^{0}C	86,2	91,6
5	The charge of distillate	t/h	11,8	10,8
6	The charge of permeate	t/h	47,5	43,8
7	The charge water from a circulation contour	t/h	8,8	8,0
8	The charge of softening seawater on a stage RO	t/h	68,1	62,6
9	The charge of softening seawater removed as a purpose product	t/h	13,6	12,5
10	The charge of seawater submitted on desalination	t/h	90	82,6

Table 2. Technological parameters of the desalination schema at various shares of a concentrate of a stage RO desalination in feed water of a stage TD (α)

№	Parametrs	α				
		0	0,25	0,5	0,75	1,0
1	The charge of distillate	7,2	7,2	7,2	7,2	7,2
2	The charge of permeate	0	5,3	11,7	19,4	29,2
3	The charge water from a circulating contour	1,0	1,9	2,8	3,9	5,3
4	The charge of feed water of a circulating contour	8,2	9,1	10	11,1	12,5
5	The charge of softening seawater mixing with a concentrate	8,2	6,8	5	2,8	0
6	The charge of softening seawater on a stage RO	0	7,6	16,6	27,7	41,7
7	The charge of softening water removed as a purpose product	1,6	2,9	3,5	6,1	8,3
8	The charge of seawater submitted on desalination	10,8	19,0	27,6	40,2	55

The note: dimension in t/h.

In the table 3 is given ionic contents of purpose products, which can be received under the offered technological schema. Ionic structure of permeate is designed according to a technique [3].

Table 3. Ionic contents of purpose products

№	Names	The contents of ions, mg-ekv/l						P, mg/l
		Na^{2+}	Ca^{2+}	Na^{+}	Cl^{-}	SO_4	HCO_3	
1	Distillate of a thermal stage of desalination	0,3	0	0	0,2	0,1	0	20
2	Permeate of RO stage of desalination	3,67	0	0	2,43	1,116	0,07	230
3	Softening seawater	214	0,003	0,015	142	68	4	13540

P- salt contents

III. CONCLUSION

Thus, utilize desalination are an effective way of manufacturing technical water at the enterprises, which have secondary power resources. On an example of a oilfield «Нефт Дашлары» is shown, that utilize desalination solves a problem of water, creates conditions for development new manufactures, and also construction of thermal electrical station.

According to integrated technical - economic accounts of an expense on seawater desalination with use of waste heat GT do not exceed 20 % from expenses for transportation of water from a coast. In the ecological attitude the offered technology can be referred to the category most perfect. Practically in the sea are dumped only own salt components of initial water. The extreme allowable concentrations on separate components are easily reached by the dispersed dumped of drains in the sea.

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