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Desalination in Algeria: Current situation and development programs

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ABSTRACT

Algeria, like other southern Mediterranean countries, is enduring water shortage which will get worse over the few next years. Algeria is known as the country most severely threatened by water stress and scarcity by early 2020. One of the important factors exacerbating this problem is the concentration of three quarters of the inhabitants and consequently the industrial and agricultural activities along the 1200 km coastal zone, which has led to an increase in the pollution of the existing water resources. Droughts due to climate change and pollution are the most important factors destabilizing the existing balance. Therefore, the desalination of sea water can provide a solution to one of the most urgent and vital and problems, of balancing and enhancing water resources, as the wide variation of rainfall, from more than 2000 mm/y in the north coastal region dropping to less than 100 mm/y in the southern Sahara, should be taken in account. Given these circumstances, we will focus on the need for desalination, the desalination program, and also the strategy and the vision of desalination in addition to other non-conventional water resources that might guarantee the optimum conditions for integrated management and sustainable development.

Keywords: Desalination; Vision, Strategy; Algeria; Management

1. Introduction

Algeria, with more than 30 million inhabitants, is located in a semi arid region, and is increasingly confronted with the problem of the scarcity of water. This North African country is characterized by irregular rainfall with a generally variable pattern of distribution. For example: the eastern region receives more than 2000 mm/y, the western region less than 400 mm/y, whereas the Sahara or southern zone, which represents over three-quarters of the country, receives less than 100 mm/y. Of the 100 billion m^3 representing the yearly rainfall received by the whole country, only 12.5 billion m^3 flow out through the rivers and wadis.

Furthermore, the quantity mobilized for dams and wells is even lower: about 4.5 billion m^3, several problems have to be taken into account to understand this poor efficiency level; the silting up of dams, the poor management of existing resources and pollution. The quantity of water effectively mobilized is thus much reduced. Algeria is ranked 6th among countries suffering most severely from water shortage, and it will jump to 4th place by the year 2025 if no suitable overall approach to the problem is adopted [2]. Seawater desalination could therefore be

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an alternative be one solution for a country such Algeria which has 1200 km of coastline on the Mediterranean Sea.

The first desalination plant was built in 1964 (just after independence) at Arzew (western Algeria), with a capacity of 576 m^3/d, using a multiple effect distillation process (submerged tubes, low pressure) to meet the needs of the petrochemical facility. The population was then less than 12 million.

The second desalination plant was built in 1980, at Mostaganem (western Algeria) and was then the world's largest reverse osmosis plant, with a capacity of about 57,600 m^3/d [2].

Now, there are 56 desalination plants in operation, with a capacity of about 146,000 m^3/d. All types of membrane and thermal desalination technologies are used.

Various agencies are involved in the construction of desalination plants (management and exploitation): the Ministry of Water Resources (represented by the Algerian water agency: ADE), SONATRACH (National Oil Company), SONELGAZ (National Electricity and Gas Company), the Algerian National Energy Company (AEC), set up recently by SONATRACH and SONELGAZ), the private sector company TONGO, and others.

The drought that hit the country in 2001 induced the government to establish a priority program for desalination (feasibility study, site selection, plant construction):

- *Drinking water sector:* A vast and very promising action program was launched in 2001. The Ministry of Water Resources plans to set up 104 plants for the production of drinking water with a total capacity of 2 million m^3/d by 2009 (representing about 6% of global world capacity); 15 of these plants have been put into operation since October 2003.
- *Industrial water sector*: A program is currently in progress, under the supervision of the Algerian Energy Company, to build three major plants, producing a total throughput of 360,000 m^3/d for industrial needs.

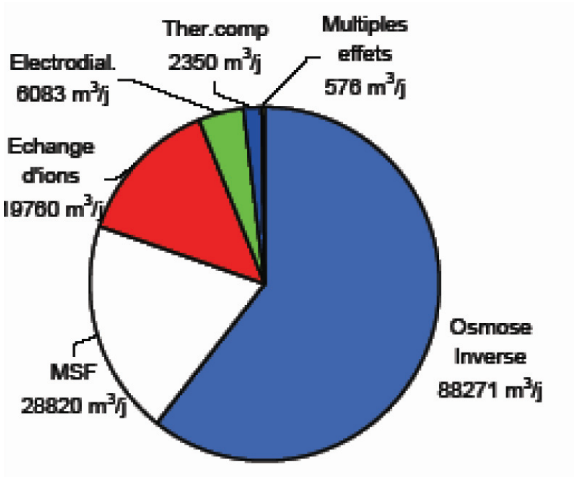

Fig. 1. Production capacity of the various technologies.

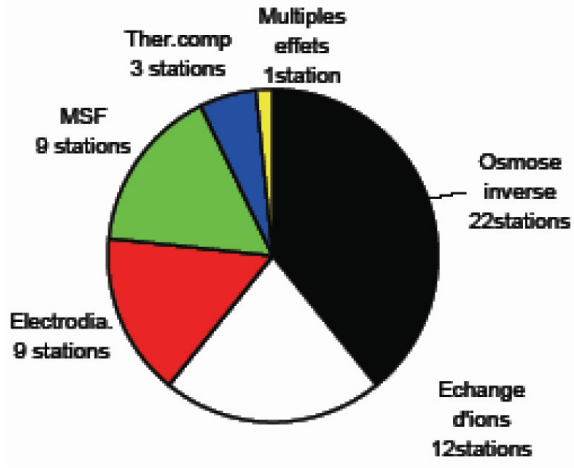

Fig. 2. Number of plants using the various technologies.

2. Existing plants

Of the 56 plants completed, 22 of them use reverse osmosis based technology, and produce more than 60% of the capacity (Figs. 1 and 2).

2.1. Plants managed by the Ministry of Water Resources

The only desalination plant built under the supervision of the Ministry of Water Resources (Ministry of Hydraulics at the time) is a brackish water reverse osmosis plant, commissioned in 1981, in Ouled Djellel (Biskra) [2], with a capacity of 864 m^3/d. This plant supplies drinking water for the inhabitants of this city.

2.2. Plants managed by SONELGAZ

Within the aim of power generation and taking into account the shortfall and the poor quality of the water distributed in the drinking water networks, SONELGAZ has included in each of its new power plants seawater desalination units.[3] (Table 1)

2.3. Plants managed by SONATRACH

At start up time, the Mostaganem plant built under the supervision of SONATRACH with a capacity of 57,600 m^3/d was considered as the world's largest plant. SONATRACH is in fact considered to have the greatest experience in the field of desalination, as well as owning the largest number of stations built from 1964 to 1982.

Their overall capacity is estimated at 107,401 m^3/d, produced by means of different technologies (MSF, ion exchange, reverse osmosis, electrodialysis, thermocompression, multiple effect and distillation), with highly variable water supply quality (seawater, charged dam water, brackish underground water (Table 2) [2].

Table 1
Plants operated by SONELGAZ

Station	Capacity (m^3/d)	Technology	Start up year
Mers el Hadjadj	1500	Thermo compression	1977
Mers el Hadjadj	2000	MSF	1991
Mers el Hadjadj	500	Thermo compression	1989
Cap Djinet	2000	MSF	1985
Jijel	2000	MSF	1992
Jijel	500	RO	1992

Table 2
Plants operated by SONATRACH

Station	Capacity (m^3/d)	Technology	Start up year
Arzew	576	MED	1964
Arzew	4560	MSF	1969
Skikda	1440	MSF	1971
Skikda	720	MSF	1971
Skikda	1440	Ion exchangers	1971
Annaba	960	Ion exchangers	1971
Annaba	3600	Ion exchangers	1973
Ghazaouat	840	Ion exchangers	1974
Arzew	3888	ED	1975
Arzew	960	Ion exchangers	1975
Hassi Messaoud	1000	ED	1975
Hassi Messaoud	110	ED	1976
Gassi Touil	55	ED	1977
Arzew	350	Thermo compression	1978
Annaba	14180	MSF	1978
Hassi Messaoud	350	ED	1978
Bel Abbes	1500	Ion exchangers	1978
Haoud Berkaoui	55	ED	1979
Hassi Messaoud	300	ED	1979
Rhourd El Baguel	25	ED	1979
Arzew	960	MSF (5 stages)	1979
Annaba	144	Ion exchangers	1979
Annaba	576	Ion exchangers	1979
Hassi-R'mel	792	RO	1979
Annaba	6240	Ion exchangers	1980
Ghardaïa	960	RO	1980
Arzew	960	MSF (6 stages)	1980
Mostaganem	57600	RO	1980
Rhourd El Baguel	300	ED	1981
Annaba	1800	Ion exchangers	1981
Reghaia	160	Ion exchangers	1982

MSF: multi stage flash, MED: multiple effect distillation, RO: reverse osmosis, ED: electrodialysis

2.4. Plants operated by other companies

Small plants have been built by private sector companies to meet production needs, such as the station built by TONGO in Rouiba, Algiers (production of alcoholic beverages), producing at a rate of 1500 m^3/d (Table 3).

Table 3
Plants operated by other companies

Campany	Locality	Capacity (m^3/d)	Process	Realised (built) by	Start up year
TONGO	Rouiba	1500	Ion exchangers	Chriwa, Germany	2000
Brewery: la Bavaroise	Annaba	35	RO	Chriwa, Germany	2000

2.5. Experimental plant of the Centre for Renewable Energies Development (CDER)

The experimental station at Hassi Khebbi (Béchar), with a capacity of 20.4 m^3/d, operated by reverse osmosis, and solar-powered, is destined for the desalination of brackish water with a salinity of 3.5 g/L, in order to supply drinking water to the locality of Hassi Khebbi, with a population of 800 [4]. The plant is designed to work at a conversion rate of 31% and under a pressure of 12 bar. This plant which was built in 1975 is currently not operating because of maintenance problems.

3. Government desalination program

3.1. Drinking water sector [5,6]

3.1.1. For immediate realization

23 small mono-block plants, with a total capacity of 57,500 m^3/d are being built as part of an emergency program launched in the summer of 2001, in the Wilaya of Tlemcen, Oran, Tipaza, Algiers, Boumerdes, Skikda and Tizi Ouzou (Fig. 3).

3.1.2. Research facilities

A study on desalination has been undertaken based on a selection of 23 sites.

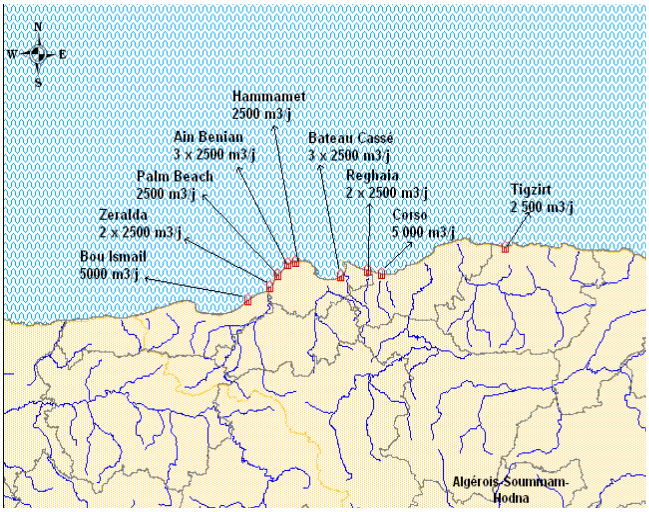

Fig. 3. Distribution of mono-block plants.

A selection of 4 major desalination plants with a total production capacity of 360,000 m^3/d have been included in the 2003 program and construction has already started. These plants have been chosen for the four big coastal cities currently facing a scarcity in drinking water: Ain Témouchent (100,000 m^3/d), Bejaia (100,000 m^3/d), Tenes (60,000 m^3/d), and Annaba (100,000 m^3/d).

Pending the results of this study, the Ministry of Water Resources has examined three sites) for planned desalination units on the Algeria coast:

- *Scenario 1*: Incorporation of coastal cities. 42 conurbations (6 million inhabitants), the total need by 2010 will be around 1,200,000 m^3/d. To meet the shortfall, it is intended to build 16 adaptable stations.
- *Scenario 2*: Towns less than 30 km from the sea and at an altitude of less than 300 m. 193 conurbations (9.75 million inhabitants), with a total need by 2010 of 1,950,000 m^3/d. To meet the shortfall, it is necessary to build 28 adaptable stations.
- *Scenario 3*: Cities located 60 km from the sea and at an altitude of less than 300 m, 235 conurbations (10.5 million inhabitants), with a total need by 2010 of 2,100,000 m^3/d, to meet the shortfall it is necessary to build 34 adaptable stations.

3.1.3. Program for construction of desalination plants

The aim is to reach 2 million m^3/d by building 26 desalination plants on the Algerian coast, from east to west. This project will produce an annual supply greater than that provided by the biggest dam in Algeria (Beni Haroun), which was intended to supply drinking water to 5 prefectures (Wilayas) through a giant transfer system. Details are presented in Table 4.

3.1.4. Status of projects: end of October 2003

15 stations have already been commissioned; the overall capacity is about 27,500 m^3/d. It is planned that the program will include construction of a desalination station of brackish water of Bredeah groundwater (Oran) with a capacity of 51,840 m^3/d. This brackish water carries a salt load of about 10 g/l.

3.2. Industry

The current policy of the Algerian government [1] is to use the underground water resources exclusively for human consumption and agriculture; desalinated water

Table 4
Plants planned by the Ministry of Water Resources

Prefectures (Wilaya)	Locality	Capacity (103 m^3/d)	Start up year
Alger	Hamma	2×100	2005
A.Témouchent	Béni Saf	100	2005
Béjaia	Béjaia	100	2005
Alger	Bordj El Bahri	100	2006
Chlef	Ténes	100	2006
Mostaghanem	Mostaganem	100	2006
Oran	Oran	2×100	2006
Tlemcen	Marset Ben M'hidi	25	2006
Boumerdès	Cap Djenet	25	2006
Tizi Ozou	Azzefoun	25	2006
Skikda	Skikda	100	2006
Annaba	Chétaibi	25	2006
Et'TARF	Echatt	25	2006
Tipaza	Bou Smail	100	2007
Chlef	El Marsa	50	2007
Oran	Marset El Hadjadj	100	2007
Tlemcen	Ghazaouet	25	2007
Annaba	Annaba	100	2007
Alger	Zeralda	100	2008
Mostaghanem	Sidi Bel Attar	50	2008
Oran	Ain Turk	100	2008
A Témouchent	A Témouchent	50	2008
Boumerdès	Corso	100	2008
Béjaia	Aokas	50	2008
Djijel	Jijel	50	2008
Et'Tarf	El Kala	50	2008
Total	26 stations	2050	

is used to meet industrial water needs for two reasons: underground water is of better quality compared to other types of water, and unlike other sectors, industry can afford the cost of desalination.

The recently set Algerian Energy Company has already begun the construction of three major plants producing a total capacity of 360,000 m^3/d; the largest one is at El-Hamma (Algiers) producing 200,000 m^3/d (Table 5).

Table 5
Plants planned by the Algerian Energy Company

Station	Capacity (m^3/d)	Technology
Complexe Kahrama-Arzew	88,880	MSF
Manufacturer HWD-Hamma	200,000	RO
Manufacturer ADS-Skikda	100,000	RO
Manufacturer BWC-Béni Saf	200,000	RO
Manufacturer SMD-Cap Djinet	100,000	RO
Manufacturer MT Fouka	120,000	RO
Manufacturer STMM-Mostaganem	200,000	RO
Manufacturer MBH-Honaine	200,000	RO
Manufacturer Souk Tlata	200,000	RO
Manufacturer El Tarf	50,000	RO
Manufacturer Macta	500,000	RO
Manufacturer Ténes	200,000	RO
Manufacturer Oued Sebt	100,000	RO

4. Conclusion

The current governmental program for the construction and operation of desalination plants (small, medium and large plants of various capacities) is on a vast scale: the aim is to produce 2 million m^3/d of desalinated water for 6 years (until 2009) for domestic needs, and 360 thousand m3/d for industrial needs.

It is also necessary to recognise the importance of the budget to ensure the necessary financial means for the maintenance of the old plants and the training of operators, to improve their management, since many of them are currently not in operation [7,8].

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