

A Multiple Effect Parallel Feeding Desalination Plant using Solar Energy Heating

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Abstract

In this work we present a study on a desalination unit for seawater, it has evaporators with horizontal tubular floating pipes working with thin film water spray. Energy was provided by hot water at 85°C, harnessed by flat plat solar collectors. Energy and mass balances equations were used to simulate the system and an iterative method was employed to solve the set o equations.

Keywords: Seawater desalination, multiple effect evaporation, parallel feeding, solar energy heating

Introduction

The Northeastern region of Brazil is formed by the states of Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Piauí and Ceará. All those states have access to the sea and the coastal regions are served by regular rainfall. But the inland have the lowest annual rainfall in Brazil, as one can observe in Figure 1.

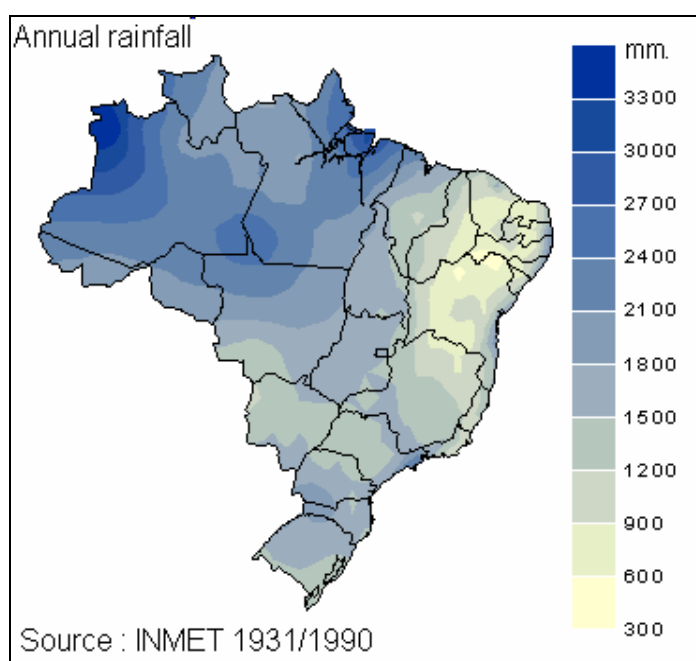


Figure A1 – Annual rainfall in Brazil

The only large and perennial river in the region is the São Francisco River, which is not long enough to reach the entire region. It is the only river that can support hydroelectric power plants, in the region.

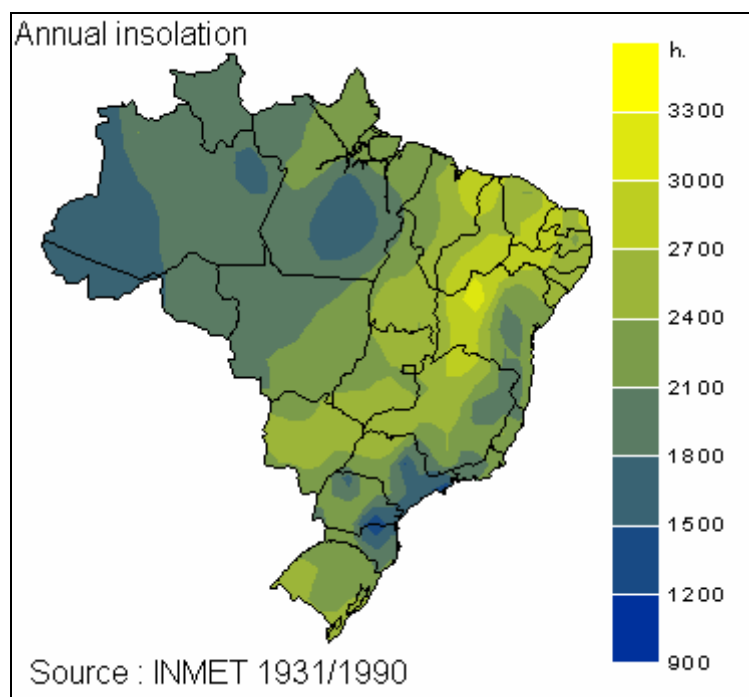


Figure A2 – Annual insolation in Brazil

Less rainfall means less clouds and much longer insolation as shown in Figure A2, and much higher solar radiation as indicated in Figure A3 (Colle et al. , 1998)

The region that presents all these shortcomings is called ‘ The Drought Polygon’; severe droughts can occur, lasting 2 or 3 years. It can be seen as a yellowish area in Figure A1. Potable water is obtained from dams and wells, the later ones used mainly by small communities and villages, in rural areas. Table A1 shows the number of existing wells and its TDS content, in the Northeastern Brazil (Ministério de Minas e Energia, 2003)

Number of Wells	TDS (mg/L)	% of wells	Water quality
3851	$c < 500$	25.1	Potable
5120	$500 \leq c \leq 1500$	33.4	Unfit
6367	$c \geq 1500$	41.5	Unfit
15338	Total wells		

Table A1 – Number of wells and TDS in NE Brazil

The data in Table A1 shows need of water desalting process for small communities in rural areas of Northeastern Brazil.

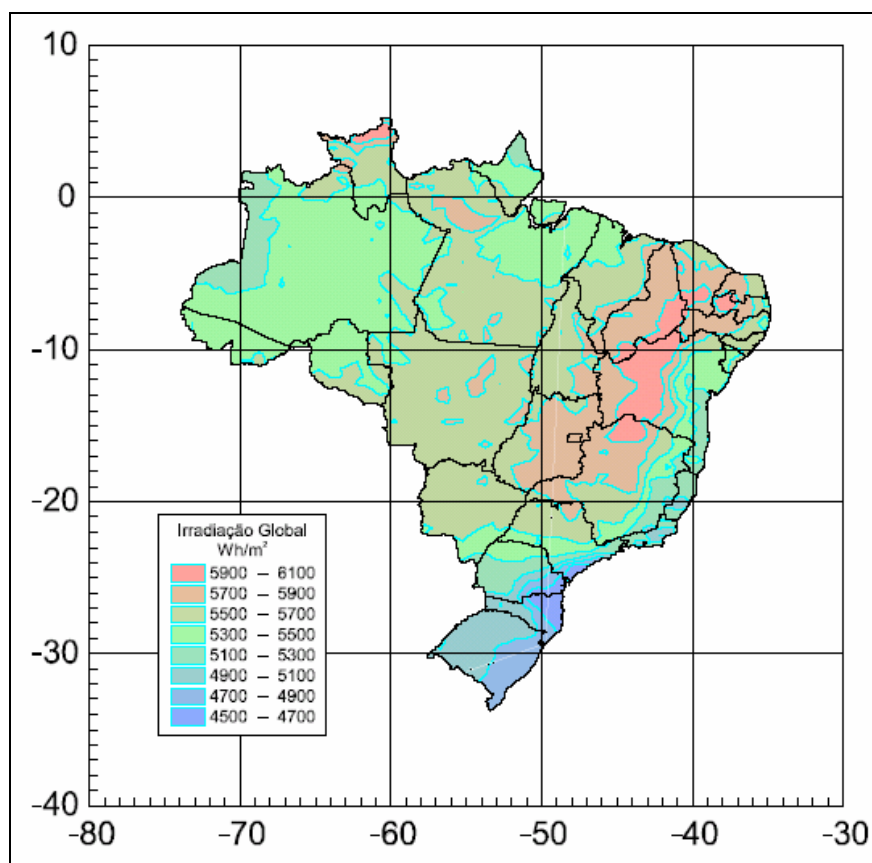


Figure A3 – Global solar radiation in Brazil

Multiple Effect Evaporator Systems

In the Middle East desalted water is obtained from the sea using multiple effect evaporators systems, heating energy is supplied from oil and gas. Multiple effect evaporators are used mainly for its energy saving characteristics, when compared to a single evaporator. Salt solutions and temperature have a synergic corrosive and scaling action on metal equipment; so maximum temperature in the system should be 70°C and maximum salt concentration 7 % (w/w).

The most common multiple effect evaporator system used for water desalting is the multiple stage flash (MSF); chosen because of its good performance concerning corrosion and scaling problems; but it demands a high number of evaporators.

A new system with parallel feeding and heat exchanger made of floating bundle of tubes kept above the concentrated salt solution, minimizes corrosion and scaling problems, and save energy in the feed pumping system. The feed is sprayed on top of bundle of tubes, forming a thin film and preventing formation of scales and corrosion. Besides the 3 first evaporators (presenting higher temperatures in the system) have tubes made of aluminum or titanium.

• Figure A4 - Multiple-evaporator parallel feeding system with solar energy heating

