Desalination

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Reprinted 2017

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Introduction

a. Water availability
b. Resource requirement
c. **Thesis**: Desalination of saline water offers optimal solution to the provision of safe water for human consumption and agriculture in arid regions that would otherwise become uninhabitable.

I. Background
   a. The desalination process
      1. Distillation method
      2. Membrane method
   b. Legal and regulatory framework

II. Advantages of desalination
   a. Pros of the distillation method
   b. Pros of the membrane method
   c. Benefits of desalination

III. Disadvantages of desalination
   a. Disadvantage of distillation method
   b. Disadvantage of membrane method
   c. Challenges of water desalination

IV. Cost-benefit analysis of water desalination
   a. Factors supporting decision for water desalination
   b. Factors negating the development of water desalination

V. Conclusion
   a. Review of major argument for and against desalination
   b. Restatement of thesis.

VI. References

Accessibility to clean and safe water for consumption is a basic need not only for drinking but also for agricultural purposes. Most developed countries have developed comprehensive legal and regulatory frameworks that ensure there are constant provisions of safe water for human consumption. While such countries have enough water for human consumption and for use in agricultural development, there are regions that do not have access to safe water. The shortage of safe water in some areas is caused by the lack of adequate resources, if any, for the provision of water for consumption. In regions that do not have access to fresh water, desalination units can have significant benefits through conversion of saline water into safe and fresh water for consumption.

Water is often classified on the basis of its salinity levels that can range from fresh to saline, hence determine the method and scope of its use. In areas that have high concentrations of saline water, a desalination plant may be required for constant production of fresh water from brackish or seawater. Larger desalination plants are often created in countries that have adequate energy sources and that incur minimal costs. The desalination of saline water is the ideal solution to providing regions with inadequate fresh water with enough safe water for human consumption and agriculture (Clayton, 2015; Elimelech, 2012).

The various processes in desalination include “intake, pretreatment, desalination, post-treatment, and concentrate management” (Anderson et al., 2008). The intake process involves the extraction of saline water at source and transporting it to the desalination plant for processing. The pre-treatment process involves removing unwanted solid objects through a filtration process. In addition, the pre-treatment process may involve the management of any pathogens that may be in the water. Meanwhile, the desalination process ensures that all salt is removed from the water, and the post-treatment process is taken through addition of chemicals that ensure corrosion is prevented as the water travels through the piping infrastructure. The concentrate management process is the final stage, where water residuals are handled, disposed and reused (Clayton, 2015). The desalination process often involves two major methods that include the membrane and distillation methods.

The distillation method of desalination uses heat, hence, the reference to thermal desalination, considering that thermal energy is required for the evaporation of water. Thermal distillation can be either “a multi-stage flash distillation” or “multiple-effect distillation” (Yarnal et al, 2009). The membrane desalination process involves the separation of water molecules from any solids that have dissolved in it without evaporating the water. For instance, membrane desalination may involve “electro-dialysis reversal or reverse osmosis” (Yarnal et al, 2009). In situations where energy consumption is a concern, the reverse osmosis process is preferred. Thermal and membrane desalination processes often require heavy capital outlay and operation costs (Anderson et al., 2008). It is prudent to undertake a project costs assessment to ensure that the construction of a desalination plant is not interrupted. Since such projects are associated with numerous fiscal and financial risks, most countries are unable to develop such plants.

Some countries prefer finding alternative sources of fresh water that are cost effective, considering that they may not have adequate economic strength to finance large desalination plants. Solutions such as boreholes and the use of tankers to deliver fresh water have been used in various parts of the world. However, these methods are often inadequate to sustain human consumption and agricultural needs.

There are numerous benefits that are associated with the desalination process. It ensures that areas that do not have access to clean and safe water for human consumption can get it without struggling. The desalination plants are ideal for the production of clean drinking water, especially in areas that do not have natural fresh water resources. The desalination process ensures that the water is subjected to various treatment processes that ensure that the water is safe and cannot harm any human being or animal after drinking it. Similarly, the water can be used for irrigation since saline water cannot sustain farming.

A large percent of the world's population lives in arid or semi-arid areas, including deserts that do not have access to fresh water. Since such countries may have access to the oceanic coast line, it is possible to ensure that the people are provided with clean water. Water is the most critical resource for social and economic development in any given region; the accessibility to water in regions that have suffered long dry spells that result in drought can benefit from desalination plants. The benefit of such desalination plants in these regions is that it reduces mortality rate and environmental degradation as the limited water resources available are stretched beyond their capacity. Therefore, desalination plants have the impact of bringing water to communities and promoting positive economic growth. Since the natural sources of fresh water, including rain, have become unpredictable, the development of desalination plants ensures that there is consistent and regular water supply irrespective of weather and climatic conditions (Ackerman, 2017). Therefore, in periods when there is water shortage, desalination plants offer an alternative source of water.

The quality of water that is produced through the desalination process is of a higher quality that often exceeds expected standards. In addition, desalination plants have the capacity to reduce the pressure that is often put on available freshwater resources, especially those that have ecosystems that need protection. Therefore, sourcing water from the sea ensures that such natural resources and ecosystems are adequately promoted, resulting in positive environmental development.

The two major desalination methods have their individual benefits, including the fact that thermal distillation ensures that the water does not contain any harmful organisms that could cause health problems to those who drink it (Gilani, 2017). Meanwhile, the membrane desalination method eliminates the need for heavy energy costs as is the cost of the thermal distillation method. The membrane desalination approach is resource effective, leading to enhanced economies of scale.

The main disadvantage of desalination is the high cost factor. A significant amount of capital outlay and operational costs are required for the development and operation of desalination plants that are capable of producing adequate amounts of fresh and safe water for human consumption in a given area. The creation of desalination plants may incur huge sums that may amount to billions prior to beginning operations (Ackerman, 2017).

Thermal distillation plants require high operational costs since more energy is needed to distill saline water. Therefore, there is a probability that almost fifty percent of total costs incurred by desalination plants will involve the cost of energy. Any changes in the energy market can have significant implications to the operational costs of desalination plants, especially in the event of a general increase in global energy costs. Similarly, membrane desalination process incurs high operational costs, considering the various processes in separating water molecules from any solids that may have dissolved in it.

In the various processes involved in the desalination process, water products are produced that need to be disposed. These chemicals and waste products generated during the purification process, including chlorine, hydrochloric acid, carbon dioxide and salt deposits, may have negative environmental implications. The disposal of the resulting brine is a major issue, especially considering that it can alter water salinity and reduce oxygenation levels in water in the site where it is disposed. The disposal of waste materials may have a negative impact on the environment since it may lead to the destruction of ecosystems that include animal and plant life.

A cost benefit analysis aims to determine whether the development of desalination plants is economically viable and worthy of investments. The lack of fresh and safe water has numerous implications for the survival of human beings and sustainability of agricultural activities. A comprehensive assessment of the availability and potential agricultural uses of fresh water is required prior to the development of the desalination plant (Miller, 2003). A cost analysis of the capital investment required to make a desalination plant operational should be conducted. Since the availability of fresh water means that communities can grow economically through increased agricultural production and development of a sustainable business environment, the costs are justifiable.

However, while the initial investment costs for the development of desalination may be a one-time cost, there are other recurring operational costs that include energy and plant maintenance costs ("Water Desalination," 2012). The cost of energy has been noted as among the major challenges facing desalination plants. In addition, negative outcomes that may impact the community, such as the fact that environmental issues associated with the disposal of waste materials must be considered, especially in view of animal and plant life that may be endangered.

It is evident that the benefits of desalination plant exceed the costs. The development of such plants often occurs in areas that do not have adequate fresh water resources, if any; therefore, the provision of fresh and clean water contributes towards saving human lives that are invaluable and promoting agricultural activities towards the production of products for the local and international market. While desalination plants have high operational costs associated with energy, they benefit the community through creation of jobs and economic activities that enhance individual incomes in the region.

The lack of fresh water can have severe impacts on people and result in a deteriorating agricultural industry. While developed countries have the resources needed to provide people with fresh water, especially through development of comprehensive desalination plants, poorer countries may not have the capacity to create and sustain such plants, hence, the increase in the number of drought incidents, high mortality rates and poverty in developing countries. Viable solutions for the provision of fresh and clean water, such as desalination plants are often discarded as a result of the high operational costs. However, the cost benefit analysis indicates that there are more benefits to ensuring that a country has adequate fresh water supply for human consumption and economic development through agricultural activities. Desalination plants offer lasting solutions to regions that do not have access to fresh water through conversion of sea water into fresh water.

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