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**Project Title:**

Future study of the synthesis of polymer membranes used in the reverse osmosis process

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**Project Necessity:** The increasing water consumption and the reduction of water resources in the country have caused the issue of water recovery and treatment in recent years to receive special attention. Desalination plants are one of the technologies that can be used to purify and recover water. Multi Stage Flashing (MSF), Multi Effect Desalination (MED) and Reverse Osmosis (RO) desalination are the three main processes known in this field. Among them, reverse osmosis has been the most used in recent years. In recent years, the role of the reverse osmosis system in water treatment has increased dramatically. This shows the importance of using this system in water treatment and supply for various industries, including power plants. In addition, the issue of drinking water supply through this system can help reduce the shortage of fresh water resources.

**Project Goals:**

- Study and study of types of polymers used in reverse osmosis process
- Study and recognition of various methods of synthesis of polymer membranes used in reverse osmosis process and introduction of the optimal method
- Collection of reverse osmosis process information from the country's power plants
- Documenting, summarizing and statistical conclusions and analyzing the data received from the power plant industry and examining the future of this process in the country

**Abstract:**

The issue of water quality and consumption in the power plant industry is very important. Due to the high pressure and temperature of steam in various components of the steam turbine as well as the circulating water in the steam

cycle system and converters, water quality is very important. The presence of impurities can damage the turbine blade or cause corrosion in various parts of the cycle (heat exchangers, drums, tanks and communication pipes). The presence of any impurities from the ion group can damage the cycle and the turbine. Therefore, purification of incoming water and recovery of cycle water consumption is very important.

The reverse osmosis process is one of the desalination systems that in recent decades has been highly regarded by craftsmen and researchers to supply ion-free water. This process has many advantages compared to thermal methods, including high efficiency and effectiveness, cost-effectiveness, easier maintenance, easier operation and more help to protect the environment. . The use of this process has been growing in recent years, which is especially evident in the Middle East.

Osmosis is a natural process in which water can flow through a membrane without the need for energy. But to create flow in the opposite direction, it is necessary to apply pressure to salt water. A reverse osmosis membrane is a semi-permeable membrane that allows water molecules to pass through, but prevents the passage of substances such as soluble salts, organic matter, bacteria, and so on. To pass water through this membrane, it is necessary to create more pressure than osmosis pressure (due to the difference in the concentration of solutions on both sides of the membrane). At this pressure, water passes through the membrane and the salts and ions dissolved in it do not pass through the membrane.

Reverse osmosis technology has developed a lot in the last 40 years, especially in the water production industry. This process is physical and the pollutants are removed under the pressure. In addition, the membrane has the ability to remove very fine contaminants and monovalent ions from water. Therefore, in the application of reverse osmosis membranes, removal is based on the size and electrical charge of the particles.

The cost of reverse osmosis water treatment includes the following three aspects.

Initial investment, membrane replacement, cost of energy (electricity) and chemicals.

The cost of reverse osmosis also increases with increasing salt concentration, but the rate of increase is lower compared to electro dialysis. Reverse osmosis is a low-cost process in cases where the total soluble solids (TDS) in the feed is between 10000-3000 ppm.

The most important features of reverse osmosis water treatment are three:

- 1- Reducing the time of water purification and recovery operations
- 2- Low space required for construction of water treatment unit
- 3- Low costs (such as investment and operation) of reverse osmosis system

The reverse osmosis process consists of four main stages: pretreatment, pressurization, separation, and stabilization. In the pre-treatment stage, to prevent damage to the membrane, the suspended solid particles are separated, the pH is adjusted and anti-fouling is added. In the pressure application stage, more pressure than osmosis pressure is applied to the fluid by using a pump. In the next step, the separation is done using a membrane in which water-soluble salts are separated and only water molecules pass through the membrane. The last step is stabilization, which usually requires pH adjustment and degassing, after which water is sent to storage tanks.

The main technological part of the reverse osmosis process is the membrane. Membranes can be made of two types, porous and non-porous. In porous membranes, the separation basis is based on particle size, and the size of the pores in the membrane can prevent particles larger than the cavities from passing through. But non-porous membranes contain compressed films that cause separation of pressure, concentration, and electrical potential. In porous membranes, porosity dimensions play an essential role in determining the separation characteristics and the type of membrane material is important in its chemical, thermal and mechanical stability, but in non-porous membranes, the type of material determines how it separates. There are two main models of reverse osmosis membranes in the form of hollow fiber and spiral wound.

The most important materials used in membranes are organic materials such as polymers or macromolecules. The choice of polymer type for membrane construction is based on various criteria such as thermal, chemical and mechanical properties of polymers as well as parameters that affect the permeability of polymers. The choice of the type of polymer used in the manufacture of non-porous membranes (dense) is of great importance. Because the choice of polymeric materials directly affects the membrane performance and especially the glass and crystal transfer temperature, which are important parameters in membrane performance. The most important polymers used in reverse osmosis membranes are cellulose acetate, polyamides and thin film polymer composites.

Summarizing studies on domestic research shows that in most cases, reverse osmosis membranes are sourced from external sources. In cases where membrane synthesis has taken place, conversion of the membrane to the pilot stage has not been reported. In general, in universities and research and production institutes, many reports have been produced on the reverse osmosis process, but unfortunately, no group or company has yet been able to make the production of reverse osmosis process membrane industrial or semi-industrial. In other words, all reverse osmosis

membranes are imported in the country and only in one or two companies after importing reverse osmosis membranes, the process of modulation and assembly of the membrane system is done. Therefore, it seems that conducting a comprehensive study on the types of polymers used in reverse osmosis membranes in the country is critical. The results of this study can be used as a beacon in the field of production and localization of membranes used in the reverse osmosis process. Summarizing the results of this research can summarize the problems facing the production of reverse osmosis membranes in the country so that in the future the field of production of these membranes in the country can be created.

In this project, an attempt is made to conduct a comprehensive and comprehensive study on various types of reverse osmosis polymer membranes. All research sources inside and outside the country will be considered as research references. In summarizing the research results, it is tried to select the most important polymers used and their manufacturing and synthesis methods. This section aims to create a basis for localization of these types of membranes. Also, during the project, several units with reverse osmosis process will be visited and the latest situation of membrane supply in the country will be reported so that the target market of these membranes and their future consumption in the country's industry will be evaluated. Methods of synthesis and manufacturing of widely used polymers in reverse osmosis will be investigated and the production of these products in the country will be investigated. Also, since there is a reverse osmosis membrane system in the chemistry and set up process, it can be used if necessary.

Based on what has been mentioned, the study of reverse osmosis membranes is important from two aspects of understanding the applied polymers in this field and how they are synthesized in power plants and water treatment industries. Be the raw materials of membranes and help localize them.

### **Steps and Methodologies:**

- Investigation of types of polymers used in reverse osmosis membranes.
- Study of various methods of synthesis of reverse osmosis membrane polymers.
- Study and properties of reverse osmosis polymer membranes.
- Collecting information inside the country about the reverse osmosis process.
- Comprehensive and purposeful documentation of the results of studies conducted in a usable way for foresight and preparation of a roadmap for research and development activities in the field of reverse osmosis membranes.

### **Main Results (technical outputs, patents, papers, books, reports, etc.):**

Final report, conference paper