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# An Evaluation of Chrome ($Cr^{3+}$) Removal from Tannery Wastewater by Using PTFE (HP) and PTFE (HCP) Membranes in MD Process

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**Abstract:** One of the most important industries is tannery industry. The tannery industry makes the base for some countries due to large exportation of this product. In this article Membrane Distillation (MD), has been used with two types of membrane for removal Chromium ion from tannery wastewater. The measurement of chrome before and after MD has been done by HACH instrument, Method 8030 with all kits needed to achieve the tests. All other instruments have been achieved according to APHA, AWWA, and WEF. The membrane that has been used are the first is (HP) Poly tetrafluoroethylene hydrophobic (PTFE), the second is acrylic copolymer (HCP), (Pall Corporation) water. The results of tested for the first membrane confirmed that the efficiency removal reaches 82.79% then lower until it reaches 72.51%. Conversely, the efficiency for the second membrane will be 47.31%, after time the removal rate drops to 35.24%. In this time, it's better to washing the membrane to reactivating again. The first membrane is more useful when simple sedimentation performed to get rid of the settable materials. The action of temperature in the work appears in the efficiency and removal by MD, so as the temperature increases, the chrome removal efficiency increases.

**Keywords:** PTFE (HP), PTFE (HCP), Chrome, Membrane Distillation, Tannery Industry, Industrial Wastewater

## 1. Introduction and Scientific Background

For producing tannery products, different types of hides and skins may be used, such as goat's, sheep, and buffalo various techniques and methods have been used to treat wastewater from tannery plants. The tannery products very rich in proteins and source as well as organic materials. For producing tannery products high amount of water may be used and huge quantity of wastewater will be discharged. [1-5]

Chrome is point out by (chrome). Chrome is denoted by (atomic number) 24, atomic weight is 51.996 its density is 7.19 $g/cm^3$. [6-8]. Chrome generally, used in different industries such as make batteries, electrical and industrial equipment and cooking utensils. This item may be joined with other ions to make different tools such as military hardware, and some musical instruments and equipment. [9-12]

## 2. Characteristics of Tannery Wastewater

Tannery industry is among the most polluting of the tannery industries regarding its large water consumption. Consumption of water to produce leather depends on the size of the plant, usually expressed in terms of maximum weight of hides held in one day, and the methods complicate. The quantity of water required in tannery industry is variable due to management of the plant, however it will be variable. The main reasons of this are different activities in this industry as washing and rinsing.

Due different activities to achieving which could produce the tannery products, the side product will be different types of waste. The types of wastewater may include high concentration of salts, acid, alkaline detergents, organic, inorganic materials as well as microbiological load,

pathogenic viruses, and bacteria. [13-16]

## 3. The Impact of Chrome with Health and the Environment

The life chain plays an important role in moving pollutants from products sources to creatures. The producing heavy metals from different industries as by product or main products will going through feed or leech through farmers [17-19]. Some transitions of heavy metals could be occurring due to cows lick pillars steel. But the major phenomena are the transition. All these events have relationship with clothes, touch, working in this field, because the motion of these metals and settling will be finally in the human bodies. [20, 21]

The accumulation of chrome in human body could be a reason in kidney and liver disruption then lead to death. On the other hand; these accumulations don't have relationship with cancer till now; however thick brain or idiocy diagnosed in some Swedish primary schools due to this item. [22-24].

## 4. Treatment Procedure

With the starting industrial revolution at the end of 18th century, different types of pollutants had rejected into the environment. The advancing of these industries commanded to developing new materials in different varieties. The treatment with these pollutants with traditional processes had difficult; however, the membrane processes confirmed effectiveness in different ways. The membranes processes have different types, but the simplest and cheapest on is the Membrane distillation (MD). The MD process have different advantages such as total (100%) elimination, severe to inlet intensity, moderate functional situations as well as steady act at high pollutant strengths, as shown in Figure 1 [25-27].

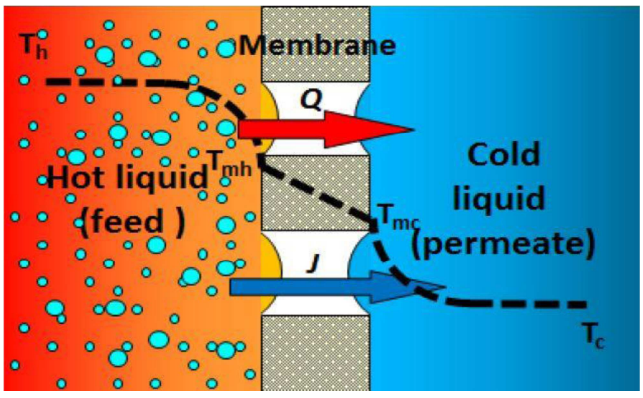


***Figure 1.*** *Basic principles of the MD process (Shirazi, Mahdi et al. 2015).*

Referring to history of MD, which confirm that first attempt has been achieved in 1963. Khayet presented the theory and modelling of the MD process in 2011. [28-30].

In this article it has been become very important to eliminate the concentration of chrome ion before discharging tannery wastewater. This action will be prohibiting movement the chromium ion to human body.

## 5. Materials and Methods

The main objects of achieving this article are exploit of two types of membranes he first is HP) Poly tetrafluoroethylene hydrophobic (PTFE), the second is acrylic copolymer (HCP), (Pall Corporation) water. The PTFE (further usually identified by its product label Teflon ®) [31-33]. The Teflon has many characteristics such as high hold endurance to both misty and dry materials, is oil and water repulsive. Whereas the second is strong hydrophobic membrane filters resistant to aggressive solvents. The implementation of membrane has fine out in several industries and services such as medical industries and can be supplied either as pure PTFE membranes or as PTFE membranes with polymer backings – such as polypropylene or polyethylene, see table 1 [34-36].

***Table 1.*** *General characteristics of ordinary used membranes.*

| COMPOSITION | Thermal Conductivity (W m−1 K−1) | Surface Energy (×10−3N/m) |
|---|---|---|
| PTFE | ~0.25 | 9–20 |
| HCP | 1.45 | 40-45.3 |
| PP | ~0.17 | 30.0 |
| PVDF | ~0.19 | 30.3 |

Tannery effluent for this study has been collected from a (Saeeda factory located in the Zaafaraniya area). The characteristics of effluent were analyzed as per American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF) [37], and are shown in Table 2.

### *5.1. Sampling*

The samples that have been gathered were conserved with high care and attention to be avoided from any mistakes. Safety from hazardous or poisonous ions such as chrome has been the main object of work. For conserving these samples 1.5 ml of nitric acid were added to keep the characteristics constant. This role applied as well as moving in hand box have cubic ices with low temperature close to 5±0.2. The main analysis parameters were shown in table 2 below.

***Table 2.*** *Characteristics of Saeeda plant tannery effluent.*

| Parameter | Tannery effluent |
|---|---|
| Chemical Oxygen Demand, mg/l | 5300-5800 |
| Biological Oxygen Demand, mg/l | 3250-3800 |
| Suspended solids (SS), mg/l | 2700-2900 |
| $Cr^{2+}$, mg/l | 90-120 |
| Sulfate, mg/l | 1800-2200 |
| Chlorides, mg/l | 5100-6300 |
| Percent of Hydrogen ion | 8-9 |
| Accessibility, ms/cm | 10-12 |

### *5.2. Chrome Test*

It has been used Alkaline Hypobromite Oxidation Method Chrome Concentration Method, Method DOC316.53.01034, with HACH apparatus. The samples have been diluted with Melique water to makes computability with test method without any interaction and rejection of measurement [38].

### *5.3. Equipment's and Apparatuses*

To achieving this work, different tools and equipment has been used such as HAC Meter for $Cr^{3+}$, HCL acid and other chemicals like NaOH, NaCl salt and different salts.

### *5.4. Membrane Materials*

Generally, membrane could be classified into Hydrophobic and Hydrophilic membranes. The raw material of these components could be polypropylene (PP), polyvinyl iodine fluoride (PVDF), Poly tetra fluoro ethylene (PTFE) and polyethylene (PE). The variety usage of membranes depends on the objective outcomes as well as economical, maintains and affordable possibilities of applying MD process in the site. [39-42].

The main featur of membrane is the porosuty, which plays big role in applying from type to type of industry. The hole sizes may range from 0.5-0.9 µm. However, the most typical size is 0.4 -1.0 µm, where the thickness of these films is in the limit of 0.04 to 0.25 mm [43-45].

The PTFE films have many characteristics over other types of films that qualify them to be of great application. Such characteristics as thermal stability, ability to resist oxidation and high contact angle with water [46-49].

It has been used PTFE part #: MSPTFE260045B, Lot#: 1801331008, pore size 0.45 µm, wettability: Hydrophobic, as part of this work to going through for making the work.

*Setup:*

The reactor which used to accomplishing this work is presented at Figure 2.

## 6. Results and Discussions

The atomic number of Chrome plays an important role in motion through the membrane in the beginning. The molecular weight of chrome will beat on other properties, so will blockage the holes due to high movement of chromium into the holes. It is noticed from Figures 3 and 4 that the first membrane has a greater ability to remove and this is due to it being mainly hydrophobic. This property will gain the membrane more advantages to prohibiting chromium ions through the openings of the membrane.

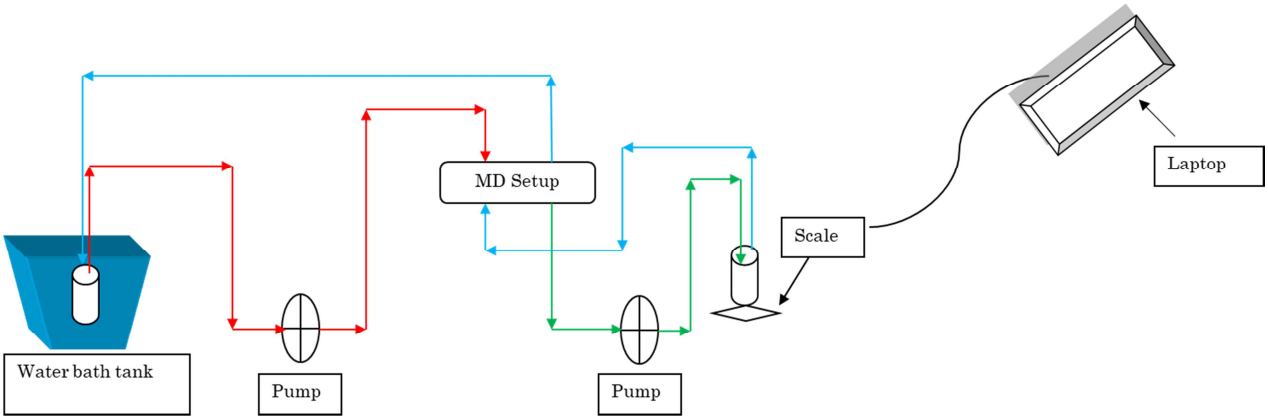


***Figure 2.*** *Shows schematic diagram of setup used at the lab.*

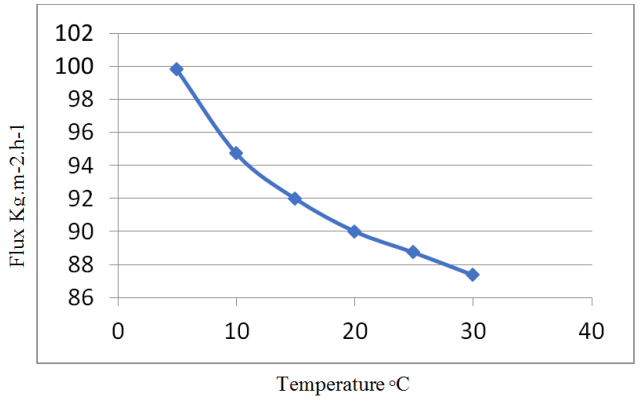


***Figure 3.*** *A relationship that shows the variability of the flow with temperature when passing tannery wastewater samples onto MD for PTFE membrane.*

At the start of operating the reactor, it's obsarved high chrome removal as shown in figures 5, 6 respectively. The reasults indicates that the best removal of chrome will be at the beginging of operation of the reactor, where the removal rate reaches 82.79%, and after that, the elimination will be least until the removal rate gets 72.51%, and then the washing of the membrane to run the reactor is required. While for the second membrane will be 47.31% and 35.24% respectively.

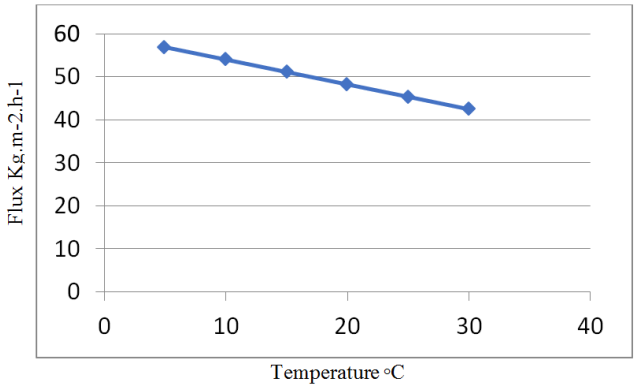


***Figure 4.*** *a relationship that shows the variability of the flow with temperature when passing tannery wastewater models onto MD for HCP membrane.*

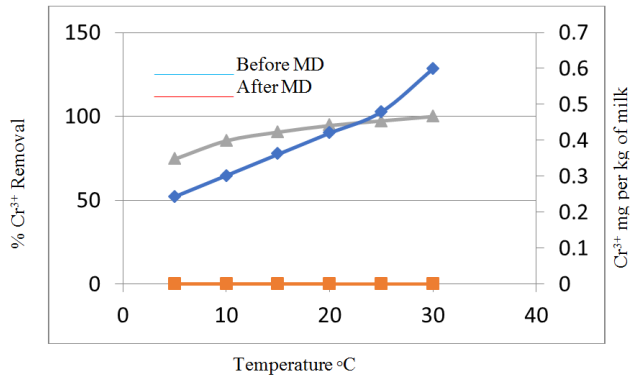


***Figure 5.*** *A figure showing the relationship between temperature changes with percentage of $Cr^{3+}$ ion removal for PTFE membrane.*

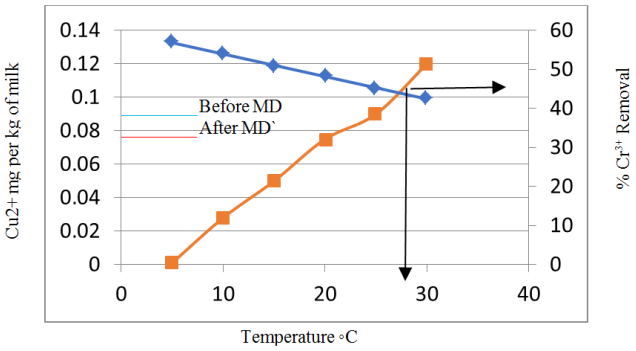


***Figure 6.*** *A figure showing the relationship between temperature changes with percentage of $Cu^{2+}$ ion removal for HCP membrane.*

As note from Figure 6, the best removal will be in 25-30°C which will be about 42.46%. On the other hand, and as note from Figure 7, the behaviour of PTFE membrane is straight throughout passing of tannery wastewater on MD model, this membrane is not effected by the shocks created through the changing of concentration, or hydraulic loading.

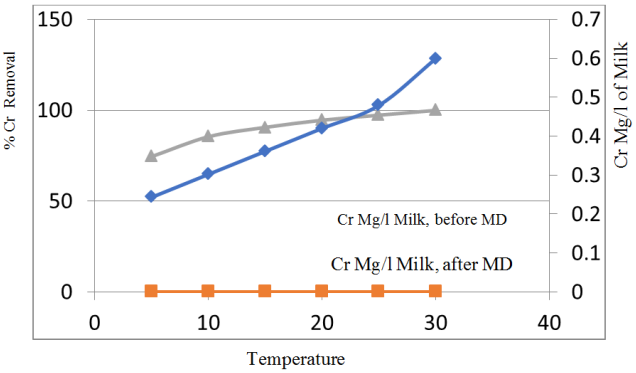


***Figure 7.*** *A figure showing the relationship between temperature changes with percentage of $Cr^{3+}$ ion removal for PTFE, HCP membranes.*

## 7. Conclusion

1) At the staring of procedure, the removal efficiency for the first membrane will be 82.79%, the then decreasing till reach 72.51%. On the other hand the efficiency removal for the second membrane will starting at 47.31%, but this figure will decreases to 35.24%. The repeated runs confirmed the activity of first membrane specifically when proceeded with simple sedimentation.
2) Recommended to use hydrophobic poly tetrafluoroethylene PTFE (HP), with tannery wastewater to remove $Cr^{3+}$. This membrane has the ability and characteristics could make stretching with the wastewater characteristics as well as hydraulic shocks.
3) The features above lead to give the opportunity for this membrane to work in expanded limits of circumstances. These limits will lead to make absolute removal of $Cr^{3+}$. The performance of PTFE membrane is constant comparing with HCP membrane. The absolute removal will mean different factors as well as the final concentration of $Cr^{3+}$.
4) As the temperature increases, the chrome removal efficiency increases. This could be due to the increased movement and permeability of water atoms through the membrane openings, carrying chrome ions with them.
5) The most important items which make disability and disruption of the reactor with membrane type HCP, is the present of organics and inorganics materials. These materials will block the holes and creating disruption of the reactor, as noted in Figure 6.

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