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**Technical Research**

# POTENTIAL OF MEMBRANE DISTILLATION IN REMOVAL LEAD FROM DAIRY WASTEWATER

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**Abstract:** The dairy industry is not usually linked with simple environmental problems, its impression of the environment with different troubles. During the last decades, several types of treatment and procedures have been applied to relieve contaminants from dairy wastewater before being discharged into the environment. The procedure used in this work has green items and saves energy. This route is termed membrane distillation (MD). The method is defined as a contemporary method that can be summed up in financial expenses and electrical effort in addition to the guests and even preservation or care. Recompenses of this system could be summarized in economical, physical as well as Operation and Maintenance (O&M) attributes. Synthetic models of dairy wastewater have been prepared. Physiochemical analysis has been done to have the best decision on the implementation of treatment. American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF) have been used as references for mad these tests. The results gathered show the ability to remove lead at a rate of 98.89%. This figure could be prepared as a high value compared with other techniques efficiency. The operation temperature to get the best treatment has been 15°C, which is very close to the normal medium. The best removal could be obtained at a temperature of 15°C. The fluctuation of temperature could be a role in rising or decreasing removal efficiency but to some extent.

**Keywords**: *Lead; lead removal; membrane distillation; dairy industry; dairy wastewater*

## 1. Introduction and Scientific Background

Numerous methods have been established and applied for reclaimed water from wastewater. These methods are generally categorized as physical, chemical, and biological processes. Examples of these methods are Reverse Osmoses (RO), Ultra-Filtration (UF), Nanofiltration systems, and Micro Filtration (MF) [1-6].

Lead: Pb and nuclear number 82; It is in the chemical table privileged in the carbon group (group four ten). Lead is a heavy metal with a high density. It has molecular weight reaches 207.2. The concentration of leads in milk is not affected by thermal processes during the route of pasting. Metal expended in manufacturing, wrapper, milled milk products, spit, and condenser liquid. The existence lead in them is one of the most important problems in the health contamination of human food [7-10].

The dairy industry is a major nerve in the food industry, and it consumes a lot of water to reach the main goal, which is dairy products. [11-14].

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From the physicochemical literature of dairy wastewater, has white, and bitter with complex turbidity, Salinity, Electrical conductivity and total dissolved solids. Bicarbonate plays a major part in the alkalinity of wastewater from the dairy industry. A low value of dissolved oxygen in waste water was recorded as a result of high organic matter, BOD and COD. The value of BOD and COD was much higher in the waste water indicating its pollutant nature. A higher amount of inorganic nutrients such as nitrogen and phosphorous were found in wastewater [15-19]. This water is rich in proteins and fats as it is in direct contact with animal mass. Also, microorganisms take an important part of this discharge in the form of bacteria, the MPN value was higher again which indicates the polluted nature of the wastewater [20-24]. Various processes in dairy industry may embrace pasteurization, cream, cheese, milk powder, and other different contents. The dairy industry deals with outsized amounts of milk, and water is the chief waste material after processing [25-29]. This article presents a simple process to remove PB from dairy wastewater, with low consumption of energy, low maintenance, low cost of land, low working and operation system [30-33].

## 2. Characteristics of Dairy Wastewater

The dairy wastewater could be characterized as high content of nutrients, detergents, milk, sanitizers, organic and inorganic contents. For instance, it is natural to use salts in the production of cheese and all milk products and related products. On the other hand, wastewater may contain a group of alkaline and acidic components and cleaning products as a result of washing and maintenance operations in the factory equipment and accessories. Therefore, coagulation-flocculation treatment will be applied to the samples before MD to prevent fouling and clogging of the membrane due to organic and inorganic materials [34-39]

This wastewater as well high concentration of organic materials which has stein of chemical and natural spots make high biological and chemical reads as well as detergents and cleaners [6]. The primary research over the recent years on the use of MD technology was mainly focused on the removal of salt and treating the seawater as well as the underground water. Also, other researchers have examined the biological techniques to treat artificial wastewater like the MMBR, which depends on the use of plastic models to enable the growth of bacteria and microbiology. However, the use of this treatment did not gain significant attention due to the lack of previous research studies. The use of biological treatment methods still needs high skills as it requires the use of microbiology such as bacteria [40-44].

## 3. Effect of Leads on Health and Environment

Lead is a poisonous metal found obviously in the Earth's crust. Lead has many uses, including the maker of lead-acid batteries for motor vehicles, dyes, paint, welding, ammunition, glazed ceramics, jewelers, toys, as well as some cosmetics and conventional medicines. Lead in gasoline continues to be used in a lesser number of countries. Lead treatment, use and disposal may lead to environmental contamination and human contact. And as lead is one of the elements, its presence in the environment continues as it is emitted.

Lead poisoning leads to hypertension, anemia, liver, and kidney and brain failure. Especially in children which has a central and peripheral nervous system, are soft bones [9, 10]. They have the speed of absorbing lead by replacing calcium in their bodies and storing it in bone structures.

And the endings of neurons disrupt different systems of neurotransmitter transmission, rather than a toxic effect on me. Dorea, fatal health, found in mother's fetal blood and mother's breast milk [45-47].

Lead can be transmitted through the food chain to humans through the use of milk. The results showed the presence of lead and copper at a concentration of 0.623, 0.566, 0.590, 0.191, 1.323, 0.152, 0.640 and 0.593 mg/ kg in buffalo, cow, and goat and lamb milk, respectively. The proportion of samples exceeding the permitted limit was 100% lead and copper in buffalo milk and lead in cow milk, 83.3% lead in lamb milk, copper in cow milk, goat and lamb, and 66.6% lead in goat milk. The results showed lead and copper concentrations of 0.524, 0.127, 0.824, 0.323, 0.958, 1.402, 0.375 and 0.462 mg / kg in powdered milk for adults, children and amputees [48-52].

Capacitors and, respectively, the proportion of samples exceeding the allowable limit for lead is 100 % in milk big % pasteurized condensate and one in the milk of adults and children, and 83.3 % for lead in infant formula and 33.3 and 16.6 % growth in pasteurized milk and intensive, the results showed no significant difference between the rates of the concentrations of lead, copper, among all kinds of raw milk in the study and the appearance of significant difference in the rate of the concentration of copper in powdered milk for adults and children on pasteurized milk and condenser [53,54].

## 4. A Plain Consideration on Membrane Distillations

The membrane distillation (MD) process is a non-isothermal membrane grounded separation used in a different application. It has a vast space of characteristics like 100% rejection of inorganic materials. MD is selected due to some significant features that it has over other traditional methods such as biological methods as the latter needs a high level of services and maintenance as well as electricity. In MD, chemical treatment can reduce COD by 78% and BOD by 84%. Therefore, researchers and scientists made significant efforts to use this process for recovering freshwater [18, 19]. MD is commonly selected due to some significant features that it has over other methods such as chemical and electrochemical methods. MD needs a low level of services and maintenance as well as electricity [55,56].

The membrane distillation mechanism is a mechanism that relies on the pressure variation mid the two sides will license the steam from the hot side over the membrane openings and condense the vapour collected on the cold side. Figure (1), [57].

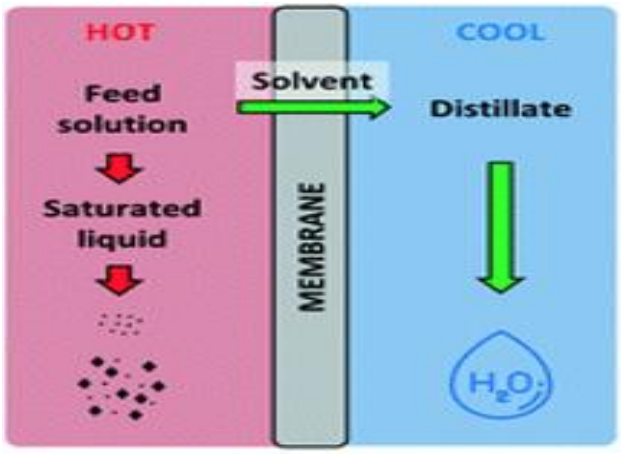


**Figure 1.** Basic principles of the MD process Environmental Science: Water Research, Issue 7, 2019 & Technology, Youngkwon Choi, et al.

At 1963, the membrane distillation phenomenon has been created obviously. Lawson and Lloyd then did a big, deep valuation in 1997. Various MD bids and their theoretical qualities were also reconsidered in detail by different research teams. In 2011, Khayet revised the speculative demonstrating and physics motions of the MD process (Wang & Chung 2015). Nonetheless, the blip of the MD route for wastewater treatment has not yet been referred. The state of art for MD,

has been reviewed and studied as well in them works. Applications of MD for reuse water from wastewater has been viewed as well. [58, 59].

## 5. Advantages of Using MD

The discovery of osmosis was mainly on the principle of finding an economical method for removing salts and treating polluted water. The goals were focused on exploiting environmental factors such as solar energy and others to implement this principle, which could lead to a massive reduction in the economic cost. This method came as an effective parameter to operate within temperatures that can be between 35 and 85 degrees Celsius. Undeniably, MD plants powered by solar energy are cost- cutthroat with RO in isolated areas. Also, straightforward operating conditions, slash operating pressure (usually ambient pressure) which increase safety; and rarer fouling problems are some other profits of the MD process [60, 61].

## 6. Materials and Methods

### 6.1. Models:

In this topic, it's have been set mock models has properties similar factual models conferring to standards properties of world dairy wastewater taxonomies.

### 6.2. Membrane Materials

Membranes mostly could be classified into Hydrophobic and Hydrophilic films. These films completed of assorted ingredients matching polypropylene (PP), polyvinyl iodine fluoride (PVDF), Poly tetra fluoro ethylene (PTFE) and polyethylene (PE). It could be offered in tubular, capillary or flat sheet forms which have been used in MD experiments.

The sponginess of these membranes may vacillate from 0.5-0.9 μm. The most communal size is 0.4 -1.0 μm. While the depth of these membranes is in the range of 0.04 to 0.25 mm [62-64].

**Table 1.** Surface energy and thermal conductivity of normally depleted membrane materials

| embrane Material | Thermal Conductivity ($W\ m^{-1}\ K^{-1}$) | Surface Energy ($\times 10^{-3}$ N/m) |
|---|---|---|
| PTFE | 0.25 ~ | 9–20 |
| PP | 0.17 ~ | 30.0 |
| PVDF | 0.19 ~ | 30.3 |

The PTFE membrane could be overcoming other membranes in several faces. These geographies could be abridged in major contact angle with water, hydrophobicity, thermal stability and higher oxidation resistance and good chemical compared to PVDF and PP [65-67].
It has been used at this topic is PTFE part #: MSPTFE 260045B, Lot#: 1801331008, pore size 0.45 μm, wettability: Hydrophobic.

### 6.3. Scheme:

The funnels for the MD application is shown in Figure (2).

The setup used at this experiment was comprise of propels, pipes, regulators, balance, laptop to organizing work

## 7. Outcomes and Conversations

The lead comprises a large nuclear figure and a big molecular weight as well. These characteristics will help it and asylum the membrane. Here, and at a particular point, a sheet of lead will be grown might formed on the membrane and may cause fouling The cow's milk fashions were exploited in the research, as they are the most broadly used in the social field.

Fluency of liquid and memo readings, singular apparatuses similar pinecones, pipettes, flasks, and funnels. The lead intensity was close in the cow milk models amid 2.22 and 0.088 mg per kg of milk with a usual of 1.154 mg/kg of milk. These quantified concentrations facilitated prepare samples for laboratory trials [68].

The first start of this process is to apply coagulation-flocculation process on the samples after test physiochemical characteristics see Figure 3. The samples gathered after primary treatment by the Jar test technique, are passed into the MD.

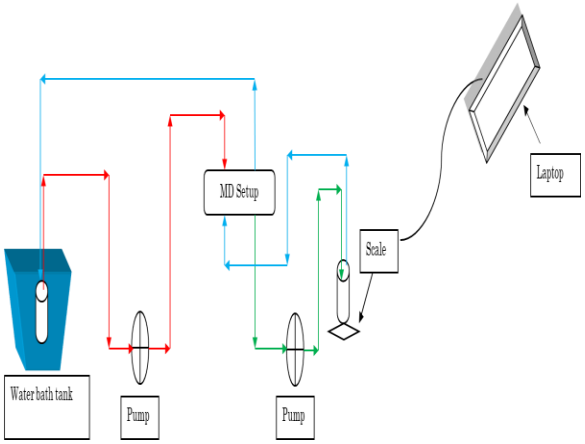


**Figure 2.** Displays illustration of setup behaved

It has been observed the flux will be constant with a slight difference of temperatures. The concentration of Lead (PB) transported during the membrane openings will rise with the surge in temperature, removal will be increases of this ion from samples due to this phenomenon.

The Pragmatic Atomic Radius: 175 picometres (pm). Although this property is small and contrasts with frame elements in general, it does give lead an advantage in reaching through the membrane.

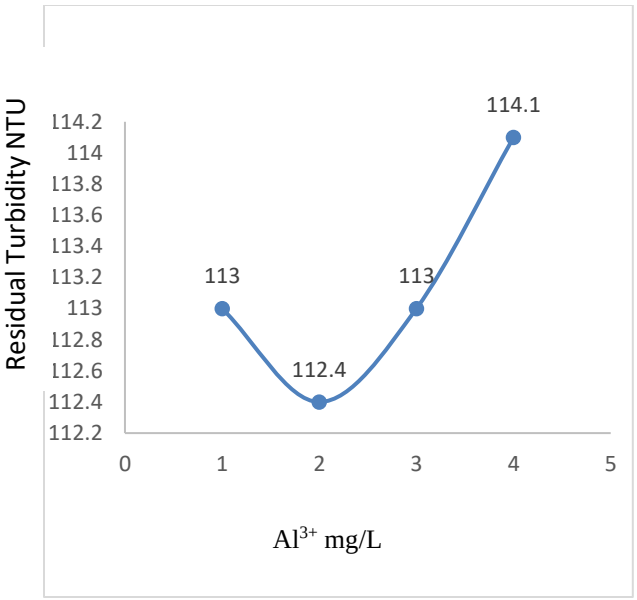


**Figure 3.** Relationship between added alum (mg/L) and residual turbidity (NTU).

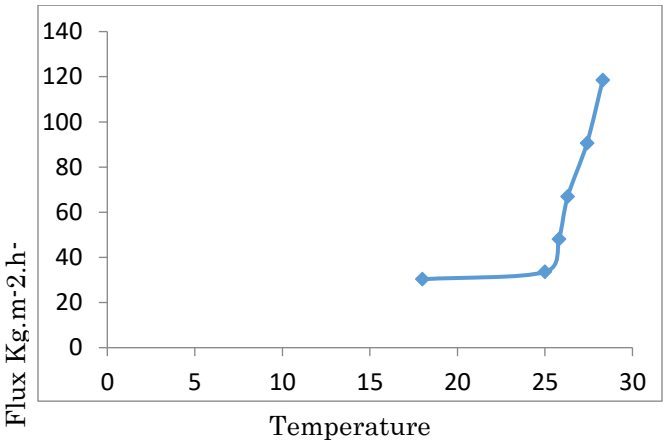


**Figure 4.** A link that shows the variability of the flow with temperature when overtaking dairy wastewater models onto MD

Regarding to Figure 6, the best removal of lead atoms occurs at a temperature of 15 ° C. The removal efficiency begins to decrease due to the accumulation of these atoms on the membrane openings, which obstructs the flow through the holes. Therefore, even the increased temperature and pressure difference mechanism between the two sides will not help the lead pass through the membrane, because the work will stop. After all, the membrane holes will begin to clog and they should be washed to clean the holes from the dirt.

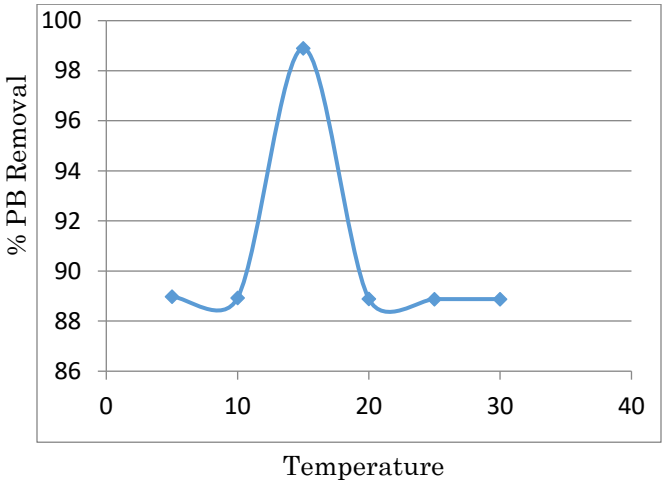


**Figure 5.** An appear guiding the connection between temperature variation and the percentage of PB ion removal

This system has proven its ability to operate at temperatures as low as 15 ° C, and these are moderate to heat limits and fairly good, with a lead removal efficiency of 98.89%, which approaches the normal temperature of 20 ° C, to achieve the best removal for lead.

Using the equation shown below, it will get the concentration of Lead (PB) after MD at different temperature.

$$y = 0.2855ln(x) - 0.6413 \quad (1)$$

Where:

x = Temperature of the bulk.
y = Lead (PB) strength next MD.

If the outermost part of the lead is 0.85 mg/kg of milk, then the exterior at temperature (15 °C) is 0.094 mg/kg of milk. The rejoinder will be an admirable and changes will be acceptable. It is illustrious from Figure 3 that the condition of the treatment scheme trusted heavily on the molecular weight of lead. Efficiency removal has been raised due to this phenomenon to 98.89%

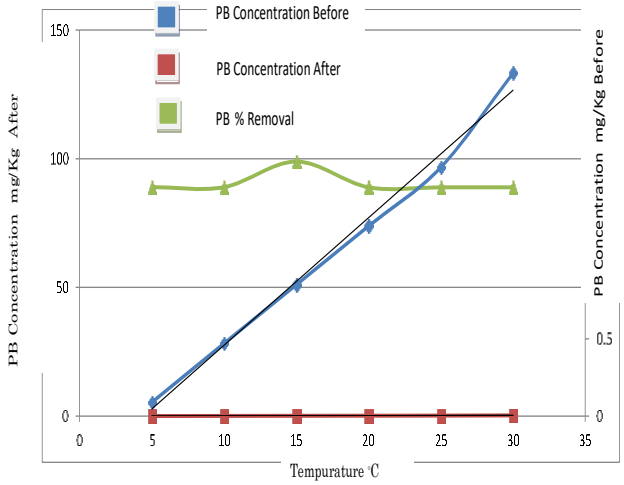


**Figure 6.** A figure displays the performance and behavior of the Lead through the way of the models into the MD at different temperatures

The figure 15 ° C as presented at Figure 4, confirmed the effectivity of treatment at this degree. The removal efficiency begins to decrease see Figure 5, due to the accumulation of these atoms on the membrane openings, which obstructs the flow through the holes. Therefore, even the increased temperature and pressure difference mechanism between the two sides will not help the lead pass through the membrane, because the work will stop. After all, the membrane openings will begin to clog and they must be washed to clean the holes from the dirt, note Figure 5.

This system has proven its ability to operate at temperatures as low as 15 ° C, and these are moderate to heat limits and fairly good, with a lead removal efficiency of 98.89%, which

approaches the optimum operating temperature of 20 ° C to achieve the best removal for lead.

## 7. Conclusion

- The removing figure of lead has been gathered by 98.89% by applied MD.
- The hotness variation has issued troubles of work productivity and the removing with MD, but to some extent. Relief of leads get on 98.9% at temperature 15 $^{O}$C,
- The organic or inorganic constituents in the samples will dissent the transient through the gaps in membrane. Possibility of disrupted function of membrane to become a major result because of blocking is an open choice.
- The fouling troubles is could be present due to organic and inorganic materials, for this reason the primary treatment it should be applied.
- occupation developed blocked instantly and might emission of odors. Fashioning fouling, and could even lead to its jam then stop,
- This method could be used in specific industries or health requirements.

## Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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