INFLUENCE OF PERMEATE FROM DOMESTIC REVERSE OSMOSIS FILTERS ON LEAD CORROSION AND LEACHING FROM PLASTIC PIPES

by

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PREVIEW

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ABSTRACT

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by

Jyotsna Shrestha

The University of Wisconsin-Milwaukee, 2016
Under the Supervision of Professor Jin Li

Reverse Osmosis filters are gaining popularity nowadays, in domestic water supply system, to meet the increasing demand of pure and improved drinking water. There are various types of domestic RO filters with varying sizes, capacities, and treatment stages available. However, there exist a few concerns regarding the RO treatment system. One of the major issues in the quality and distribution of drinking water is the corrosive water that the RO system produces. Therefore, this research herein tends to focus on the corrosive effect of the permeate water on lead metal, as lead is considered a serious problematic drinking water contaminant. In addition, study of the effect of RO product water on leaching of organic carbon from common plastic plumbing materials was also conducted. Three RO filters with varying treatment stages—two-stages, five-stages and seven-stages were chosen for the tests.

PREVIEW

The lead corrosion was evaluated using immersion corrosion test of lead coupons in water samples for a total of forty days. The two-staged filter showed the highest corrosion effect among the three filters, and the seven-staged filter showed the least. As the number of treatment stages increased, the significant decrease in pH, conductivity, hardness and alkalinity of the water samples also seemed to be less. The overall findings suggested that the impact of number of treatment stages of the filters had a substantial effect on the corrosive property of the water.

From the migration test, it was found that the PEX and PVC pipes were prone to organic carbon leaching as compared to the CPVC pipes. The two-staged filter showed the highest extraction of organic compounds in all of the three pipes, and the seven-staged filter showed the least extraction of TOC. In all the samples, including the control, the initial TOC leaching on the third day was higher than the subsequent leaching periods of six and nine days. The leaching of TOC by the RO water samples was hence successfully quantified.

PREVIEW

To

my husband,

for his love and support.

PREVIEW

TABLE OF CONTENTS

PREVIEW

PREVIEW

LIST OF FIGURES

PREVIEW

PREVIEW

LIST OF TABLES

PREVIEW

LIST OF ABBREVIATIONS

2,4-D	2,4-Dichlorophenoxyacetic acid
AC	Activated Carbon
CPVC	Chlorinated polyvinyl chloride
CTA	Cellulose tri-acetate
CTO	Chlorine, Taste, Odor
DI	Dissolved ion
GAC	Granular Activated Carbon
GPD	Gallons per day
GPG	Grain per gallon
GPM	Gallons per minute
ICP-MS	Inductively Coupled Plasma-Mass Spectroscopy
LCR	Lead and Copper Rule
MPY	Milli-inch per year
NSF	National Sanitation Foundation
PEX	Cross-linked Polyethylene
POU	Point-of-use
PPB	Parts per billion
PPM	Parts per million

PREVIEW

PSI	Pound-force per square inch
PVC	Polyvinyl Chloride
RO	Reverse Osmosis
SDWA	Safe Drinking Water Act
TDS	Total Dissolved Solid
TFC	Thin Film Composite
TFM	Thin Film Material
THM	Trihalomethane
TMAFC	Tap Master Artesian Full Contact
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

PREVIEW

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PREVIEW

Chapter 1

Introduction

1.1 Background

The need for safer drinking water is increasing day by day. Clean drinking water scarcity is a growing concern all over the world. 663 million or one in ten people still lack access to improved drinking water supplies.[1] Even people who have access to water supplies such as household connections, public faucets, and boreholes may not have microbiologically safe water. As a result, various solutions are implemented to purify water, the techniques getting continuously improvised by novel and more efficient researches.

To meet the growing demand for higher quality drinking water, homeowners and businesses are installing the similar technology used to process popular bottled water brands like 'Dasani' and 'Aquafina'— Reverse Osmosis Filtration. RO is considered one the finest techniques to purify water and is extensively used industrially, with recent increasing domestic use. In fact, RO is the fastest growing form of in-home water treatment in the U.S.[2] RO is a pressure-driven process in which a semi-permeable membrane is used to pass water, filtering out dissolved constituents. The membranes used for RO have a thick barrier layer in the polymer matrix where most separation occurs. In most cases the membrane is designed to allow only water to

PREVIEW

pass through this thick layer while preventing the passage of contaminants such as arsenic, copper, iron, lead, chromium, fluoride, radium, cyanide, nitrates, bacteria, pesticides, PCB, and benzene. As a result, RO vastly improves water purity, color and taste.[2,3] Especially for membrane desalination, decreasing costs and higher quality production of potable water are some of the many significant reasons why this technology continues to be a preferred water treatment option in the world.

However, with the increasing popularity there exist various issues regarding the RO treatment system. One of the major concerns in the quality of drinking water and the distribution system is the corrosive water that the RO system produces. In the drinking water industry, internal corrosion of drinking water systems has often been an issue affecting water quality, public health, and the cost of safe water provision. Through this research information about the effect on the corrosion of metal pipes (lead in this case), of the product water of the domestic RO filters that are used at homes is to be highlighted. Moreover, this research tends to shed some light on the effect of the product water in leaching of organic carbon from common plastic plumbing pipes (PVC, CPVC and PEX in this case) as the use of plastic pipes in the water distribution section is gaining immense popularity.

PREVIEW