SiO_2-PDMS as Oil Removal System

Materials Research

GÓMEZ-LÓPEZ, Rosa Viridiana, SALAZAR-HERNÁNDEZ, Carmen, SALAZAR-HERNÁNDEZ, Mercedes and LEÓN-REYES, María del Rosario

Abstract

This paper presents an oil removal system design based on the use of hydrophobic silica (SiO_2/PDMS) obtained by the co-condensation of silica with polydimethylsiloxane (PDMS) using DBTL as a polycondensation catalyst. The hydrophobic silica entrapped in the foam was evaluated by gravimetry; in addition, infrared spectroscopy will allow the identification of hydrophobic silica in the foam and the main functional groups in the foam. The hydrophobic character was determined through the modification in the water absorption capacity of the foam and by measuring the contact angle. On the other hand, optical microscopy allowed the identification of changes in the foam surface due to the presence of SiO_2/ PDMS. Finally, the effect of the amount of PDMS on the oil-in-water removal capacity was determined.

Introduction

Nowadays, water quality is a relevant issue of high environmental concern, since water is exposed to many pollutants, including oily substances that cause serious environmental damage [1]. To remove this type of substances, the use of hydrophobic surfaces has been proposed [2-6].

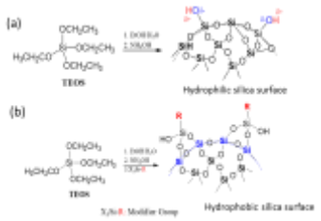


Figure 1. (a) Production of hydrophilic silica (b) Production of hydrophobic silica

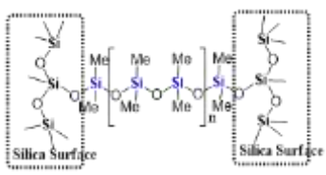
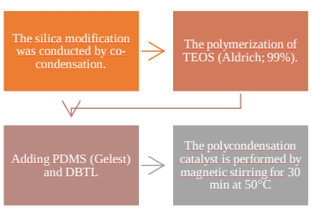


Figure 2. Structure for SiO_2/PDMS-functionalized

The modification of a silica using PDMS through the sol-gel method and the use of a polycondensation catalyst to obtain a sol solution containing the structure shown in Figure 2. In this work, the SiO_2-PDMS is impregnated in polyurethane foam to determine its effect as an oil-in-water removal system.

Materials and methods

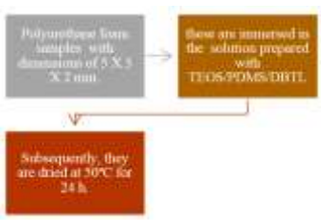
SiO2/PDMS Synthesis



	TEOS	PDMS
SiO_2-10PDMS	10 g	1 g
SiO_2-20PDMS	10 g	2 g
SiO_2-40PDMS	10 g	4 g

Table 1 Amounts of TEOS/PDMS used for silica modification.

SiO_2-PDMS-functionalized Foam impregnation



Oil Removal Capacity Measurement

Results

Infrared Spectroscopy Characterization of R-SiO_2

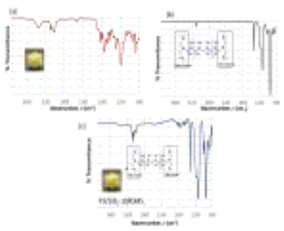


Figure 3. FT-IR (a) polyurethane foam (b) SiO_2-PDMS (c) P.F/SiO_2-PDMS

P-Foam/R-SiO_2 Porosity

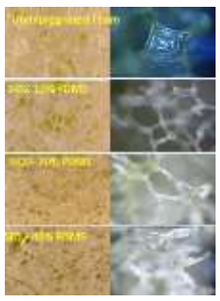


Figure 4. Porosity changes into P. Foam due to SiO_2-PDMS deposited

Oil Removal Capacity

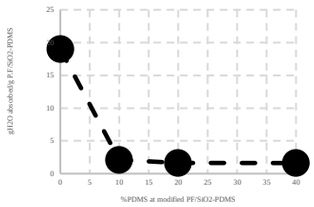


Figure 5. Water absorption capacity for P.F/SiO_2-PDMS

Hydrophobic Assessment

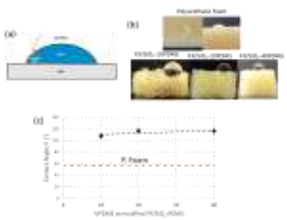


Figure 6. (a) Contact angle (b) water drop on surface foam and surface foam modified (c) contact angle according to PDMS amount in SiO_2-PDMS

Conclusions

The SiO2-PDMS was impregnated in the macroporosity of the Polyurethane Foam; modifying its physical properties such as contact angle and water absorption capacity. The P. foam presentas a contact angle of 57.50°, corresponding to a hydrophilic material, however, the oil removal capacity was 10 g oil/m^2 P. foam. On the other hand, Polyurethane Foam impregnated with modified silica is a hydrophobic material with a higher oil removal capacity.The increase in oil removal capacity in the P.F/ SiO2-PDMS is due to the integration of hydrophobic groups (PDMS) in the foam which improves the compatibility with the hydrocarbon increasing the removal capacity up to 21.22 oil/m2 PF/SiO2-PDMS.

Future of research

Leave an open field for future improvements research and application of methodology that approaches the objetive of achieving the greatest removal of oil contaminants in aqueous media related to water contamination.

Acknowledgments

The authors are grateful for the financial support granted by the Secretaria de Investigación y Posgrado of the Instituto Politécnico Nacional through Project **SIP 1172/2022.**

References

1. Gupta R.K, Dunderdale G.J, England M.W, Hozumi A (2017) Oil/water separation techniques: a review of recent progresses and future directions, Journal of Material Chemistry A, 5:16025. https://doi.org/10.1039/C7TA02070H
2. Xue Z, Cao Y, Liu N, Feng L, Jiang L (2014) Special wettable materials for oil/water separation, Journal of Material Chemistry A,2:2445-2460. https://doi.org/10.1039/C3TA13397D
3. Salazar-Hernández C, Salazar-Hernández M, Carrera-Cerritos R, Mendoza-Miranda J.M, Elorza-Rodríguez E, Miranda-Avilés R, Mocada-Sánchez C.D (2019) Anticorrosive properties of PDMS-Silica coatings: effect of methyl, phenyl and amino groups, Progress in Organic Coating, 136:105220. https://doi.org/10.1016/j.porgcoat.2019.105220
4. Salazar-Hernández C, Salazar-Hernández M, Hernández-Arias L.J, Mendoza-Miranda J.M (2021) Removal of Oil Pollution in water using hydrophobic silica, Journal of Systematic Innovation, 5(16) :1-5. DOI: 10.35429/JSI.2021.16.5.1.5
5. Li Q, Qian F, Yuan K, Dong W, Han Y, Lu Y (2022) Properties of superhydrophobic filter media prepared by TiO_2–SiO_2@PDMS coating, Journal Sol-Gel Science and Technology. https://doi.org/10.1007/s10971-022-05871-4
6. Dai X, Wei Q, Wang Y, Li Q, Cui S, Nie Z (2022) A novel strategy to enhance the desalination stability of FAS (fluoroalkylsilane)-modified ceramic membranes via constructing a porous SiO2@PDMS (polydimethylsiloxane) protective layer on their top, Chemical Engineering Journal, 435 (1) 134757. https://doi.org/10.1016/j.cej.2022.134757

Contact: GÓMEZ-LÓPEZ, Rosa Viridiana **E-mail: rgomezl1601@alumno.ipn.mx** **Project website: https://www.ecorfan.org**

DOI: 10.35429/S.2022.1.4.12.25