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# "CFD THERMAL ANALYSIS ON MEMBRANE DISTILLATION WITH DIFFERENT GEOMETRY"

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## ABSTRACT

***In CREO 2, a sketch-based, feature-based parametric 3D modeling programmed created by PTC, a CAD analysis of membrane distillation is constructed. The model is created in sections, which are subsequently combined using constraints. The MD method has primarily been utilised for desalination, but one of its most promising long-term applications is the water recovery from waste streams. Additionally, it has shown to be a reliable method for removing various contaminants. Although it is capable of treating a variety of wastewaters and brines, its potential to compete with modern water treatment technologies like RO and thermal-based systems is still constrained by the absence of experimental data at the pilot scale and information on particular membranes and modules method currently looks to be one of the main impediments to its industrial use. Moreover, there's another major challenge against MD to be applied for effluent treatment.***

***Keyword**: CAD, CREO, RO, MD*

## I. INTRODUCTION

Water desalination is a technique of converting saline, impure water from sea or in-land reserve and converting it to potable water. Several desalination techniques exist today, such as, Multi Stage Flash (MSF), Multi Effect Distillation (MED), Vapor Compression Desalination (VC), Membrane Distillation (MD), Reverse Osmosis (RO), Forward Osmosis (FO), Electro-Dialysis (ED) etc. Each desalination technique has its advantages and disadvantages. Membrane distillation is particularly attractive owing to simple construction, inexpensive operation and low maintenance. A MD unit has seawater and coolant separated by a hydrophobic membrane. The feed stream or saline water stream is heated above the temperature of coolant externally. Because of the temperature gradient, there exists a vapor pressure gradient and conjugately a vapor concentration gradient. The concentration gradient drives vapor from the saline channel to the coolant channel. It condenses on the coolant channel to form pure water. Hence, theoretically it is possible to produce permeate at 100% purity. Based on the mode of operation and construction MD is classified into Direct Contact Membrane Distillation (DCMD), Air Gap Membrane Distillation (AGMD), Sweeping Gas Membrane Distillation (SGMD), Vacuum Membrane Distillation (VMD) etc. Goal of the present studies is to understand DCMD to a greater detail. In a DCMD module, permeate and saline streams are in direct contact with the hydrophobic membrane. DCMD shows simples construction among all MD techniques. Water desalination becomes an insistent need, due to the huge demand of fresh water across the globe, and the accompanied decrease in its availability worldwide. In the same time, the existing desalination technologies need vital improvement in term of sustainability aspects, such as energy consumption factor, or alternatively new technologies have to be developed and progressed to achieve a convenient level of sustainability. Desalination term refers to the process of minerals removal from saline water, and thus producing fresh water from seawater or brackish water. During the last two decades, desalination plants have evolved rapidly to reach more than 150 countries. Globally, 80 million cubic meters of desalinated water is being produced

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daily by more than 17 000 desalination plants, 50% are utilizing sea water as the source [24]. Kingdom of Saudi Arabia (KSA) is the largest desalinated water producer in the world, and it currently produces about one-fifth of the world productions, in which it produced 955 million cubic meters of water in 2012. Desalination plants cover major regions in the Kingdom, where 26 plants are located along the Arabian Sea and Red Sea. East coast has 6 plants which produce 504 million cubic meters of desalinated water making up about 52:8% of the total water produced in the Kingdom. Red Sea has additional 20 plants which support Jeddah, Makkah and Taif and produce about 451 cubic million cubic meters of water [1, 28]. Fresh water scarcity has emerged as a big challenge of the current era. Growing population, improved living standards, flourishing agricultural sector and industrialization have played a major role in making the problem worse. It has been estimated that more than one billion people on the earth don't have the access to clean freshwater [11]. On the other hand, conventional energy sources and fresh water reservoirs are becoming scarce quickly. Consequently, a strong need to develop less energy intensive and environment friendly water purification techniques has emerged. The overall volume of fresh water reservoirs might be enough to fulfill the current demand but unfortunately the distribution of these reservoirs does not match with population distribution across the globe. The ocean accounts for ~97% of the global water reserves whereas only ~3% is available as the fresh water the most part of which in form of glaciers and ice caps (2.06%), and a small part as ground water (0.90%) and surface/other fresh water resources (0.03%) [2,3]. Accordingly, seawater and brackish water desalination techniques have gained the popularity to fulfill the demand. As alternative to 1st generation thermal based desalination techniques, 2nd generation desalination technologies based on membrane operations (mainly reverse osmosis (RO)) gained popularity during last two decades or so [4]. Currently, RO accounts for 60% of desalination erections across the globe, thanks to its order of magnitude which requires less energy than its thermal counterparts. However, desalination technologies have to address the issue of disposal of produced brine and further decreasing of energy consumption for their sustainable growth.

## II. MODULE DESIGNING

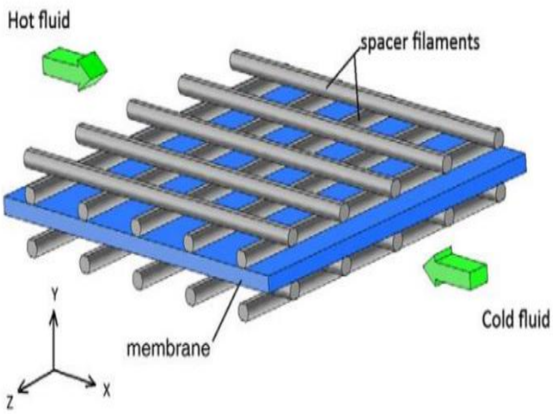


Fig.1 Spacer – filled membrane distillation channels

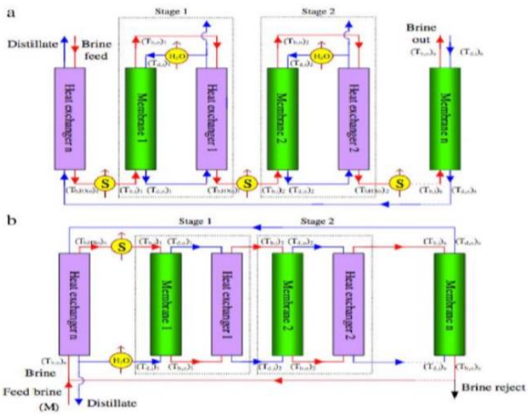


Fig.2 : Classification of water desalination techniques

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## III. MODELLING

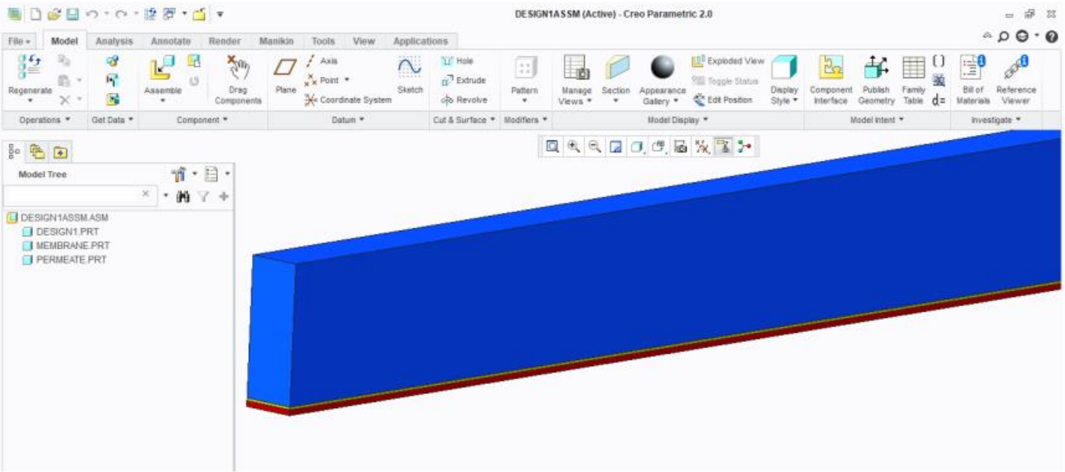


Fig.3 CAD 1- model Assembly Using Coincident Constraints

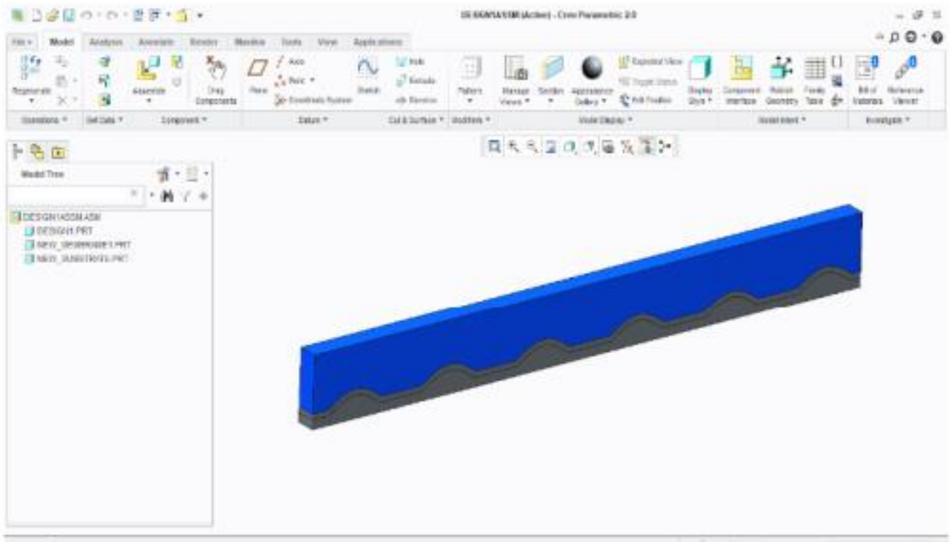

Fig.4 CAD 2- model of assembly

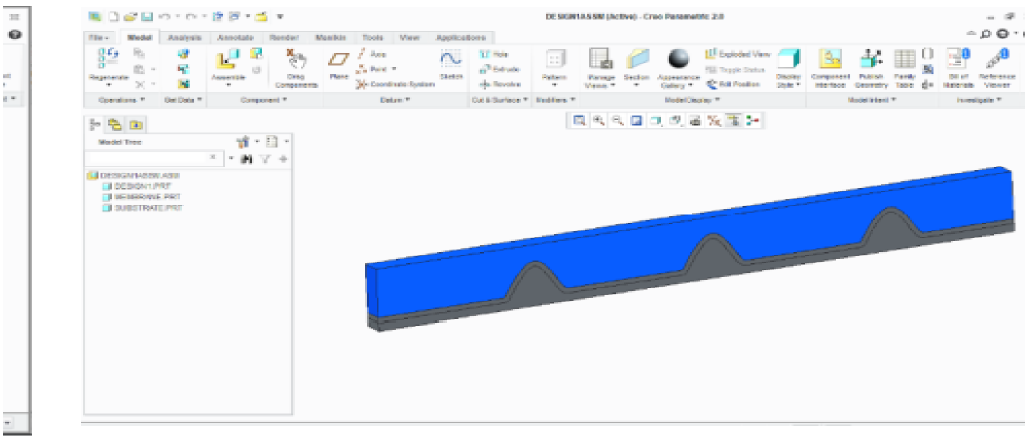

Fig.5 CAD 3- model of assembly

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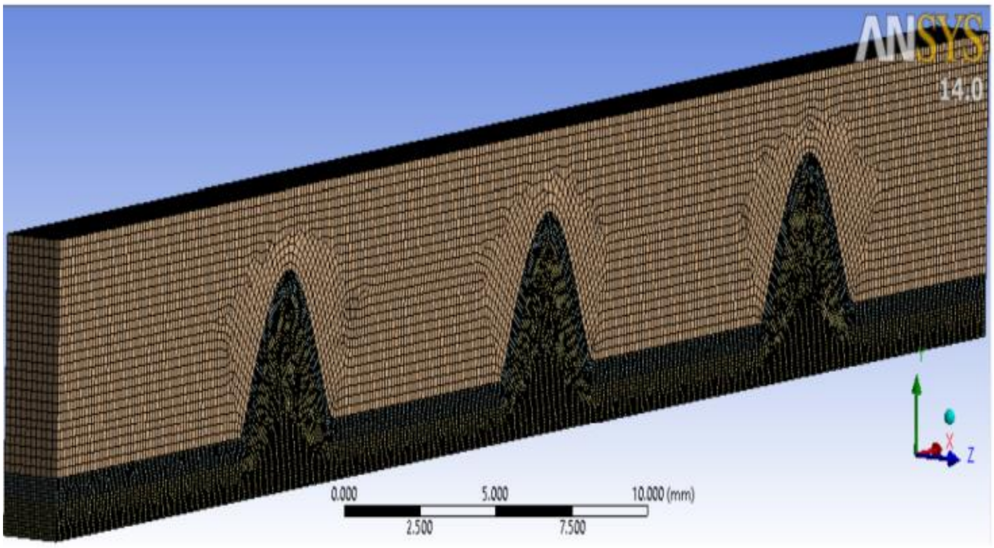


Figure 5.16 Meshing CAD model in ANSYS

Fig.6 CAD - model meshing

## IV. RESULT

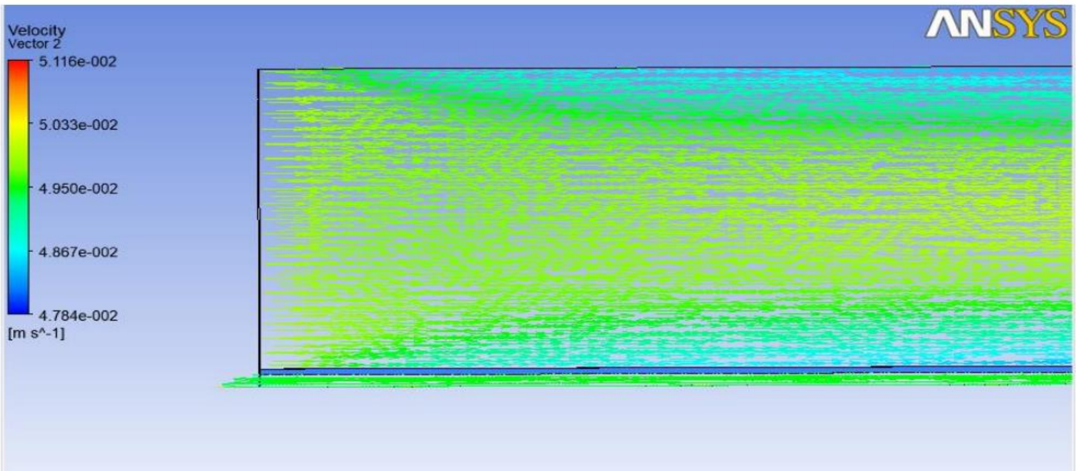


Fig.7 velocity vector of design 1

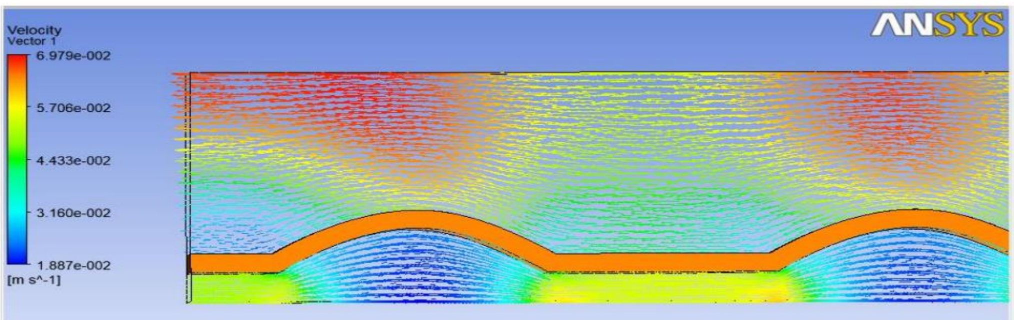


Fig.8 velocity vector of design 2

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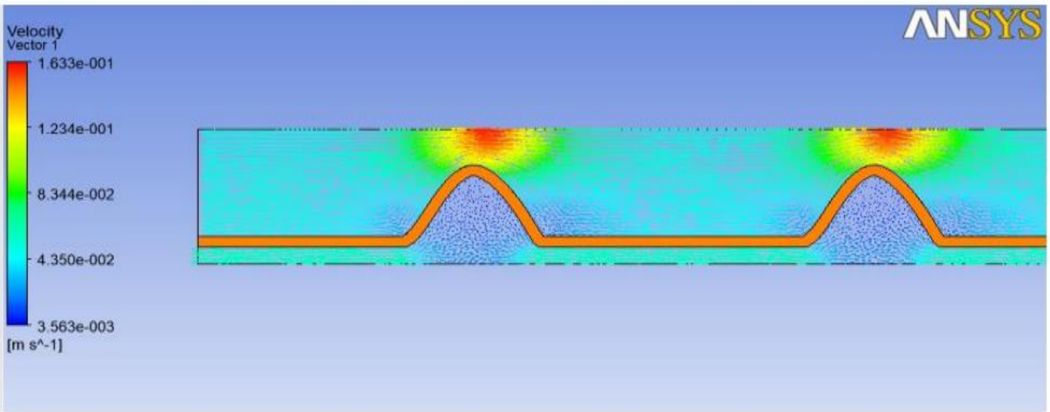


Fig.9 velocity vector of design 3

## V. CONCLUSION

In proposed work , a CAD analysis of Membrane Distillation, CAD model is developed in CREO 2 which is sketch based, feature based parametric 3d modeling software developed by PTC. The model is developed in parts and then assembled using constraints. The MD method has been mainly used for desalination; but, the water recovery from waste streams is one of the most promising applications of MD for the long run. It has also proved to be a suitable technology for removal of other impurities. Whereas it is capable of treating several types of wastewaters and brines, its ability to vie with current technologies, like Ro and thermal-based water treating technologies, is still restricted due to its lack of experimental data in pilot scale and specific membranes and modules. On the other hand, finding new and suitable applications for the MD method currently looks to be one of the main impediments to its industrial use. Moreover, there's another major challenge against MD to be applied for effluent treatment. Effluent streams usually include many chemicals that would doubtless result in membrane surface fouling and membrane pore wetting. This can be because of the actual fact that the deposition of those contaminants on the membrane surface may build the membrane less hydrophobic and lead to pore wetting and thus the flux decline. This is often the reason that limited works on waste material treatment using MD are compared with desalinization. In proposed work, the result had an enhancement of 10% as compared to previous works using CFD as a tool and fabricating specific membranes for MD applications in waste matter processing is one of the most promising future views.

## REFERENCES

[1] Shirazi, Mohammad Mahdi A., et al. "Computational Fluid Dynamic (CFD) opportunities applied to the membrane distillation process: State-of-the-art and perspectives." Desalination 377 (2016): 73-90.
[2] Shirazi, A., Mohammad Mahdi, and Ali Kargari. "A review on applications of membrane distillation (MD) Process for Wastewater Treatment." Journal of Membrane Science and Research 1.3 (2015): 101-112.
[3] Drioli, Enrico, Aamer Ali, and Francesca Macedonio. "Membrane distillation: Recent developments and perspectives." Desalination 356 (2015): 56-84.
[4] Hitsov, I., et al. "Modelling approaches in membrane distillation: A critical review." Separation and Purification Technology 142 (2015): 48-64.
[5] Chang, Hsuan, et al. "CFD simulation of direct contact membrane distillation modules with rough surface channels." Energy Procedia 75 (2015): 3083-3090.
[6] Wang, Peng, and Tai-Shung Chung. "Recent advances in membrane distillation processes:Membrane development, configuration design and application exploring." Journal of Membrane Science 474 (2015): 39-56.
[7] Kullab, Alaa. Desalination using membrane distillation: experimental and numerical study. Diss. KTH Royal Institute of Technology, 2011.

ISSN : 2455-9679
Impact Factor : 4.256

[8] Rezaei, Mohammad, David M. Warsinger, and Wolfgang M. Samhaber. "Wetting prevention in membrane distillation through superhydrophobicity and recharging an air layer on the membrane surface." Journal of Membrane Science 530 (2017): 42-52.

[9] L. Song, Z. Ma, X. Liao, P.B. Kosaraju, J.R. Irish, K.K. Sirkar, Pilot plant studies of novel membranes and devices for direct contact membrane distillation-based desalination, Journal of Membrane Science, 323 (2008) 257-270. [

[10] M. Gryta, M. Tomaszewska, J. Grzechulska, A.W. Morawski, Membrane distillation of NaCl solution containing natural organic matter, Journal of Membrane Science, 181 (2001) 279-287.

**[11]** X. Yang, R. Wang, L. Shi, A.G. Fane, M. Debowski, Performance improvement of PVDF hollow fiber-based membrane distillation process, Journal of Membrane Science, 369 (2011) 437-447.