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# Molecular Distillation: A Review on Applications and Affecting Parameters

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## Abstract:

*Molecular distillation is very important separation process for separation of heat sensitive materials, which are affected by exposure to high temperature for long time. This type of distillation finds application in edible oil industry and other edible product industry. The parameters affecting molecular distillation include feed temperature, feed composition, distillation temperature and condensation temperature. Various investigators have studied molecular distillation for various products, in order to study the effects of these parameters on separation. Present review summarizes the studies and research carried out on molecular distillation*

## Keywords:

Temperature; pressure;yield; purity; concentration

## Introduction

Distillation is very important unit operation in chemical industries. Here relative volatility is a basis for selecting the operation. This operation needs high temperature, as the feed needs to be heated at boiling point. Other modifications of distillation such as solar distillation, membrane distillation and extractive distillation are widely studied and accepted for separation in various processes [1, 2, 3, and 4]. In case of the heat and temperature sensitive materials, it is very important to expose the feed (if needed) to elevated temperature for minimum time. If exposed to high temperature, these products get degraded. In case of molecular distillation, strong vacuum is used to separate components in heat sensitive materials, with high boiling point at atmospheric pressure. The current review provides a summary of the studies and research carried out on molecular distillation.

## Research on Application and Affecting Factors in Molecular Distillation

Molecular distillation was used for purification process of octacosanol extracts from rice bran wax by Chen et.al.[5].They investigated the parameters like the octacosanol content, triacontanol content and the ratio of octacosanol content (Co) to triacontanol content (Ct) in distillates and residues, the yields of distillates and residues, and split ratio (yield of distillates to the yield of residues). The studies indicated that with increase in temperature and decrease in pressure, the separation increases. The reason is, because of increase in temperature and decrease in pressure, the mean free path (MFP) increases. They obtained the yield of 37-38 percent. When the temperature was decreased, the MFP decreased and maximum molecules were not able to reach the condenser. So the separation became less effective. It was

concluded that the molecular distillation can be used for purification process of octacosanol extracts. Fregolente et.al. carried out studies on molecular distillation for enrichment of natural products[6].They applied the molecular distillation process to enrich borage oil in gamma-linolenic acid (GLA). They obtained maximum GLA concentration of 33.5 percent, about 1.5 times more than initial concentration. Rossi et.al. used molecular distillation for fractionation of d-limonene and geranial from lemon essential oil [7]. They studied technical feasibility of molecular distillation for this purpose. They determined best operating conditions for the process. The yield increased with temperature. They first analyzed three different oil samples. According to their study, modifications in feed rate led to more significant changes in product quality. Zuniga et.al. proposed modeling and simulation of molecular distillation process for a heavy petroleum cut[8]. They incorporated physical and chemical property relationships, mass and energy balance equations and other mathematical tools for the purpose. They computed the process variables, such as film thickness, evaporation rate, film surface temperature, concentration profiles, and amount of distillate flow rate. They observed that the inlet variables such as feed rate and temperature have large influence on the process. Lieu et.al proposed a mathematic model on mechanism analysis of distillation [9]. The emphasis of their work was on processing of wiped film molecular distillation and analysis of mass transfer and heat transfer. They studied the wiped film evaporator. They studied the parameters like feed temperature, feed rate and wiper rate. They provided basic model for industrial design and optimized production. Guo et.al used solid catalyst for upgrading bio-oil molecular distillation fraction [10]. By using this technique, it was possible to improve corrosive properties and stability. Shao et.al. carried out the molecular distillation of ordinary binary mixture in order to study influence of feed and condenser temperature [11]. They observed that evaporation rate decreased with increase in condenser temperature. Marttinello et.al carried out simulation of deacidification process by molecular distillation of deodorizer distillate [12].They used mathematical model to analyze the molecular distillation. They assumed steady state conditions during the process. The deacidification operation of sunflower deodorizer distillate was studied. According to these studies, mass flows of lighter compounds in the distillate and heavier compounds in the residue for different evaporation temperatures should be as high as possible in order to get larger separation efficiency. Cermak et.al. studied various types of distillations for fatty acids[13]. According to them in case of fatty acid, the formation of emulsions in the last stage of condensation is major disadvantage of molecular distillation. At this stage, a water spray is used. According to studies carried out by Hu et.al., with increase in temperature, the purity of product increases but yield decreases[14].They concluded that seal oil fatty acids can be successfully purified for healthcare applications. Ooi et.al used molecular distillation for Extraction of carotenes from palm oil[15]. Karanja, malkanguni, undi, and sesame oils were molecularly distilled by Bhat et.al.[16]. Sandler and Bird used molecular distillation for detection of milk fat adulteration.

## Conclusion

The molecular distillation is very important operation in the separation of products in health and food sector. In these sectors, the materials to be handled are heat sensitive and undergo decomposition and deterioration when exposed to high temperature. The parameters affecting the molecular diffusion are feed and

condensation temperature, feed rate, pressure and concentration of feed. With increase in temperature and decrease in pressure, the separation increases. It can be concluded that, by using optimum operating conditions, molecular distillation can be used to separate many heat sensitive components effectively.

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