

Model and Analysis of Vacuum Membrane Distillation for the Recovery of Volatile Aroma Compounds from Black Currant Juice

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Fruit juice purification involves an increase of the solid content of the juice from 10–12 % up to 65–75 % (w/w), in order to reduce liquid volume. This lowers storage, packaging, and transportation costs, and inhibits microbial spoilage. Juice concentration steps usually involve aroma-stripping.

Lately, membrane distillation has become an alternative. Lower temperatures, reduced vapor spaces (compared to conventional distillation), lower pressures (compared to other pressure driven membrane separations), less membrane/process solution interactions, less mechanical demands on the membrane, and negligible conductive heat loss through the membrane are some of the benefits of membrane distillation over other processes. Depending upon the method creating the feed/permeate pressure difference, membrane distillations fall in one of the categories:

- Direct-contact-membrane-distillation, DCMD
- Sweeping-gas-membrane distillation, SGM
- Vacuum-membrane-distillation, VMD

In VMD, the feed solution is on one side of the membrane and a vacuum is on the other side, in order to create a driving force for a trans-membrane flux. The membrane acts as a support for a vapor-liquid interface. Depending on the pore sizes and operating conditions, VMD may impart some selectivity based on individual Knudsen diffusing species. However, the degree of separation is largely determined by the vapor-liquid equilibrium conditions on the membrane/solution interface.

The aroma profile of black currant juice comprises more than 60 components. We have used twelve to validate a VMD model. The model predicts permeate concentrations given the feed composition, operating temperature, and vacuum pressure. The feed concentrations are assigned experimental values in the simulations. The concentrations are so low that infinite dilution can be assumed. This leads to a simplification resulting from treating the system as twelve aroma/water binaries. This model is integrated with property models for both the aroma compounds and the polymer(s) used for the membrane. The model has been validated using experimental results.