«Vapor permeation» method

Description:

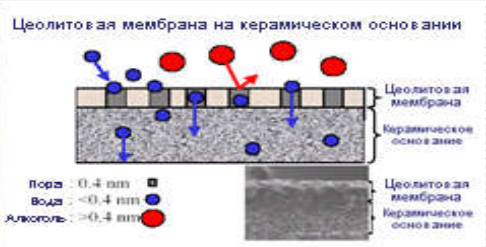
The method is based on the use of zeolite membranes, which are ceramic tubes with zeolite sputtering. The vapor phase (consisting of water and ethanol) enters the intertube space of the dehydration apparatus; the water vapor (whose molecular value is smaller than the pores of the selective membrane) passes through a ceramic tube with zeolite sputtering and is carried away by a vacuum pump. Ethanol vapor (with molecule size larger than pores of the selective membrane) leaves the apparatus and enters the condenser of dehydrated ethanol. The driving force for water vapor penetration through the zeolite membrane is the pressure difference between the tube space (created by the vacuum pump) and the intertube space (created by the heating steam of the evaporator apparatus and the dehydrated ethanol condenser).

Advantages:

- Minimum downtime (due to low operating costs and no regeneration);
- maximum degree of dehydration (due to high membrane selectivity);
- low operating costs and energy costs;
- minimization of human factor influence on the process;
- rapid start-up and shutdown.

Disadvantages:

- High initial investment;
- limited lifetime of the membranes.



«Vapor permeation» method

Operational parameters		
finished product productivity	100,0	m3/day
alcohol concentration in the finished product	99,8	%, mass.
Feedstock capacity	104,0	m3/day
alcohol concentration in the original product	94,0	%, mass.
amount of return (recycling)	4,0	m3/day
alcohol concentration in the return (recycle)	2,0	%, mass.
consumed resources: Consumption of heating steam, kg steam/liter of finished product, not more than 0.45; Consumption of cooling water 30 degC with ΔT=15 degC, 1 /1 of finished product, not more than 24; Consumption of cooling water 3 degC with ΔT=7 degC, not more than 2.4; Power consumption, kW-h/liter of the finished product, not more than 0.012;		
additional costs due to recycling	4,0	%
number of staff	1	Per./shift
indicative investment	…	thous. $

Zeolite-based membranes such as NaA

NaA-type zeolites are used for dehydration of various media in the adsorption process. The pore size of NaA-type zeolite is 0.41 nm, and the hydrophilic ability of this zeolite is characterized by a high separation factor. The membrane of this zeolite is used for the same purpose. In case of liquid phase it is called "pervaporation", in case of vapor phase it is called "vapour permeation".

Zeolite membranes are used in the form of a thin layer on a ceramic base, which makes it possible to conduct the process at high flows. In industrial scale application of zeolite layer on inner surfaces of ceramic elements (tubes) is preferable to avoid mechanical damages and to organize optimal flow.

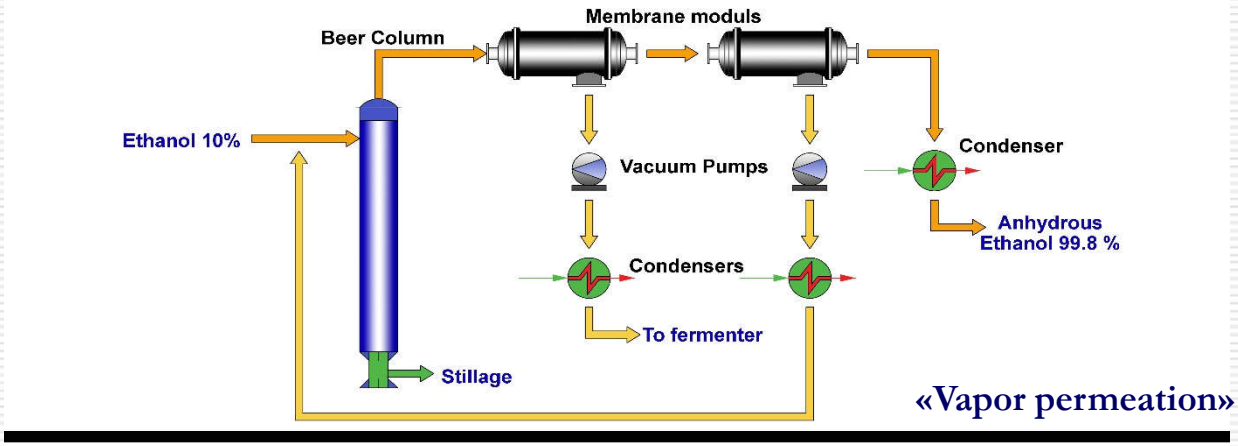
NaA-type zeolites in the form of membranes can be applied to tubular bases represented by mono-channel or multi-channel tubes.

NaA-zeolite membranes can be used for dehydration of organic solutions. For example, dehydration of ethanol, to obtain water content in ethanol < 0.2 % (wt.), to achieve the necessary condition of using ethanol as fuel.

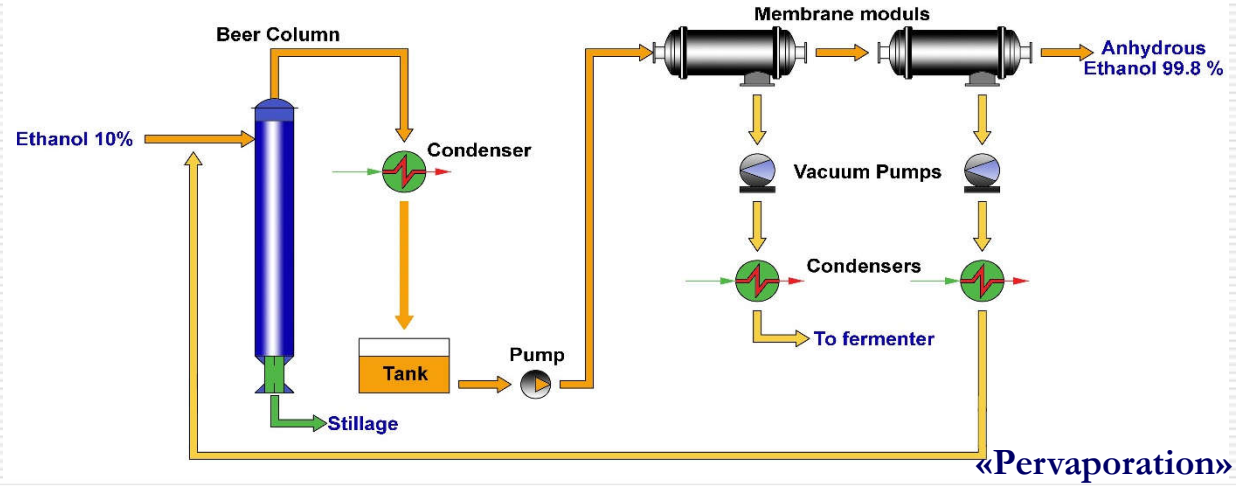
The use of zeolite membranes makes it possible to run the dehydration process at higher parameters: P = 6.5 bar (abs.) and t = 135 ˚C.

The dehydration equipment based on zeolite membranes due to its high selectivity, reliability and durability is unambiguously superior to the existing analogues: packed columns and polymer membranes.

Comparison of dehydration methods



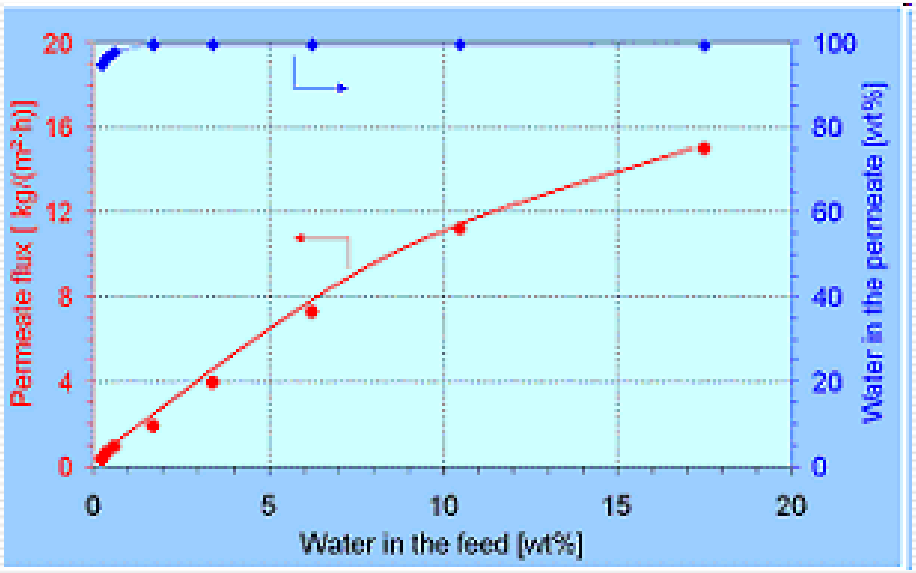
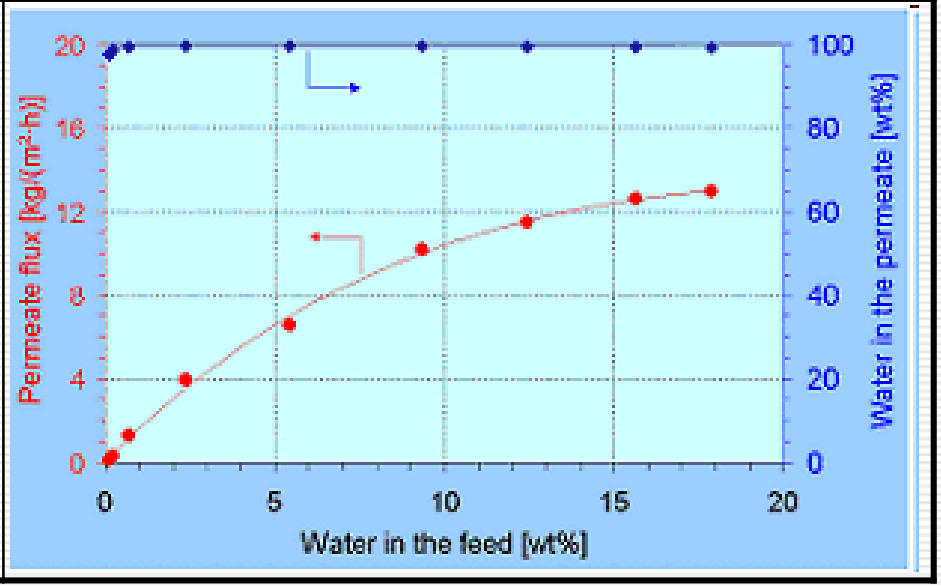
«Vapor permeation»

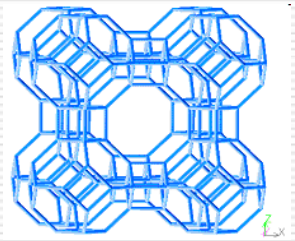


«Pervaporation»

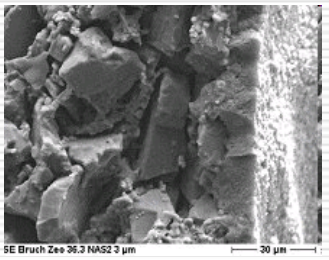
Zeolite membrane dehydration equipment is the most modern, economical and advanced. The only question is the method of dehydration: "Pervaporation" or "Vapor permeation" (vapor or liquid phase). For integration of ethanol dehydration plant into the existing scheme of a distillery, it can be unambiguously said that "Vapor permeation" method is more acceptable and economical due to the absence of intermediate condensation of ethanol vapor coming out of rectification.

Comparison of dehydration methods

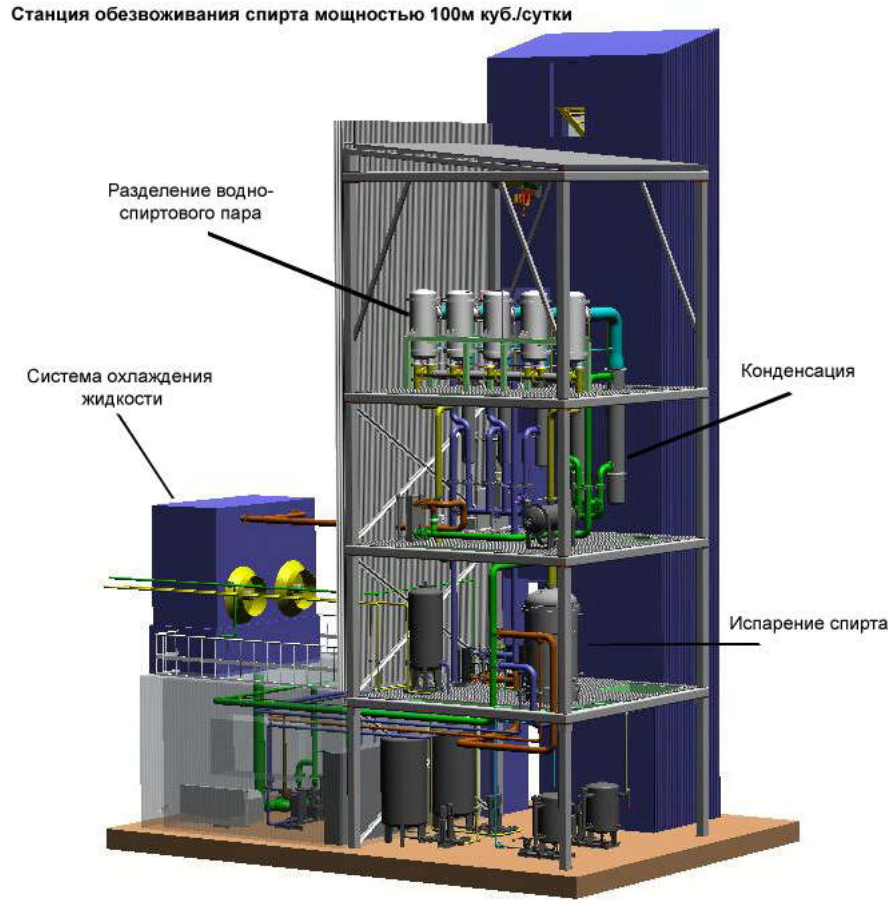
«Vapor permeation»	«Pervaporation»
	

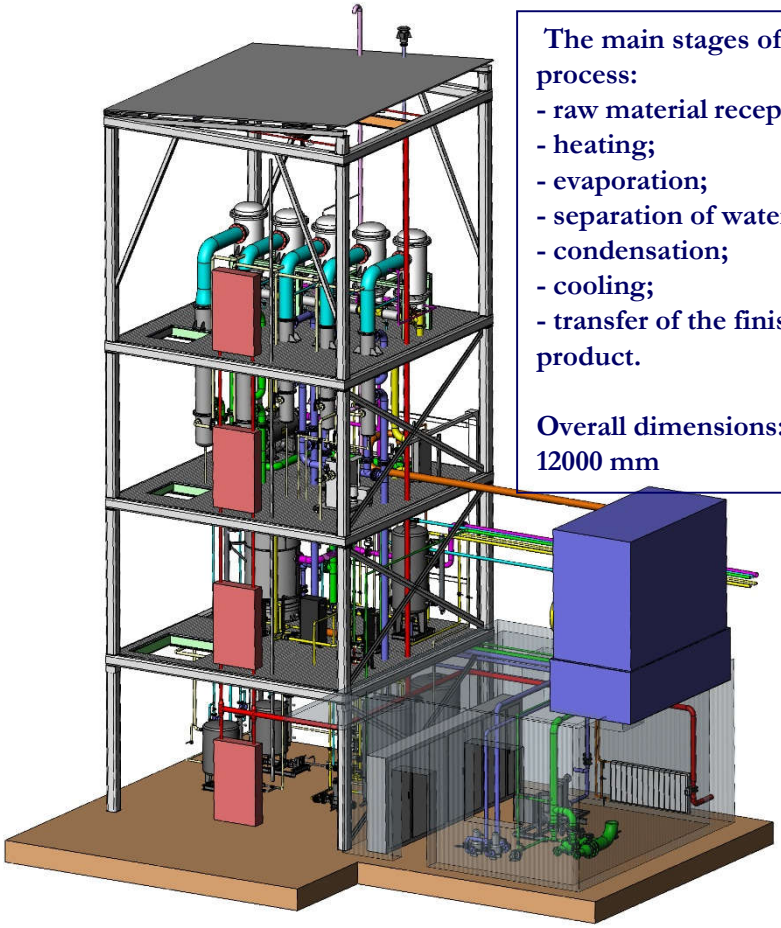






Plant equipment layout «Vapor permeation»





The main stages of the process:
- raw material reception;
- heating;
- evaporation;
- separation of water vapor;
- condensation;
- cooling;
- transfer of the finished product.

Overall dimensions: 8500 x 12000 mm

Dehydration technology