SUPERIOR PERFORMANCE WITH ZEOCHEM® MOLECULAR SIEVE Z3-03 FOR ETHANOL DEHYDRATION

INTRODUCTION

Molecular sieves are currently used in many ethanol dehydration plants to produce absolute alcohol. This is done by the dehydration of the overhead from the rectification column. This technology finds particular use in instances where there is a requirement for ethanol which has not been contacted with benzene and can therefore be used for pharmaceutical purposes, although many plants are finding the economics of such processes very worthwhile in relation to older technologies. While older technology used a liquid phase dehydration technique, more modern technology uses PSA at high temperature to effect the dehydration.

APPLICATION

Ethanol dehydration is an increasing application for molecular sieves. Normally adsorption is used for removal of trace impurities while liquid scrubbing or distillation is used for bulk separations. This is also true for ethanol but, since normal distillation will only produce approximately 190 proof alcohol, the molecular sieve dehydration unit would see an abnormally high water content. We are able to design a practical drying system because of the unique properties of 3A molecular sieve.

Zeochem AG has developed a special grade of 3A molecular sieve formulated for ethanol dehydration. This grade Z3-03 is an especially hard, dense bead which can tolerate the extreme stresses of ethanol drying.

Ethanol and water are both highly polar compounds and are very strongly adsorbed on standard adsorbents. Because of the co-adsorption of ethanol the actual water removal capacity can be very low. A 3A molecular sieve solves this co-adsorption problem because it has a reduced pore diameter (3 angstrom). This excludes the 4.4 angstrom ethanol molecule but admits the 2.8 angstrom water molecule. It is possible to have water loadings on 3A molecular sieve as high as 18-20 wt% because of the high water concentration and ethanol exclusion.

Ethanol can be dehydrated in either gas or liquid phase. If the gas phase is chosen then pressure swing is normally the best choice. Normally the working water capacity for pressure swing units is low (1-4 wt%) in comparison to thermal swing units because only a small fraction of the water is removed by regeneration during the desorption step. Pressure swing regeneration is practical in this case because of the very short cycle times, typically of the order of 2 to 30 minutes.

Liquid phase requires a thermal swing regeneration. A typical thermal swing liquid unit consists of two beds, one adsorbing and one on regeneration. One bed adsorbs up flow from 2 to 8 hours while the other bed is drained, heated and cooled, then refilled. There are several methods to heat a bed during thermal swing regeneration. The most common is to use a recirculating stream of nitrogen, but CO_2 can also be used. It is necessary to heat the beds to at least 230° C with a 260° C gas stream.

The beds are normally cooled and filled with *dry* ethanol effluent from the bed on dehydration. There is a danger of a violent temperature excursion if a regenerated bed is rapidly filled with wet ethanol. This is due to the very high water load and the consequent heat of adsorption (1800 btu /pound of adsorbed water). There have been cases of runaway exothermic reactions forming ethers and aldehydes because of these heat surges. Thus we emphasize filling a freshly regenerated bed with dry ethanol. This dry ethanol acts as a heat sink when wet ethanol is added to the bed.

ADVANTAGES OF ZEOCHEM® MOLECULAR SIEVE

1. **High Density Beads**
   The high density beads produced by Zeochem AG give a higher adsorption loading per unit length and hence a better usage of the volume inside the columns.

2. **Good Dynamic Performance**
   A second important measure of performance in addition to the equilibrium capacity is the rate of adsorption as measured in terms of MTZ or mass transfer zone length. This maximises the use of the bed by minimising this lost bed length or MTZ length.

3. **High Strength Beads**
   ZEOCHEM® molecular sieve beads have a high crush strength, a very smooth surface and very round shape and out-perform competitive products on physical properties.

4. **Good Attrition Resistance.**
   Allied to the absolute strength of the particles is the ability to resist the high abrasion forces present in the beds. The regular temperature and pressure changes tend to produce attrition between the individual beads.

5. **Good Flow Distribution**
   The carefully controlled bead size ranges are narrow and are designed to suit this particular application. Perfectly formed spherical particles within this narrow size range ensure an evenly packed bed, and hence an even flow distribution.

In addition to offering the optimum product for the application Zeochem AG also offers **Technical Service** as part of our service to potential customers:

a) Zeochem AG experts cooperate with the customers to optimise the unit design to their individual requirements.

b) Zeochem AG offers back-up technical service, while trouble shooting services are also available.

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