

## SUPERIOR PERFORMANCE WITH ZEOCHEM® MOLECULAR SIEVE Z4-04 FOR NATURAL GAS DEHYDRATION

### The Duty

Natural gas dehydration plants have been operating world-wide on a variety of technologies and in a number of variations for many years. Gases to be dehydrated cover straight natural gas, through heavier associated gases, and sour gases of various types; while molecular weights may extend over the range from 18 to 25. Many plants use 'turbo-expander' technology to compress, chill-down and liquefy the natural gas to enable various heavier and more valuable components to be separated out from the imported feed gas. In order to work at these low temperatures the natural gas must be dried to very low dew-points, typically of the order of -100°C, and molecular sieves are the commonly used technology for this duty. This has for many years been accepted as a fairly straightforward duty for molecular sieves. It is also a duty which is fairly costly in terms of the energy required for pressure loss, and for regeneration heating, and also in the need to shut the plant down at regular intervals to replace the molecular sieve charge – typically every two to four years.

### Recommended Product For This Duty

ZEOCHEM® Z4-04 molecular sieve is a specially developed form of the A-type crystal structure which is particularly suitable for use in natural gas dehydration plants and similar processes. The combination of an open crystal structure, a high equilibrium capacity for moisture, together with excellent dynamic characteristics, superb physical properties marks ZEOCHEM® Z4-04 as a new standard for natural gas dehydration applications; and we are now able to offer a molecular sieve with properties which we consider are the best available. It is already approved by major natural gas processing companies.

### Performance Improvements Over Current Alternative Products

Additional improvements now include:

- Improved Dynamic or Kinetic Characteristics
- Improved Hydrothermal Stability
- Improved Physical Strength under Plant Operating Conditions

### 1. Improved Dynamic or Kinetic Characteristics

Zeochem AG has developed a product with exceptionally good dynamic performance. This can be seen by measuring the rate at which the moisture is adsorbed, as seen by the Mass Transfer Zone Length (MTZ length).

Collaborative work has shown that Z4-04 gives kinetic benefits resulting in a significant shortening of the MTZ length as against comparable competitive products.

### 2. Improved Hydrothermal Stability

A second important performance factor in the field is the hydrothermal stability. A molecular sieve mainly loses capacity due to the combined effects of

- a) heat and
- b) water vapour pressure.

When these two conditions are encountered in, for example, the regeneration step of an adsorber column, the molecular sieve suffers a loss in capacity.

By intensive development work in the laboratory and from operational feedback from on-site, Zeochem AG has been able to produce a product with exceptionally good hydrothermal stability as characterised by a very low rate of decay of the capacity for moisture.

### 3. Improved Physical Strength under Plant Operating Conditions

As an adsorber bed goes through its operational cycle of adsorption and regeneration, it experiences a series of temperature and pressure changes which impose a physical strain on the individual beads. Thorough research and development work at Zeochem AG Uetikon has resulted in unique process improvements in our manufacturing route which in turn has enabled us to offer a product where the resistance to break-down as characterised by our 'freeze-thaw' test is considerably better than competitive grades.

## ADVANTAGES

ZEOCHEM® Z4-04 molecular sieve continues to offer the following performance benefits

### 1. Excellent Mechanical and Bed Crush Strength Data

ZEOCHEM® Z4-04 bed crush strength data is the best in the industry. Like most inorganic materials, adsorbents are much stronger under compressive forces compared to tensile forces. The spherical shape of ZEOCHEM® Z4-04 ensures all physical forces which impinge on it are compressive forces, resulting in lower pressure drop and longer life. Zeochem's unique manufacturing process also minimises the internal stresses within the particle itself.

### 2. Better Flow Distribution

The spherical shape of ZEOCHEM® products and the controlled distribution of bead sizes provide even packing in the columns, better flow distribution and superior mass transfer characteristics over a wide range of operating conditions.

### 3. Low Pressure Drop

Pressure drop stability is important over the thousands of operating cycles encountered in natural gas dehydration. ZEOCHEM® Z4-04 shows minimal product break-up and superior attrition resistance. The spherical shape and smoothness of ZEOCHEM® Z4-04 provides a lower pressure drop than with other adsorbents. This gives lower compression costs, greater throughput and / or greater liquids recovery.

### 4. More Capacity per Unit Bed Volume

ZEOCHEM® Z4-04 with its high packed density provides more adsorption capacity per unit volume of packed bed. You gain from reduced operating costs due to higher throughput or from longer adsorption cycles resulting in longer lifetime.

### 5. Excellent Mass Transfer Characteristics

The high surface area per unit volume of packed bed permits excellent mass transfer rates. An open macropore also enhances mass transfer efficiency. These characteristics increase the overall bed capacity to adsorb water.

### 6. Engineering Service

Zeochem AG has a policy of selling not just a product, but also providing the technical service to help our customers to maximise the output from their plant. Zeochem AG can evaluate each situation and make design and operating recommendations specific to each plant's needs. Services available to our customers include process simulation capabilities, on-site trouble shooting and optimisation, start-up assistance and personnel training programs.

All the above cost advantages result in substantial savings which are summarised in the enclosed table.

## COST COMPARISON

### ZEOCHEM® Z4-04 BEADS VERSUS CURRENT INDUSTRY STANDARD 4A ALTERNATIVE SOURCE EXTRUDATES

Beaded molecular sieve has a number of cost advantages over pelleted or extruded products as described on the previous page. The following table shows these differences in terms of the OPERATING COSTS per year.

It does NOT include the extra earnings resulting from the less frequent shut-downs or from better product recovery. (Example see next page)

<b>Basis</b>	<b>Natural Gas Dehydrator operating with two beds on a 16 hour cycle and regeneration with dry product gas</b>
Flow Rate	200,000 Nm <sup>3</sup> /hr
Temperature	25°C
Pressure	32 bara
Molecular Weight	20
Heat Capacity	2.4 kJ / kg / °C
Adsorption time	8 hours
Service Lifetime	minimum 3 years, but projected 4 years for Z4-04
Regeneration time	5 hours heating at a temperature of 280°C
Inlet Water	saturated at plant conditions ie 193 kg / hr
Outlet Dew Point	< -100°C

<b>Adsorbent Type and Operating parameters</b>		<b>ZEOCHEM® Z4-04 beads 2.5-5 mm</b>	<b>Typical 4A 1/8 inch extrudates</b>
Bed Internal Diameter	mm	3000	3000
Bed Height	mm	3000	3580
Weight of adsorbent per bed	kg	15400	16550
Pressure Drop	mbar	350	480
Adsorbent unit cost	US\$ per kg	3.10	2.5
Regeneration Flow	Nm <sup>3</sup> / hr at 32 bar	10550	11100
Furnace Requirement	kWh	1660	1750
<b>Cost Summary</b>	<b>in US\$ per year</b>	<b>4 year life</b>	<b>3 year life</b>
Adsorbent Cost in US\$ per year		23870	27584
Pressure drop cost at 2.42 US\$ / mbar / 1000 Nm <sup>3</sup> /hr per year		169400	232320
Heating cost at 6.83 US\$ / 1000 kWh		62075	65440
<b>Total Costs in US\$ per year</b>		<b>255345</b>	<b>325344</b>

The above table clearly shows that the yearly pressure drop and heating costs alone can far outweigh the initial costs of the molecular sieve, over the assumed 3 year service lifetime.

IN THIS CASE SAVINGS TOTAL  
US\$ 69,999 PER YEAR OF OPERATION

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Would you like to receive further information?  
We are pleased to help you at any time.

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