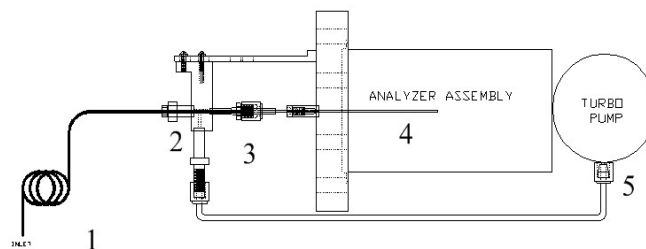


## High Performance EO Analysis by MS Using a Molecular Leak Inlet System

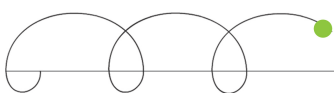
A critical component of any process mass spectrometer is the sample introduction system. If not properly designed it will lead to both quantitative inaccuracy and instrument maintenance problems. The Monitor IND 3000 has a number of different inlet system options. After extensive evaluation on-line for ethylene oxide stream analysis, we have determined that a uniformly heated molecular leak system provides the best accuracy over a wide range of compositional change with the best operating productivity.

The IND 3000 molecular leak inlet consists of five carefully designed components, as shown in the following diagram. A heated capillary (1) takes a small sample from the conditioned process stream into a heated intermediate pressure flow-by region (2). The pressure of this region is maintained in the 1-3 mbar range, using the high pressure intermediate (IPH) drag stage of the turbomolecular pump (5). A small portion of the reduced pressure sample is admitted into the mass spectrometer through a heated critical orifice (3), the diameter of which is designed such that the knudsen number for flow through it is greater than unity. Under these conditions the flow is molecular and therefore independent of gas viscosity changes. The representative gas sample is then directed to the ion source via a resistively heated sample tube (4). All inlet surfaces that can be in contact with the sample are heated up to 160° C to prevent condensation yet not high enough to decompose individual analytes.



- 1 flow divider capillary
- 2 intermediate pressure region (1-3 mbar)
- 3 critical orifice
- 4 sample tube to ion source
- 5 IPH drag stage of TMP31+

Changes in sample composition, and therefore sample gas viscosity, can lead to significant discriminatory errors in quantitation if the sample introduction into the mass spectrometer is made under viscous flow conditions. A well designed molecular leak is generally regarded as nondiscriminatory with respect to gas composition changes. To prove this point, the following data were acquired on two cylinder gases for 6 components in the EO stream analysis. The calibration was performed on the methane stream and those response factors used for nitrogen stream measurement without recalibration. Observe the accuracy for the ballast gases, methane and nitrogen, as the levels change from 60-70% to 0%. This is a common occurrence during plant startup or catalyst change-outs, where reactor conditions begin with nitrogen ballast, and then is often exchanged to methane over time. This switchover can be made without recalibration while maintaining accurate data.



	CH4 Stream Certified Cylinder	CH4 stream IND3000 Analysis	N2 stream Certified Cylinder	N2 stream IND3000 Analysis
methane	63.98	63.97	0.00	0.00
argon	2.00	2.00	0.08	0.09
nitrogen	3.00	3.00	71.51	71.52
oxygen	0.00	0.00	4.97	4.94
ethylene	18.00	18.00	13.27	13.40
ethane	3.00	3.00	0.00	0.00

Thorough inlet heating insures that surfaces are free from “sticky” and condensable species. This results in better quantitative analysis and fewer problems with plugging or flow restriction by water and glycols. Monitor recommends that sample streams be adequately conditioned prior to sampling. Generally a condensable trap followed with Balston particulate filter is adequate. Additional membrane filters can be used, but are not generally necessary.

Monitor Instruments’ Series 3000 cycloidal mass spectrometers provide process analysis in a wide variety of industries. Our application specific inlet systems, versatile Gas-Wizard™ software, and stable analyzers assure cost effective, high quality process control information. We invite you to visit our website ([www.monitorinstruments.com](http://www.monitorinstruments.com)), to request information via e-mail at [info@monitorinstruments.com](mailto:info@monitorinstruments.com), or post at 290 East Union Rd., Cheswick, PA 15024, USA, or to contact us by telephone at +1.724.265.1212 or fax at +1.274.265.1199. We will give your application the careful, confidential consideration it deserves.

