ANALYZER
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HIDEN ISOCHEMA

In the spotlight:

IGA-003-MC takes centre stage in characterizing adsorbents for gas separations

In November last year, a paper describing the method used by the IGA-003-MC was published in *Industrial & Engineering Chemistry Research*.

The Integral Mass Balance (IMB) method allows binary gas adsorption isotherms to be measured quickly and accurately, by combining an open (flowing) volumetric system with in-situ gravimetric measurement and determination of the outlet gas composition using a quadrupole mass spectrometer.

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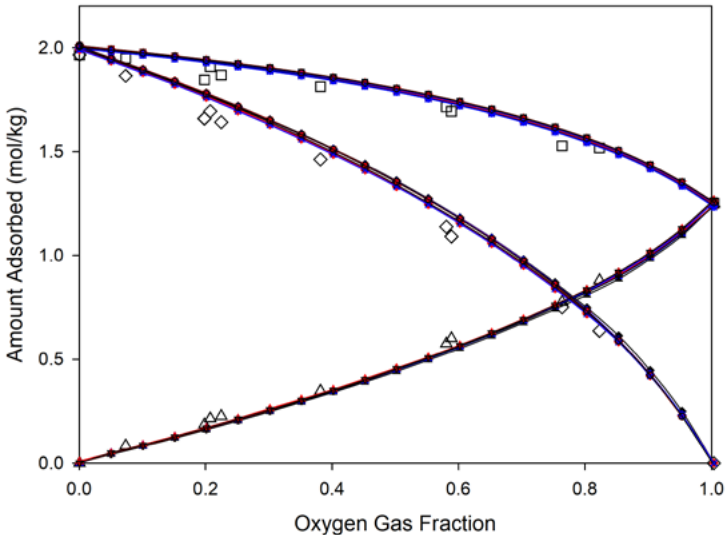
Binary adsorption equilibria are of widespread interest for the assessment of nanoporous materials for gas separations using processes such as Pressure Swing Adsorption (PSA) and Temperature Swing Adsorption (TSA).

When assessing new materials for these applications, it is important to determine properties such as working capacity and selectivities. Models, such as Ideal Adsorbed Solution Theory (IAST), are widely used to estimate multicomponent behavior from pure gas data, but their accuracy depends on the properties of the gases and the adsorbent. When designing and optimizing separations, it is important to check the results of model calculations, as large errors in calculated selectivities, for example, are possible.

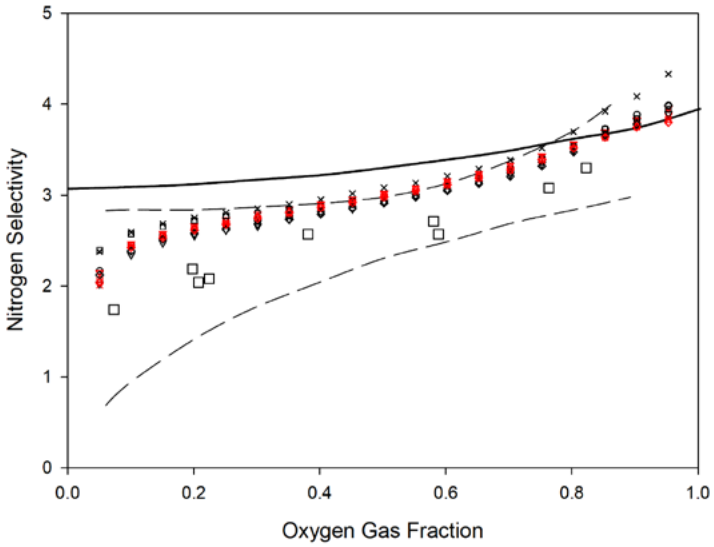
The **IGA-003-MC** consists of an IGA system equipped with a module for controlling the flow of gas mixtures, a specially designed IMB reactor, and a Dynamic Sampling Mass Spectrometer (DSMS). To perform an IMB experiment, a gas mixture is introduced at the base of the IMB reactor, and the weight response and outlet gas composition are measured as a function of time. Integration of the various signals allows calculation of the quantities of each adsorbed component.

Advantages of this approach include the combined speed and accuracy of the measurement, compared to existing techniques, and the ability to measure full binary adsorption isotherms in a single, automated experiment, with no need to regenerate the material between each point. The method can also be readily extended to measure the adsorption of ternary and higher mixtures.

In the recently published paper, the technique was demonstrated and validated by replicating the measurement of N_2/O_2 adsorption by zeolite 5A, using the same sample as a previous study. The work was carried out in collaboration with Professor Orhan Talu of Cleveland State University in the US.



Binary N_2/O_2 adsorption isotherms for zeolite 5A measured on an IGA-003-MC



N_2/O_2 selectivities for zeolite 5A calculated from data measured on an IGA-003-MC

"The development of the IMB method is a really exciting advance for Hiden Isochema, as binary and multicomponent adsorption is a technically challenging field. The IGA-003-MC now offers researchers the ability to rapidly characterize adsorbents for gas separations using small samples."

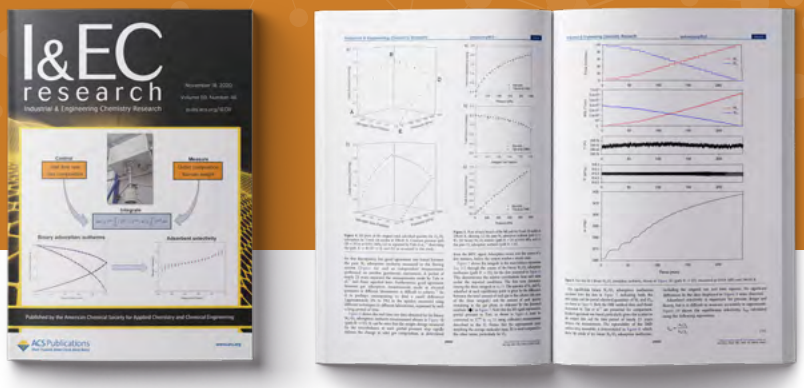
Dr Mark Roper
Sales & Marketing Director, Hiden Isochema

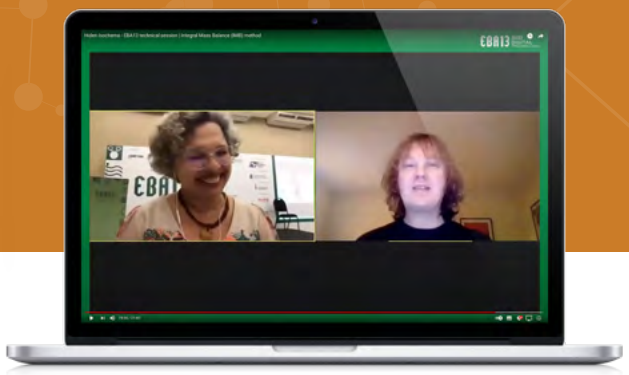
The IMB method was also showcased at EBA13, the 13th Brazilian meeting on adsorption.

EBA13 2020
13º Encontro Brasileiro de Adsorção

Dr Darren Broom, a co-author of the paper and Product Manager at Hiden Isochema, gave a talk on 'Measuring binary gas adsorption equilibria using the Integral Mass Balance (IMB) method', including the binary N_2/O_2 adsorption isotherms measured to validate the technique.

The talk is available to view on our YouTube channel

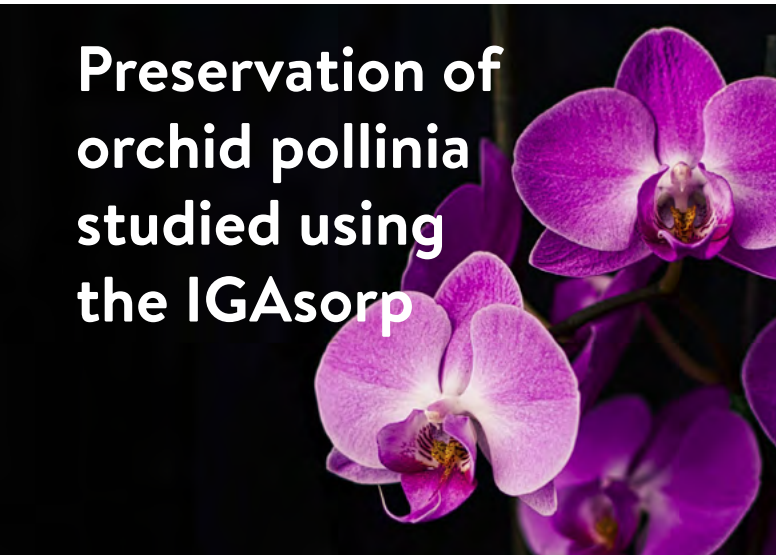




Full details are reported in the journal *Industrial & Engineering Chemistry Research*
DOI: 10.1021/acs.iecr.0c04162

Prof. Diana Azevedo interviews Dr Darren Broom at EBA13

Preservation of orchid pollinia studied using the IGAsorp



Scientists from the UK and Brazil have recently published findings of a study to investigate potential techniques for storing orchid pollinia.[1]

Moisture sorption by pollinia from two different species of orchid was characterized by determining isotherms using an **IGAsorp** dynamic vapor sorption analyzer at the research facility at the Royal Botanical Gardens (RBG), Kew, in the UK.

The study, conducted by RBG alongside Brazil's Federal University of Rio Grande do Sul and University of Western São Paulo, concluded that pollen of both species is desiccation tolerant and can be stored at sub-zero temperatures as a means of supporting ex situ conservation of species and breeding programmes.

Reference:
[1] C. C. Custodio, N. B. Machado-Neto, R. B. Singer, H. W. Pritchard, P. T. Seaton & T. R. Marks, Protoplasma, 2020, 257, 1401–1413

RSC INTEREST GROUP
POROUS MATERIALS

Global online seminar series continues into 2021

Hiden Isochema is delighted to continue sponsoring and supporting the seminar series organized by the Royal Society of Chemistry's Porous Materials Interest Group.

Originally set up in response to the initial Covid-19 lockdown, the aim of the series was to bring together the porous materials community at a time when many facilities, laboratories and offices were forced to close. Leading academics from around the world have presented regular online seminars on a wide variety of key topics, with attendees participating from their home offices. Due to popular demand the seminars will continue to run throughout 2021, with an exciting line-up of speakers planned.

For more details check out @RSC_PorMat on Twitter.

Recycling refrigerants to combat climate change

A project run by The University of Kansas in the US aims to develop energy efficient and sustainable processes for separating and recycling refrigerant mixture components.

Project EARTH (Environmentally Applied Research Toward Hydrofluorocarbons) is a new research project headquartered in the Shiflett Research Group at University of Kansas (KU) School of Engineering. The research is focused on identifying sustainable processes for the selective separation of hydrofluorocarbon (HFC) refrigerant mixtures.

Supported by a four-year, $2 million grant from the US National Science Foundation (NSF), the Project EARTH collaboration comprises four universities along with several private corporations, including Hiden Isochema, and the US National Institute for Standards and Technology (NIST).

Much of the experimental work will take place at KU, where the NSF award will support equipment and materials costs, as well as the training and education of a new generation of engineering students. Eventually, the researchers hope to provide a distributed chemical manufacturing process for more than 100 EPA certified recyclers in the US.

Hiden Isochema's **IGA** and **XEMIS** instruments are being used to measure the uptake of different components of HFC refrigerant mixtures by ionic liquids and various adsorbents. A recent paper, for example, reported the use of an **IGA-003** to determine both the solubility and diffusivity of HFC-32 and HFC-125 in imidazolium-based ionic liquids for the separation of R-410A.[1]

Kalin Baca, Graduate PhD Fellow at the University of Kansas' Shiflett Research Group using a Hiden Isochema IGA instrument

Reference:
[1] A. R. C. Morais, A. N. Harders, K. R. Baca, G. M. Olsen, B. J. Befort, A. W. Dowling, E. J. Maginn & M. B. Shiflett, Industrial & Engineering Chemistry Research, 2020, 59, 18222–18235

Hiden Isochema will be supporting the following virtual events in 2021:

DATE	CONFERENCE
31 May – 4 June	Interpore
9 – 11 June	Enerstock
23 - 25 June	Faraday Discussion: MOFs for energy and the environment
5 – 9 July	FEZA
12 – 15 July	15th International conference on materials chemistry (MC15)
13 – 15 September	EuroMOF
7-19 November	AIChE Annual Meeting

Dates are subject to change, please confirm details with event organizers.

Follow us on Twitter **@HidenIsochema** for our latest updates, research, materials science and anything else we find interesting!

PUBLICATION ROUND-UP

Metal-Organic Frameworks

High Ammonia Adsorption in MFM-300 Materials: Dynamics and Charge Transfer in Host–Guest Binding

X. Han, W. Lu, Y. Chen, I. da Silva, J. Li et al

Journal of the American Chemical Society, 2021, 143, 3153−3161

Researchers from the UK and US present a study of ammonia adsorption in a series of isostructural analogues of the metal-organic framework, MFM-300. A range of techniques were used – including neutron powder diffraction, in-situ synchrotron single crystal X-ray diffraction, and EPR spectroscopy – but both isotherms and cyclic stability tests were performed on an **IGA**. The results showed that isostructural analogues containing different metal centers exhibit significantly different adsorption properties. Furthermore, four of the five analogues were shown to be stable to ammonia cycling, over the course of 20 cycles, while an indium-containing sample degraded under cycling at ambient temperature.

Porous Liquids

Porous Ionic Liquids: Structure, Stability, and Gas Absorption Mechanisms

J. Avila, C. Červinka, P.-Y. Dugas, A. A. H. Pádua and M. C. Gomes

Advanced Materials Interfaces, 2021, DOI: 10.1002/admi.202001982

A team from France and the Czech Republic investigate various properties of type III porous liquids formed from phosphonium-based ionic liquids and metal-organic frameworks (MOFs). In the study, an **IGA-001** was used to determine the solubility of CO_2 and CH_4 in four different porous ionic liquids. It was found that the relative increase in gas sorption in the porous liquids, compared to the pure ionic liquid, is proportional to the relative amount of MOF present. The porous liquids were also shown to be remarkably stable, exhibiting no visible signs of degradation over the course of six months.

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