CPACT News

Issue No. 7
Spring 2005

CENTRE FOR PROCESS ANALYTICS AND CONTROL TECHNOLOGY

ALIVE AND KICKING!!

A meeting to highlight the achievements of the 'KNOW-HOW' project was held at the University of Newcastle on 10/11 January 2005. Posters were displayed and presentations given by the academic leaders and industrial partners who had participated in projects relating to the four themes:

- Monitoring of Chemical Processes
- Monitoring of Solids Processing
- Methodologies for Process Modelling, Optimisation and Model Portability
- Fermentation Monitoring and Control

These were well received and the final section of the meeting was spent discussing 'CPACT - the way forward'.

Although the five universities and 28 supporting companies were disappointed that the submission to EPSRC for an Innovative Manufacturing Research Centre (IMRC) in Process Analytics and Control Technologies was not successful, the interest generated and sector need for such a Centre, together with the enthusiasm for the proposed research activities from our industrial partners, has fuelled a renewed positive approach.

It is clear from the enthusiastic support given to the ethos of shared generic R&D across the process sector that many companies welcome the continuation of the current CPACT activities, i.e. a combination of a progressive research portfolio, technology translation and training opportunities. Significant effort is being expended to investigate alternative funding sources and up-to-date news on the progress of these applications will be provided on the CPACT web pages (www.cpact.com).

In the meantime, CPACT research activity is continuing. The key areas are summarised below with further details available on the web-page:

Strathclyde

- *Direct process mass spectrometry of process liquids*
- *Analysis of VOCs in fermentation off-gas, and evaluation of NIR and MIR spectrometries and passive acoustics for in-process analysis of fermentation liquors*
- *Signal processing and modelling for passive and active acoustics, and development of active acoustic spectrometry for in-process measurements*
- *Monitoring of powder blending, granulation and other solids processes*
- *Development of software to allow spectral information to be incorporated into the control procedures used with the CPACT reactors at Strathclyde*

Hull

- *Chemometrics for the analysis of acoustic/spectral data*
- *Design of experiments and selection of optimal approach for development of robust calibration models*
- *Development of microwave spectrometry methodologies*
- *Curve resolution for calibration-free process analysis*

Newcastle

- *Enhanced process understanding and process performance monitoring methodologies for batch, continuous and batch/continuous systems.*
- *Development of modelling algorithms that incorporate the process dynamics, multiple operating modes and non-linear behaviour.*
- *Novel approaches for the fusion of data from different sources including process and spectroscopic data for the development of robust models.*
- *Development of signal processing tools for the extraction of signals from data that has a very low signal to noise ratio and subsequently the selection of the most appropriate 'variables' for the development of robust calibration models.*
- *The development of techniques for the transfer of models between process lines or different operational sites.*

APACT 05

ADVANCES IN PROCESS ANALYTICS AND CONTROL TECHNOLOGY CONFERENCE

20-22 April 2005

Process Analysis and Control for Profit

Process analysis and control technologies are increasingly important to manufacturing companies in the pharmaceutical, chemicals, petrochemicals, biotechnology and food industries. The financial, safety and environmental benefits of Process Analysis and Control (PAC) are proving powerful incentives and increasing numbers of companies want to participate in the PAC revolution.

- *How do we develop a successful PAC strategy?*
- *What benefits can we expect to achieve?*
- *Which techniques and methods should we use?*
- *What new technologies are being developed?*
- *Where do we get the training?*

For the answers to the above questions and much more, attend APACT 05!

The 2005 APACT conference will take place at the Marriott Forest of Arden Hotel on the outskirts of Birmingham. This is an open forum for the presentation and discussion of recent advances in engineering and scientific topics relevant to process analytics and control technologies. Plenary and keynote speakers will describe the formulation and implementation of PAC strategies, review the benefits that can be achieved, and report developments.

SUCCESSFUL USE OF PROCESS ANALYSIS AND CONTROL INVOLVES MANY TECHNOLOGIES - IT IS TRULY A MULTIDISCIPLINARY ACTIVITY.

Following the success of previous conferences in Glasgow, Edinburgh,York and Bath, APACT 05 will be a three-day meeting featuring plenary and parallel sessions on topics crucial to the achievement of manufacturing excellence.

The conference is open to all interested participants and provides opportunities for academics and industrialists to present their research to an informed multi-disciplinary audience. The programme will include contributed lectures, poster presentations and a vendor exhibition. Three pre-conference introductory courses will also be held in the following topics: Introduction to Process Analysis (for Engineers); Process Control for Beginners; Introduction to Chemometrics.

THERE'S MONEY TO BE MADE IF PROCESS ANALYSIS AND CONTROL ARE INTEGRATED PROPERLY.

The Marriott Forest of Arden Hotel and Country Club is located in a peaceful setting surrounded by lakes and woodland with the added attraction of two 18-hole golf courses, including the Arden Championship Course which is one of the most famous in England. The hotel has excellent conference facilities and a superb leisure environment including pool, spa, sauna and tennis courts.

Despite its relaxed and peaceful atmosphere, the hotel is only 4 miles from the NEC and Birmingham International Airport and mainline railway station. There is also easy access to the national motorway network.

The social programme will allow plenty of networking opportunities and the conference dinner promises to be a 'not-to-be-missed' event at Warwick castle where guests will be treated to a themed evening of entertainment during a 'Kingmaker's Feast'.

FOREST OF ARDEN HOTEL

Plenary speakers:

- Mel Koch, Center for Process Analytical Chemistry, Washington - *"The impact of micro-instrumentation on process analytical technology"*
- John MacGregor, McMaster Advanced Control Consortium, McMaster University - *"Industrial experiences with digital imaging methods for process monitoring and product quality control"*
- Sandro Macchietto, Department of Chemical Engineering, Imperial College - *"Integrated batch processing"*
- Paul Oram, BP Chemicals - *"The use of applied manufacturing technology to achieve manufacturing excellence"*

WARWICK CASTLE

Keynote speakers:

- Alan Findlay, Microsaic Systems - *"IONCHIP: real-time information from the entire process with a mass spectrometer chip"*
- Peter Fryer, Centre for Formulation Engineering, University of Birmingham - *"Visualisation and modelling of food processes"*
- Jeff Gunnell, Process Analytics, ExxonMobil Chemical Company - *"From pipeline to pixel: an update on progress with NeSSI"*
- George Irwin, Queen's University, Belfast - *"New Directions and Research Challenges in Networked Control Systems"*
- Adam Kowalski, Unilever - *"Challenges facing the manufacture of structured products"*
- James Kraunsoe, AstraZeneca - *"The role of PAT in developing new products"*
- Alasdair Thomson, BP Chemicals - *"Making light work on-line"*

For further information and on-line registration visit the APACT website at www.apact.co.uk or contact Carol Badger or Natalie Driscoll:
Email: admin@cpact.com Tel: +44 141 548 4836

THE USE OF CATERPILLAR FOR DETERMINING THE END-POINT OF AN ESTERIFICATION REACTION

Caterpillar is an adaptive algorithm that can be used for detecting process changes as an alternative to fixed or static models. The idea is to compare the current variation with past variation.

In Caterpillar, two windows are placed side by side in the data (Figure 1) and are moved step-wise through the data. The first window is used as a reference window and the second as a prediction window. A Principal Component Analysis (PCA) model is calculated for the reference window to describe the variation of the samples in this window. The samples in the prediction window are then compared to this model. If several of the samples in the prediction window are significantly different from the reference PCA model, this is interpreted as process change. Both windows are moved through the data allowing the reference model to adapt to any process changes. This means the algorithm will detect the onset of new phases in the process data as they occur.

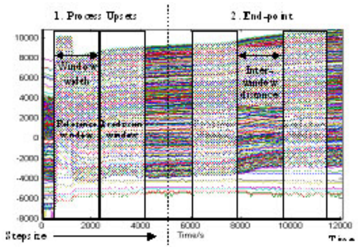


Figure 1: Diagram to show how the Caterpillar algorithm works by moving two windows, through the data, stepwise, either side-by-side to identify process upsets within a reaction matrix (1), or separated by an inter-window distance, to determine end-point of the reaction (2)

The algorithm has been used to track a fluidised bed process using acoustic emission monitoring[1]. It has be used successfully to distinguish between the different phases in the process, and detect the start of agglomeration allowing this to be avoided.

The algorithm has been adapted to enable it to determine the end-point of a reaction. This works in the same way as the original Caterpillar algorithm, but instead of the windows being placed side-by-side, they are separated by an inter-window distance, and the lead window becomes the reference window (figure 1). A PCA model is built based on the samples in the reference window, to model the current variation. This is compared to the past variation in the samples in the prediction window until steady-state variation is observed which is interpreted as the end-point of the reaction. The method has been used to determine the end-point of an esterification reaction.

The acid catalysed esterification of acetic acid with butanol had been monitored by guided microwave spectroscopy (GMS) and near infrared spectroscopy (NIRS). The reaction is carried out at 40°C within a microwave chamber (500 ml), with a 2 mm transmission probe inserted. The spectra are collected every minute for 3 hours. Figure 2 shows typical collected spectra.

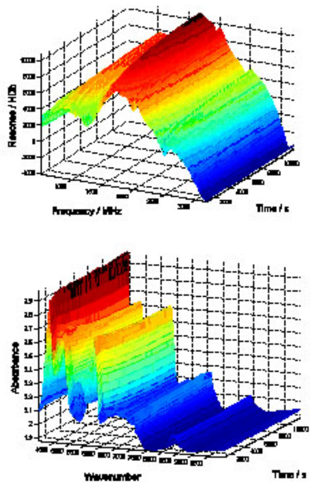


Figure 2: Mesh plots of spectra from the esterification of butanol by acetic acid a) MW spectra and b) NIR spectra

Several variables can be optimised within the algorithm. The number of PCs in the model should equal the number of components in the system. For the reaction considered, the products increase at the same rate and so contribute the same variation to the system and therefore, the two products are seen as one component. This is also true for the reactants which decrease at the same rate. The inter-window distance should be 1 to 3 times the window size. The step size and window size depend upon the data, and must be set small for this data set as it is composed from only around 300 spectra.

The best results were found using 3 PCs, window size of 5, an inter-window distance of 2 times the window size, and a step-size of 1. The results obtained are shown in figure 3.

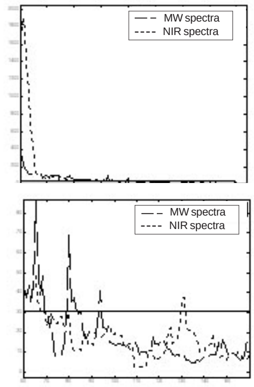


Figure 3: Comparison of Caterpillar results to determine end-point of an esterification reaction. The dotted line indicates the NIR spectra and the dashed line the MW spectra. a) the entire reaction, b) smaller part of the reaction to show when the reaction reaches end-point.

The plots show the results obtained when Caterpillar was applied to the NIR and microwave (MW) spectra. The horizontal line indicates the confidence level, and once the variation in the samples fall below this level, the reaction is deemed to have finished. It can be seen that the two types of spectra do not apparently follow the reaction in the same way. The results seem to suggest different end times for the reaction, which implies a problem with one of the techniques. This may be caused by differences in the way that the spectra are recorded. In the MW method, data are recorded for the complete reaction volume, whereas in the NIR method, only a small volume of the reaction liquid is analysed at any one time. Further work is needed to optimise the use of the Caterpillar algorithm for this application.

Conclusion

This work shows the possibility of using the Caterpillar algorithm to determine the end-point of processes. At present the work is only preliminary and needs to be done to optimise the algorithm, and determine why the NIR and MW results are different in the esterification example.

Researchers:
R. H. Wellock, G.R. Flaten, A.D. Walmsley - Centre for Process Analytics and Control Technology, University of Hull

[1] Caterpillar - an adaptive algorithm for detecting process changes from acoustic emission signals, Flaten, G.R., Belchamber, R., Collins, M., Walmsley, A.D., Analytica Chimica Acta (in press).

MODELLING TEMPERATURE-INDUCED SPECTRAL VARIATIONS IN CHEMICAL PROCESS MONITORING

Background

Spectroscopy in combination with multivariate calibration models has been increasingly widely applied in process monitoring applications. In industrial on-line and in-line applications, spectral measurements are not recorded under well-controlled laboratory conditions. A consequence of this is that fluctuations in external variables, such as temperature, will materialise in a non-linear shift and a broadening of the spectral bands. Hence using the spectra utilised in the development of a calibration model will materialise in the resulting predictions being poor. Consequently the correction of external factors on the spectra is essential for the building of a robust calibration model for process analysis.

A number of methodologies have been proposed to address the issue of temperature fluctuations. The majority of which assume linear temperature effects. However this assumption is only realisable for systems with relatively small temperature variations. If the temperature fluctuates over a wide range, the non-linear effects cannot be appropriately modelled using linear methods. A number of non-linear methods such as Continuous Piecewise Direct Standardization (CPDS) and Extended Penalized Signal Regression (EPSR) have been proposed. However they require the identification of several meta-parameters with these meta-parameters being critical to their performance. The optimization of these parameters is complex and time consuming and in the case of CPDS, the underlying assumptions have not been explicitly explained or proven, thereby reducing the confidence in the predictions attained following its application.

Methodology

An alternative methodology, loading space standardization (LSS), has been proposed. LSS has been proposed for the correction of temperature-induced spectral variations. Its advantages include the validation of the basic assumptions and easy implementation. The basic assumption behind LSS is that the temperature effects on the absorbance of each chemical component in mixture samples can be modelled by simple smooth non-linear functions such as second order polynomials. Since it is difficult, if not impossible, to obtain the pure spectra of all chemical components in the training mixture samples for grey chemical systems (incompletely characterized chemical systems), second order polynomials have been fitted to the elements of linear combinations of the pure spectra at different temperatures that can be obtained through the singular value decomposition of:

$$\mathbf{X}_{ave} = \sum_{k=1}^{K} \mathbf{X}(t_k) / K$$

where $\mathbf{X}(t_k)$ is the spectral matrix measure at t_k. After the model parameters have been estimated, the spectra of future test samples can be standardized to the corresponding spectra as though they had been measured at the training temperatures. The calibration model established under the training temperature can then be used to predict the concentration of the target components in the test mixture samples.

Application Study

An NIR spectral data (http://www-its.chem.uva.nl) was used to evaluate the effectiveness of LSS. The data was assembled from ninety five NIR spectra of 19 ternary mixtures of ethanol, water and 2-propanol, that were recorded over the range 580nm to 1049nm with a resolution of 1nm using a HP 8454 spectrophotometer, equipped with a thermostable cell holder at five temperatures (30°C, 40°C, 50°C, 60°C and 70°C). The spectral region between 850nm and 1049nm formed the basis of the data analysis. The 19 samples at each temperature were divided into 13 training samples and 6 test samples.

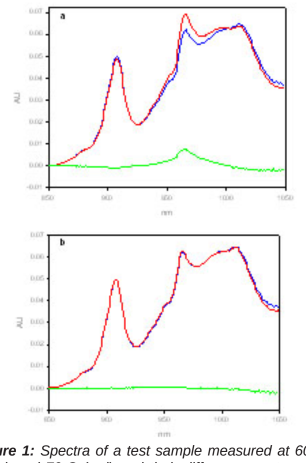


Figure 1: Spectra of a test sample measured at 60°C (blue) and 70°C (red) and their difference vectors (green) before (a) and after correction (b) to 60°C by LSS.

Figure 1a shows the spectra of a test sample measured at 60°C and 70°C and their difference vector. Significant spectral differences introduced as a consequence of the temperature variations can be observed over the range 950nm and 1000nm. When the LSS model was built from the spectra of training samples measured at training temperatures other than 70°C was considered, the temperature effects are effectively removed (Figure 1b). The predictive performance of the LSS correction model is summarised in Table 1.

It can be seen that the local calibration models built at 50°C, 60°C and 70°C can provide satisfactory predictions for the test samples at 40°C, 50°C and 60°C, respectively, when the LSS correction model is applied. In terms of the RMSEP, the results are comparable to those summarised in Table 2, where the predictions are made by PLS local models built at the same temperatures as the corresponding test samples. This demonstrates that LSS can effectively remove the temperature-induced spectral variations and maintain the predictive abilities of the multivariate calibration models.

***Table 1:** Prediction errors (RMSEP) of PLS local models for test sets at temperatures other than the training samples after application of LSS correction model (All the training samples excluding those at test temperature were used in LSS correction model building)*

Temp (°C)		RMSEP		
Sample	*Model*	*Ethanol*	*Water*	*2-propanol*
40	50	0.0108	0.0065	0.0088
50	60	0.0140	0.0102	0.0186
60	**70**	0.0088	0.0063	0.0095

***Table 2:** Prediction errors (RMSEP) of PLS local models for the test sets at the same temperature as the training samples*

Temp (°C)		RMSEP		
Sample	*Model*	*Ethanol*	*Water*	*2-propanol*
40	40	0.0106	0.0067	0.0093
50	50	0.0166	0.0111	0.0218
60	**60**	0.0098	0.0043	0.0083

Compared with other methods for correcting temperature effects, LSS has the advantages of easy implementation and good performance. There are only two parameters in LSS to be determined, the number of significant factors to be retained when performing singular value decomposition of $\mathbf{X}_{ave}$ and the degree of the polynomials. The former can be set as the number of latent variables used in the PLS1 local calibration model and according to previous research, second order polynomials can be used to account for the temperature effects on IR or NIR spectra.

One limitation of the LSS model is the requirement to measure the temperature for every spectrum. Moreover, LSS requires that the same training samples are used to record the spectral data sets at different training temperatures. Thus it may not be applied to historical process data. Further work is on-going to remove this requirement.

Researchers:
Zeng-Ping Chen, Julian Morris, Elaine Martin - Centre for Process Analytics and Control Technology, University of Newcastle.

Chen, Z.P., Morris, A.J. and Martin, E.B. (2004) Correction of Temperature-Induced Spectral Variations by Loading Space Standardisation. Analytical Chemistry (In Press)

KNOW-HOW TO SUCCESS

CPACT members have been quick to recognise some interesting results from the research carried out during 'KNOW-HOW' and these are highlighted in the success stories printed below.

Thermo ELECTRON CORPORATION

VG Sentinel dB Mass Spectrometer

The involvement by Thermo Electron with CPACT has been very beneficial to us, in a number of ways. Firstly, it has given us an opportunity to develop analytical applications that would otherwise not be given attention. Specifically, one of the projects that has been of great interest to us, has been the on-line analysis of liquid streams by mass spectrometry. There has been great progress in this project. The project has demonstrated the type of hardware configuration required for optimum performance and excellent sensitivity for trace components in liquid streams has been shown. Another benefit has been from the work on the application of chemometrics to on-line environmental MS data: this work has helped us gain insight into the problem of species interference. This led us to develop a new mass spectrometer (the VG Sentinel äB) for this application with significantly improved performance in terms of reduced interference between spectrally similar components. Additionally, membership of CPACT has helped keep us informed generally on latest developments in process analytical measurement instrumentation and techniques and their use in industrial control. Lastly, membership of CPACT has provided us with many opportunities for meeting users and technical experts and finding out what are the current analytical challenges and areas for development of our products and services.

Acoustic Monitoring - BP Chemicals

BP Chemicals and other organisations operate fluidised bed reactors and it is crucial to closely monitor bed behaviour to ensure reliable operation. Passive acoustics is seen as a useful tool for achieving this. Intrinsically safe sensors are attached, non-invasively, to the outside of the vessel and pick up the impact of particles with the vessel walls. The signals are analysed using Fourier Transform techniques to convert them to a spectrum of acoustic signal intensity versus occurrence frequency. This data can then be analysed using chemometrics to give a qualitative indication of bed health. However a disadvantage of this technique is that a library of different operating condition data is required to build the model and this can be difficult and time consuming to prepare. It can also be invalidated if the conditions or configuration of the reactor are changed, a common occurrence. To get around this problem, CPACT was approached to investigate the possibility of developing a calibrationless adaptive technique. CPACT researchers suggested using a variation on adaptive principle component analysis that they dubbed "Caterpillar". This algorithm works by adapting based on a moving window of data and alerts the user to any sudden changes in the behaviour of the bed, an important indication of a problem to the operator. The algorithm has now been coded in a Matlab graphical user interface by the CPACT researchers for easy testing by end-users and Process Analysis and Automation Ltd are ready to deploy it in their acoustic monitoring package when the next appropriate order is received. Other applications have also been identified, for example drying and granulation end points for pharmaceutical companies, and these are being investigated.

Researchers:
Geir Rune Flaten, The University of Hull
Tony Walmsley, The University of Hull
Zaid Rawi, BP Chemicals Ltd

FLUIDISED BED

NSTS Nuclear Sciences & Technology Services

Real Time Process Monitoring at British Nuclear Group

British Nuclear Group operate a waste vitrification plant, for the immobilisation of highly active waste, with three lines. Due to it's very nature, sampling of the plant output is impossible for practical purposes. Therefore, the effective monitoring of the performance of the calcining furnaces is essential for the qualification of the immobilised glass product. The hostile environment and consequent shielding make the installation and maintenance of on-line sensing systems problematic and so modelling of existing process parameters to improve on and replace existing, maintenance intensive measurement systems is seen as important for plant efficiency. A large volume of historic plant data has been analysed and models produced for the "power balance", initially, for line 1 and later for lines 2 and 3. Assessment of the models is underway, on-line, and so far they have proved to be reliable, for the short period of time that they have been running. Differences between the models for the 3 lines have been noted and much of this has been attributed to different ages of the furnace tubes. This may lead to a time based deviation from the existing models and cause step changes when the tubes are replaced. Future work will examine these issues and consider additional techniques, such as caterpillar, for fault detection etc.

Researchers:
Tom Musicka, University of Newcastle
Colin Clarke, Nuclear Sciences and Technology Services

CAREER NEWS

ALISON NORDON

Alison Nordon is a Royal Society University Research Fellow in the Department of Pure and Applied Chemistry at the University of Strathclyde. Alison was awarded a Fellowship in October 2004 to investigate 'New acoustic paradigms for non-invasive chemical process characterisation'. Royal Society University Research Fellowships are for 5 years and provide an opportunity for researchers to build an independent research career.

Prior to the award of her Fellowship, Alison was a CPACT researcher at the University of Strathclyde. Alison joined CPACT as a Research Fellow in 1998, following completion of a PhD in solid-state NMR spectroscopy at the University of Durham. During phase I of CPACT, Alison worked with Colin McGill on the development of low-field NMR spectrometry for process analysis. Although Alison came to CPACT primarily as a NMR specialist, she particularly enjoyed the challenges associated with conducting multi-disciplinary research in the field of process analysis and control, and thus took opportunities to develop her knowledge in areas such as chemometrics, signal processing and optical spectroscopic techniques. Alison continued her association with CPACT into phase II where her interest in the use of acoustics for process analysis developed. In 2002, Alison was promoted to the position of Senior Research Fellow within CPACT and played a leading role in a number of projects that were conducted within the chemical processes, solid processes and bioprocesses themes.

Although no longer a CPACT researcher, Alison will work alongside David Littlejohn in the area of process analysis.

GARY MONTAGUE

Gary Montague is a relative newcomer to the CPACT team but in joining he brings expertise in process systems and control and application skills in biochemical engineering. He studied Chemical Engineering at the University of Newcastle before going on to take an MSc in Control Systems at the University of Sheffield in the mid 1980s. Following this, he was given the opportunity to undertake a PhD in Newcastle under the supervision of Julian Morris. His research concentrated upon the application of control approaches to the penicillin fermentation and was undertaken in collaboration with Beecham Pharmaceuticals. He has subsequently found that his Chemical Engineering and Control Systems studies provide a broad based education that offered many opportunities to research in a diverse range of application areas. His current position is Professor of Bioprocess Control but he has taken every opportunity to build a diverse research portfolio and has also championed the applications aspect of research and development. Whilst predominantly working in the chemical and biochemical sectors, he has also been involved in food processing which has brought a 'diet' of Weetabix biscuits, french fries and beer! As part of the CPACT commitment to technology transfer, he also contributes to the Continuing Professional Development course programme.

VENDOR COMPANY PROFILES

ABER INSTRUMENTS LAUNCH NEW RANGE OF ON-LINE BIOMASS PROBES

Aber Instruments, established in 1988, has a unique technology based on radio-frequency dielectric spectroscopy for measuring in real time the concentration of live biomass in bioreactors. It works with a wide range of bacteria, yeast, fungal, plant and animal cells and is also suitable for immobilised cells. The company rapidly established a niche in the brewing industry with most of the global brewing companies such as Interbrew, Anheuser Busch, SAB Miller and Coors now using the Aber "Yeast Monitor" as the standard for adding the correct amount of yeast in order to achieve more consistent fermentations. In comparison with other probes used for process control, the Aber biomass sensors can be steam sterilized or cleaned *in situ* and are considered by the industry to be robust, reliable, stable and require minimal maintenance time and cost.

In the bio-pharmaceutical industry, Aber Instruments recognised that a biomass measurement instrument needed to meet the strict requirements of "Good Manufacturing Practise" if the technology was going be utilised in production bioreactors. In 2003, Aber Instruments, introduced a new range of innovative "Biomass Monitors" with on-line probes that met the FDA standards. The new Model 220 range is now used for monitoring and recording of the critical phases of each fermentation or culture. In some very critical cases with mammalian, yeast and fungal cells, the Biomass Monitor is now used to control a constant level of live biomass in the bioreactor.

The company has also recently in 2004 introduced a new range of probes that are more suited to both development and industrial bioreactors using bacteria or filamentous cells. A 4 channel version of the Biomass Monitor is also manufactured within an IP65 enclosure and is ideal for production plants.

Aber Instruments joined CPACT in September 2004 to provide a closer link with academia for projects involving monitoring biomass in the biopharmaceutical industry but they also see an opportunity for their dielectric based technology to be applied in other process industries where CPACT has the contacts and expertise.

For further information contact John Carvell, Sales and Marketing Director, Aber Instruments Ltd, 5, Science Park, Aberystwyth SY23 3AH, UK
Phone: +44 (0) 1970 636303
Email: jc@aber-instruments.co.uk
Web: www.aber-instruments.co.uk

ABER INSTRUMENTS LTD

AMCS

Analytical Measurement Calibration & Safety Limited

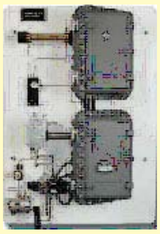
AMCS was formed in 2003 from a group of experienced Process Gas Analyser (PGA) Engineers with the intent to provide an expert applications based service to Industrial Users in the U.K which we felt had been increasingly lacking in recent years.

There are large barriers to entry into the PGA market, where the primary customer is the Hydrocarbon Processing (HPI) Industry, a traditionally very conservative market looking primarily at applications for safety, quality, process efficiency and emissions control. Equipment is sold in relatively low volumes in global terms and will often require specific approvals to ensure, for example, that it can be safely used in a hazardous area or that it can reliably offer the degree of precision that an environmental authority requires for estimating plant emissions.

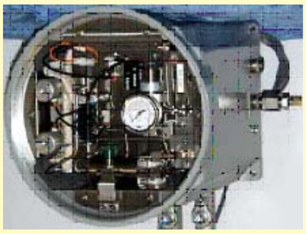
Technologies in such an environment change very slowly –most laboratory analytical techniques for gas measurement never make it to the process environment. Such techniques as there are almost invariably require sample gas to be conditioned to a clean, dry, "ambient" state before presenting to the Analyser. Expertise in such sample conditioning systems is essential knowledge for a supplier – AMCS have recently moved into purpose built premises which enable preparation and testing of complete Analyser systems.

Sample conditioning is generally a necessary evil in PGA – it adds cost, analysis time, unreliability, maintenance time and reduction of precision. AMCS consequently has a strong interest in CPACT's support of the NeSSi project which seeks to create standard conditioning platforms, but further seeks to promote in-situ analytical methods which either minimise or eliminate the need for such systems all together where possible. We are currently involved in a project with BP Marine for SO_2 and NO_x analysis on sea going vessels using "hot, wet" UV analysis where the sample preparation is limited to heated short sample lines. We strongly promote Tuneable Laser Diode analysers which are capable of cross stack/ duct/process pipe measurement without sample conditioning and whose very narrow bandwidths enable reduction in interference not possible with more conventional Infra Red X duct analysis and are currently cooperating with Companies seeking to provide these and similar innovative non sampling technologies.

AMCS has been particularly successful with measurements in Natural Gas recently, primarily with the relatively unique technologies supplied by the Ametek Corporation such as the precise moisture in gas measurements using the oscillating crystal method originally developed by Dupont and the reverse chromatography /UV method for measurement of H_2S, COS and methyl mercaptan, six of which units have recently been sold to Shell offshore platforms.



MODEL933 H2S ANALYSER



MODEL3050 MOISTURE ANALYSER

YAMATAKE HGC303

We are also involved in on line Calorific Value measurement using the world's smallest genuine process gas chromatograph originally developed by Yamatake/Honeywell.

The Hydrocarbon Processing industry in particular increasingly requires fast, accurate gas composition information to run processes efficiently, safely and cleanly.

AMCS are an enthusiastic, knowledgeable but still small organisation. We hope and believe that working with CPACT will help us to contribute to satisfy this demand.

For further information contact Noel Beauchamp or Sam Langridge, AMCS, 14 Woodside, South Marston Park, Swindon, Wiltshire, SN3 4AW
Tel: +44 (0) 1783 824111
Email: slangridge@amcs-uk.com
Web: www.amcs-uk.com

Global Interest in CPACT Research

Interest in CPACT's research has continued to spread across the globe over the past twelve months with representation at a number of international and national conferences and meetings. The areas embraced have been diverse and have included PAT (Process Analytical Technologies), crystallisation, wind power, food, computer applications and machine learning.

The ever increasing interest in PAT has resulted in Professor David Littlejohn presenting a series of lectures at the Analytica Conference 2004 in Munich and at Process Analytical Technology conferences in Princeton, NJ and Frankfurt. Additionally he discussed recent developments in process analysis in Penang, Malaysia, Wilmington, USA and at Novartis in Basle. UK talks included presentations at the Food Sensor Network meeting and at a RSC meeting on "What's new in process analysis?"

Newcastle researchers have been extremely active and have presented their research at international conferences in Budapest (5th International Conference on Control and Automation), Boston (DYCOPS 2004), Poros (BatchPro), Brussels (World Batch Forum's 2004 European Conference) and Lisbon (ESCAPE-14). Internal conferences and meetings in the UK where CPACT personnel have presented their research have included Batch Production in 21st Century, the NCAF Conference series, Total Crystallisation Solutions, Emerging Chemometricians, and Sheffield Machine Learning Workshop.

The next six months sees CPACT continuing to disseminate its research across Europe. Conferences to be attended include ESCAPE 15 (Barcelona), the IFAC World Congress in Praha and World Chemical Engineering Congress (Glasgow) and FACSS (Quebec).

Essential Mathematics for Process Engineering Research (EMPiRe)

The EPSRC sponsored course on Essential Mathematics for Process Engineering Research (EMPiRe) will be running for a second year (12-18 May 2005) following on from its success in 2004. The aim is to provide course participants with the ability and the confidence to use advanced mathematical and statistical tools as an integral part of their every day research. The course focuses on three areas (i) Basic Mathematics, First Principles Modelling and Numerical Solution, (ii) Statistical Modelling and Design of Experiments and (iii) Optimisation. The novelty of the course lies in the unique blend of industrial lectures that position the area of focus, academic lecturers from the UK, Australia and Europe and also the practical experience gained though hands-on practical classes. Attendance is not restricted to the full course, it is structured in such a way to allow specific areas to be attended in isolation.

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