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CELEBRATING 50 YEARS OF DISTILLATION AND ABSORPTION CONFERENCES

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> *"Equipment most generally used for Gas Absorption: Tower packed with suitable solid. Types of Tower Packing. A wide variety of types of packing have been suggested at one time or another. These may be classified as follows: 1. Broken Rock..."*
> **(Elements of Chemical Engineering by Badger, Walter L. and McCabe, Warren L. McGraw-Hill 1931)**

It is 50 years since the first international Distillation Symposium was held in Brighton's Metropole Hotel, from 4th to 6th May 1960. The idea of such a Symposium had been suggested by Mr Leslie Holliday, Chairman of the Distillation Panel of the Association of British Chemical Manufacturers and the British Chemical Plant Manufacturers Association. When Frits Zuiderweg heard of it, he responded enthusiastically and suggested the conference be held in Venice. Nothing came of this suggestion, and in his opening address, Sir Alexander Fleck, Chairman of ICI and a distinguished radio-chemist, commented that, in bringing the chemical engineers of Britain and Europe together, it was very suitable to meet in Brighton, "one of the English towns closest to European centres".

After the second Symposium in 1969 was held in Brighton (under Zuiderweg's chairmanship by now), the event became known as the Brighton Conference. In 1979 it was felt that the Hilton Hotel in London would be more appropriate to a big international meeting, but many delegates remembered the informality and friendliness of the seaside venue and in 1987 we returned to Brighton, to the new Conference Centre there.

The next conference was held in 1992 in Birmingham. Not only had the interval between events become shorter, in keeping with the pace of technical development, but for the first time the meeting was explicitly dedicated to both the unit operations, Distillation and Absorption. The conferences had always had strong support from the Netherlands, and in 1997 we met at Maastricht. In 2002 the Symposium was organised at Baden-Baden, and four years later in 2006 we returned to London. Now, in 2010 we are again in the Netherlands, in Eindhoven.

All these conferences have been organised under the overall supervision of the European Federation of Chemical Engineers (EFCE), and since 1969 its Working Party on Fluid Separations (formerly Distillation, Absorption and Extraction). In his opening address in 1960, Sir Alexander Fleck commented that the EFCE was, he guessed, an organisation of a type much beloved of the British – loosely knit, and with strength in its diversity much greater than might be expected from what he called "mere uniformity". Well, it is true that the EFCE is indeed very proud of its broad geographical and technical coverage, and accordingly each of these conferences has brought up for review the best and most interesting technical developments of the day, from across the world. The Symposium has always been international, as the presence of both American and Russian experts in 1960 clearly demonstrated. The set of published proceedings comprises a unique record of 50 years of progress in distillation and absorption technology and its application.

But as the world itself has evolved, so has the nature of the conference. In 1960 there were 600 delegates, and 28 papers were presented (half from the UK): discussion of the papers was recorded and printed with the proceedings. In 2006 there were some 215 delegates and 100 papers including 32 poster presentations. The discussions were, I am sure, no less lively than in 1960, but they were not recorded. If we have thereby lost some valuable oral contributions, the discussions, though they were always well-informed, have become much less like the conversation in a gentleman's club. In 1960 Mr GA Dummett, later to become President of the Institution of Chemical Engineers, was able to comment on the very low "Bikini" factor of a paper by Zuiderweg and colleagues (on column internals), defining this factor as the ratio of interesting subjects revealed to the essentials concealed. Truly the world has changed in 50 years, and our diversity as a professional community, by gender and nationality, has become much more genuine than it was in 1960.

For industrial presenters, revealing sensitive technical information has always had to be weighed against the need to verify claims with real data. Over the years this has caused a few problems, as the organisers have rightly tried to keep out advertising material of little technical merit. But a strong industrial presence at every Symposium has been of enormous benefit in keeping the focus on real needs and applications. Fractionation Research Inc (FRI), an industrial research consortium founded in 1952, has played a useful role in this. The paper by Silvey and Keller in 1969: *Performance of three sizes of ceramic Raschig rings in a 4ft diameter column* was the first of many from FRI to present reliable large scale data. Thus we continue to attract a diversity of delegates from user companies, contractors, equipment suppliers, universities, research institutes, all of whom contribute richly to the quality of the programme and the discussions: no "mere uniformity" there!

Looking back over the contributions at this Symposium since 1960 reminds us that we are always building on the work of others. And has there ever been a more powerful example of an insight into the workings of a class of processes, than the simple construction so memorably described by Warren MCabe and Ernest Thiele in *Graphical Design of Fractionating Columns (Ind Eng Chem **17,** 605 1925)*? It was fitting that Dr Thiele was an invited guest at the first Brighton Distillation Symposium – he died only in 1993, at the age of 98. It was his co-author McCabe, whose book written with Walter Badger introduced the McCabe-Thiele method to a wider audience. Even today, the McCabe-Thiele diagram remains a powerful tool for explaining the concepts underlying separation processes. More advanced students may appreciate the method of residue curve maps introduced to many for the first time at the 1979 Symposium in a paper by Mike Doherty and John Perkins. This method extends the insights of McCabe-Thiele to multi-component, reactive and azeotropic systems. Neat ways of *thinking about* the *whole* process continue to be developed, and play a key role in helping the understanding that leads to innovation.

As we look back, we can now identify 1960 as the beginning of a new era in which we became able to calculate what is actually happening inside processing equipment. Partly this was the result of improved understanding resulting from experimental studies of hydrodynamics and mass transfer: trays did not always bubble, we learnt – frequently there was only spray. *Quel surprise!* But a vital role was played by the vast increase in calculation power that we obtained. In 1960, text books and magazine articles on distillation and absorption still proposed using short-cut methods such as correlations and nomograms for actual design, and in industry these methods, supplemented by proprietary know-how, were universal. Yet by 1963 Perry's Chemical Engineers' Handbook (4th edition p 13-42) was able to report on "automatic" computers *"Ready availability of such computers in many organizations has favoured the use of the exact but tedious design methods over the short-cut methods used so extensively in previous years"* and that "*as many as ten components can be accommodated"*. Accurate tray-to-tray calculations and iterative or large-scale matrix methods applied to real systems only became feasible with the introduction of programmable computers. Such methods did not need the old simplifying assumptions such as equal molal overflow, equal stage efficiency, zero pressure drop, plug flow or perfect mixing. And if the computer could calculate the vapour-liquid equilibrium anew for each part of the column, there was an incentive to have accurate, not simplified, thermodynamic models which could predict properties correctly. The same applied to hydrodynamics, mass transfer and other features of column operation: when the computation power became available, accurate descriptions of phenomena became useful.

Thus the conferences have marked a dramatic improvement in knowledge and its application to design and operation. This project is far from finished, but many of the benefits are already clear. For example we can now make schemes and equipment much more complex than was possible prior to 1960. An example is the Lucite International "Alpha" technology for methyl methacrylate manufacture which won the 2009 Kirkpatrick Award. This features a particularly effective distillation train incorporating interlinked columns with complex three-phase, reactive and azeotropic systems. The thermodynamic methods, structured packing, computerised process modelling and heat integration technology used will be familiar to delegates here: I merely point out that the invention and design of such a complex process before 1960 would have been completely impossible.

The need for innovation in Distillation and Absorption is huge, because the scale of operations is huge. The largest columns and throughputs are found in the oil and gas industries. Between 1960 and 2008 global daily consumption of crude oil rose from 2.9 million tonnes to 10.3 million tonnes, and every gram of this is distilled, perhaps several times, before the products are finished. The rise in consumption of natural gas from 1960 to the present day is equally impressive, from 1.1 million tonnes per day oil equivalent to 7.6 mtpdoe. This gas needs to be dried, and sometimes cleaned of acidic or other undesirable components in treating columns. Natural gas liquids, which must also be recovered by separation processes, add some 10% to the crude oil figure.

Not surprisingly, the world is now worried about the effect that combustion of fossil fuels is having on the climate. Coal makes a significant contribution to this of course, and the combustion of fossil fuels is putting some 30 billion tonnes of carbon dioxide in total into the atmosphere each year. One route to mitigation of this problem is through absorption of carbon dioxide, either from flue gas, or in some manner integrated with gasification, followed by sequestration of the CO_2.

In the 50 years since 1960 we have had many alarms about the cost of energy, which have often given a boost to our work on heat integration, high efficiency internals, novel processes and such-like. But the challenge of climate change now promises to be a paradigm-changing driver towards the new and different technologies needed in the future world of the low-carbon economy. However the future develops, we can be sure that the use of distillation and absorption technology will continue to be key operations in the sustainable delivery of the products that people need.