

TRIBUTE TO DR. GEOFF BIGNOLD

Dr. Geoff Bignold, formerly of the Central Electricity Research Laboratory, National Power and subsequently RWE npower in the UK, died on 4th August 2012 at the age of 67. Geoff was an outstanding scientist in the field of power plant chemistry, contributing a wealth of valuable research findings, notably studies on erosion-corrosion, which continue to be widely reproduced to this day. He was respected world-wide and will be sadly missed, not just for his wealth of knowledge and experience, but particularly as a friend and colleague to many.



Geoff studied in chemistry at Bristol University from 1962 and was awarded his degree in 1966.

He was offered jobs at both the National Physical Laboratory (NPL) and the Central Electricity Research Laboratory (CERL), but chose CERL, joining in September 1966.

CERL was based in Leatherhead and was considered to be the cornerstone of the research into corrosion issues for the Central Electricity Generating Board (CEGB) in the UK for 30 years from 1962 until it closed following privatisation in 1992.

Geoff started in Bert Masterston's Electrochemistry section, where he worked on developing high temperature electrodes for use in the power industry. Others in his section were Brian Case and Dudley de G Jones. One of his first research tasks was to measure the conductivity of pure water and therefore the ionic product (K_w) of water at temperatures up to about 270 °C using a specially designed laboratory apparatus.

Geoff completed a CASE (co-operative awards in science and engineering) sponsored external PhD titled 'Electrochemistry of Iron in Acid and Alkaline Aqueous Systems' under Prof. Martin Fleischmann at Southampton University and was awarded his doctorate in

July 1972. Sadly, and with some sense of irony, Prof. Fleischmann passed away just one day before Geoff.

Later, Geoff studied the electrochemical aspects of stress corrosion cracking of steels in alkaline solutions, the electrochemical behaviour of Incoloy 800 in sodium hydroxide at high temperature, the behaviour of Inconel 600 in high temperature phosphate solutions, together with the waterside performance, electrochemical behaviour and stress corrosion cracking susceptibility of 9%Cr1%Mo boiler tube steel in Advanced Gas-Cooled Reactor (AGR) nuclear power stations. With a colleague, Geoff Mann, Geoff developed an electrochemical model for high temperature corrosion of carbon steel that is still a plausible model for corrosion in concentrated caustic environments.

Although this early work was mainly pure research, by the mid-1970s, his research became more focussed on boiler corrosion issues in the new AGR reactors that were built in the UK. This led to Geoff's membership of the Water Chemistry Working Group that was set up to look into all aspects of AGR water chemistry. The WCWG had members from CEBG headquarters, all of the central laboratories, all of the scientific service departments, the UK Atomic Energy Authority (UKAEA) and the industry companies associated with AGR design and construction. The Working Group covered the main and decay heat boiler water chemistry, boiler corrosion and stress corrosion cracking, off-load storage and chemical cleaning associated with the AGRs.

Geoff became chair of this group in the mid-1980s, a position that he held until the privatisation of the UK power industry in 1990. Geoff was also part of the working group that formulated the AGR water chemistry guidelines and he later worked on aspects of Pressurised Water Reactor (PWR) steam generator corrosion problems.

When erosion-corrosion (now known as Flow Accelerated Corrosion) was found in the Hinkley Point B boiler inlets in 1975 and a similar threat to the other AGRs was recognised, Geoff became the senior member of a CERL team organised to study erosion-corrosion risks to the boiler inlets at Hartlepool and Heysham 1 using a large rig, called the 'Isothermal' rig. This type of damage could lead to severe damage to the boilers, which would require expensive repairs. Twenty-eight rig runs lasting up to 1000 hours each were carried out spread out over a period of eight years. The unique feature of these tests was that, in addition to replicating the Hartlepool/Heysham 1 boiler inlet design, boiler water chemistry and flow rates, the specimens produced were ideal for the theoretical study of this form of corrosion.

The full programme of work covered many aspects of the problem, but the key feature was an on-line erosion-corrosion damage monitoring method based on the use of surface activated specimens. In addition, in some tests, the electrochemical state was monitored *in-situ* by an internal high temperature reference electrode designed by Geoff, which showed that erosion-corrosion could be halted by adding oxygen to the water. The latter forms the basis of the water chemistry used successfully at Hartlepool and Heysham 1 since the early 1980s. Overall, the tests still remain one of the best experimental studies of erosion-corrosion and are widely reproduced in scientific corrosion books [1-3]. Another of Geoff's contributions to this work was his development of an electrochemical model to describe the erosion-corrosion process, which was the first model to predict the high flow dependence observed experimentally.



The team running the 'Isothermal' rig at CERL in 1987. From left to right: Geoff Bignold, Keith Garbett, Dennis Libaert, Ron Sale, Ian Woolsey, Chris de Whalley and Diane Brooke (née Thomas). The rig was used for all of the flow accelerated corrosion tests carried out between 1978 and 1987.

In 1990, Geoff's work on AGR and PWR water chemistry problems came to an end when he was assigned to the non-nuclear company National Power. Furthermore, when the Leatherhead laboratory closed in 1993, he was transferred to work in Swindon.

In National Power, or as it later became RWE, one of Geoff's roles was similar to that at Leatherhead, but it was now focussed on optimising the water chemistry of the existing fossil-powered stations and that of the newly built Combined Cycle Gas Turbine (CCGT) stations. In addition, his role later included co-ordinating National Power's research programme and mentoring new chemistry staff and supervising technicians. Geoff also represented National Power on the UNIPEDE (Union Internationale des Producteurs d'Énergie Électrique – now EURELECTRIC) Thermal Generation committee that in 1997 published chemical guidelines for the water/steam cycle of fossil fired units [4].

In 1998, Geoff was promoted to be one of the few Corporate Engineers in National Power. The underlying philosophy of the Corporate Engineer role is that it is defined by the business need and the ability of the individual to make an outstanding contribution and not by a narrow definition of technical competence. This meant that Geoff was responsible for co-ordinating power generation operational chemistry work programmes, drafting chemistry procedures, investigating corrosion and material degradation issues and strategic studies, which he continued until taking early retirement from RWE in 2005.

After leaving RWE, Geoff followed many of his peers and became a consultant, setting up his own company, GJB Chemistry for Power Ltd. He took on projects in Hong Kong, Venezuela, Spain and Australia as well as in the UK. He dissolved his company and retired fully in April 2011, although he remained active in BIAPWS and IAPWS after this time. Geoff's experience and expertise meant that he was frequently requested to attend

and present papers on power plant chemistry topics at conferences and meetings worldwide. Some of these conferences include the Australian Power Institute (API) Chemistry Conferences and the EPRI Cycle Chemistry Conference [5].

In 1998, Geoff applied to become a member of the Royal Society of Chemistry and he was accepted as a Fellow of the Royal Society of Chemistry and a Chartered Chemist in 1999.

As part of his work at National Power, Geoff became the company representative on the BIAPWS (British and Irish Association for the Properties of Water and Steam) committee in 1997. Geoff was nominated to the role of BIAPWS Chair in 2000, carrying out his duties for the maximum four-year period. After his term in office, he continued to be an active committee member, organising and regularly participating in the annual BIAPWS Symposia [6]. One of Geoff's last presentations was at the 2012 symposium earlier this year where he gave a very well received talk on the basic principles of power plant cycle chemistry corrosion and deposition processes in a session aimed at developing chemists and engineers interested in chemical operations. Geoff also represented BIAPWS on the British Standards committee which dealt with the European standards for boiler water chemistry, working actively with BSI and European colleagues to support revisions of these standards. In 2012, Geoff was accepted as one of the first Honorary Members of BIAPWS.

Geoff's involvement in BIAPWS brought him into contact with IAPWS (International Association for the Properties of Water and Steam), the international organisation. Geoff attended most annual IAPWS meetings, either representing BIAPWS or attending as an individual member. He was particularly involved with the Power Cycle Chemistry (PCC) committee of IAPWS. He was usually co-opted as "Clerk of Minutes" (Secretary) for PCC meetings, because of his willingness to do the job, his technical knowledge of the subjects under discussion and, additionally, because of his ability to write on detailed topics in a style that was clear to all.

In 2008, IAPWS started the production of cycle chemistry Technical Guidance Documents (TGDs) and Geoff became an inaugural member of the Task Group charged with driving forward this new initiative. In 2009, Geoff took the lead on developing a Technical Guidance Document on "Instrumentation for Monitoring and Control of Cycle Chemistry for the Steam-Water Circuits of Fossil-Fired and Combined-Cycle Power Plants" [7]. This was published at the IAPWS Annual meeting in The Netherlands in September 2009. In 2011, IAPWS decided to revise this TGD and again Geoff was asked to take the lead. In his usual way, he developed an international consensus to improve the document. This is expected to be approved for publication at the IAWPS September 2012 annual meeting in Boulder, Colorado.

Geoff's contribution to IAPWS was recognised in 2010 when he was awarded an IAPWS Honorary Fellowship.

Geoff will be remembered as a major contributor to the development of power plant chemistry internationally, but he will also be remembered by all those who were fortunate enough to spend time with him as a kind, open and generous person with a passion for his subject, a willingness to help and a desire to share his knowledge and experience to help the next generation of power plant chemists. He will be sadly missed by all who knew him.

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