

Development of Vacuum Experimental Demonstrations for the Science Educators' Workshop

A Short History

In 1973, the AVS National Education Committee produced a book entitled *Experimental Vacuum Science and Technology* (Marcel Dekker, New York, 1973), which was "intended as a source of ideas for those involved in the instructional aspects of vacuum science." However, the experiments detailed in this book were fairly advanced and more suited for the college level.

Edwards High Vacuum was also marketing two educational vacuum pumping units, Models EQ2A and EQ4B, which came with a wonderful booklet entitled *Experiments in Vacuum Physics*. The technical level of these experiments was more applicable to teaching high school science courses.

These publications sparked the interest of the National Education Committee giving us ideas on how to develop a workshop that would teach educators how to perform vacuum demonstration experiments in their classrooms.

About the same time, I learned of and became fascinated with the Chemathon program coordinated by Annette Freitas, then Chair of the Northern California Chapter's (NCC AVS) Education Committee.

The Chemathon

The Chemathon was a ten-hour marathon of experiments for chemistry students developed by the Albany High School Chemistry Club and their chemistry teacher Peggy Carlock.

Peggy and Annette met after the 1987 program put on by the Albany High School Chemistry Club and became friends. Through this chance encounter, the NCC AVS Education Committee learned of the Chemathon's financial difficulties caused by the large, unanticipated number of participants.

NCC AVS Supports the Chemathon

Thus, the NCC AVS used its financial and intellectual resources to help sponsor this endeavor. This led to expanding the program to include vacuum science demonstrations.

Volunteers from the NCC AVS demonstrated five vacuum experiments during the 1988 program. The experiments used for the demonstration included the:

- Falling Feather
- Transmission of Sound
- Expanding Balloon
- Buoyancy of Air
- Triple-point of Water

These experiments were ideal for an educators' workshop on vacuum science that was being discussed by the AVS National Education Committee. As new committee members, Ken Nebesny and Art Nelson were asked (volunteered) to identify experiments and find the equipment necessary for this new program.

ICMCTF 1990 in San Diego

Cost was an issue, so we found a very inexpensive bell jar with a hand held vacuum pump in the Cole-Palmer catalog. The Committee met at the ICMCTF in San Diego in 1990 where we proudly demonstrated three of the vacuum experiments to then AVS President Dave Hoffman. The experiments included the

expanding balloon, the transmission of sound, and the triple-point of water.

The expanding balloon and transmission of sound demonstrations went well. However, after squeezing the hand pump for at least 15 minutes, we realized that the triple-point of water was not to be achieved with this apparatus – great exercise though for strengthening one’s grip!

Obviously, we had to identify an inexpensive rotary vane pump with adequate pumping speed. Ken and Jim Solomon found what we needed with the help of Marvac Scientific. Bruce Kendall did the performance measurements on the pump and later identified an inexpensive two-stage rotary pump for additional experimentation.

Science Educators’ Workshop Held at the International Symposium

With all of our equipment in hand, we descended on Toronto for the first Science Educators’ Workshop at the 37th AVS International Symposium.

Frank Shepherd, Local Arrangements Chair, had assembled the teachers, and it was up to us as members of the National Education Committee to enlighten the teachers on the possibilities of vacuum experiment demonstrations in the classroom.

Dave Hoffman opened with his own demonstration on vacuum force – simply sucking the air out between two disks that were sealed with a rubber O-ring. This was simple and cheap to build, yet very effective for demonstrations.

The whole program and the basic idea had generated excitement in all sectors of the Society. Not only was the AVS President performing, but also Nalge donated 25 bell jars to the Workshop. The opening program was a great success and we were off!

The Second Year at the International Symposium

The following year’s workshop was held in Seattle at the 38th International Symposium. Not only local teachers attended the Workshop, but also those teachers sponsored by other AVS Chapters. The Chapters selected teachers from their regions based on the successful participation of the educators’ students in local science fairs or physics/chemistry bowls. Realizing teachers are flying cross-country with all expenses paid is quite the incentive for future teacher participants!

Subsequent Workshops Expand

Subsequent Workshops were also well received by the teachers, and our program expanded into a full two days. The program now includes lectures on vacuum science, experimental demonstrations, tours of laboratory facilities, and the equipment exhibition. (The equipment exhibits are very popular with the teachers due to the graciousness of the exhibitors and all the free items.)

Today’s Science Educators’ Workshop

Jim Solomon, Raul Caretta, Marilyn Barger and Richard Gilbert currently present lectures on vacuum science. In addition, significant enhancements to the experimental portion of our program have been incorporated.

Bruce Kendall continues to develop advanced experiments and pump evaluations for our advanced program:

- Boyle’s Law with corrections (Physics Teacher 12/96)
- Refractive Index of Gases (1998 Vossen)
- Diameter of a Molecule
- Barometers and Altimetry

- Pirani Gauge
- Thermister and Thermocouple Gauges
- Cold Cathode Gauge (spark plug in magnetic field)
- Crooke Radiometer
- Pumping Speed and Ultimate Pressures

Throughout the 12 year history of the workshop, the instructional team constantly sought out ways to improve the workshop. Suggestions from attendees, interactions with teacher organizations, and collaborations with other AIP member Societies have all added to the quality and success of the current workshop's format and agenda.