

C₃ NEWS

Spring 1994
Vol. 19, No. 1

Newsletter of College Chemistry Canada / La Chimie Collégiale au Canada



21st Conference

This issue of *C₃ News* provides all the information needed to register for the 21st College Chemistry Canada Conference, to be hosted in June, 1994 by the British Columbia Institute of Technology and the Open Learning Agency.

A preliminary program of invited and submitted papers is included, and the themes of Chemistry at Work, Chemistry and the Independent Learner and Chemical Education are well-represented.

On the social side, receptions, lunches, the banquet, a favourite Vancouver restaurant guide, and the annual fun run are taking

shape, and the natural beauty of British Columbia is free as usual.

A registration form for the conference is included as an insert in this edition. Early registrants can save some money, although

you'll see from the fees that *C₃* continues to provide the very best value for money for any conference anywhere. As soon as you register, you'll receive a package of information on how to make the most of your trip to B.C.

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Notice of Meetings

A meeting of the College Chemistry Canada Inc. Executive and Board of Directors will be held on Thursday, June 9th at 2:00 p.m. in the Boardroom of the Open Learning Agency, 4355 Mathissi Place, Burnaby, B.C.

The Annual General Meeting of College Chemistry Canada Inc. will be held on Friday, June 10th, at 5:00 p.m. in the BC Tel Theatre at the British Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, B.C.

All C₃ members are encouraged to attend.

Call for Nominations

At the Annual General Meeting of C₃ on June 10th, the following positions will be elected:

1995 Conference Coordinator
(1 year term)

Program Coordinator (1 year term)

Editor (2 year term)

Regional Directors (1 year term)

2 each from:

B.C. and Yukon

Manitoba, Saskatchewan, Alberta and

N.W. Territories

Ontario

Québec

Atlantic Provinces

CIC Liaison (1 year term)

2YC₃ Liaison (1 year term)

CSCT Liaison (1 year term)

Please send nominations to Bob Browne, C₃ President (*address on page 8*).

Membership Renewal

The expiry date of your current membership is given on the address label of this newsletter. To renew your membership (and thus to keep receiving this newsletter) send \$20.00 to the C₃ Secretary, Bob Perkins (*address on page 8 of this newsletter*). Membership may also be renewed by attending the 21st C₃ Conference in June, 1994.



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Articles of any length will be gladly accepted. Please send typewritten copy to the Editor at the above address or send by fax. Copy can also be sent on a 3 1/2" disk, MAC format using Microsoft Word, or any wordprocessor producing ASCII output.

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Hydrogen Peroxide: The Environmentally Friendly Chemical

by Bob Browne

It is a bit of an understatement to say that British Columbia is not known for its chemical industry, so when chemical plant closures occur, it is does not go unnoticed. Late in 1991 the Vancouver Sun reported "70 lose jobs as CanadianOxy shuts down Squamish plant". The plant in question produces chlorine for the pulp and paper industry. A year previous, this same firm closed a chlorine and caustic soda plant in Nanaimo, leaving only one remaining chlorine-producing plant in the province, in North Vancouver. A spokesman for the company referred obliquely to a move towards a more "environmentally preferred chemical" which had caused a reduction in the demand for chlorine. A few months later I toured a recently opened peroxide plant in Prince George. The hydrogen peroxide business, it appeared, was taking over.

In the late 1980s the North American market for H₂O₂ was growing at the rate of 10 to 15% per year, with the Canadian sales increasing by an impressive 40% in 1988. Driving this growth was the Canadian pulp and paper industry's rapid adoption of bleached chemithermomechanical pulping (CTMP) technology. The CTMP process, first used in Sweden, uses a higher percentage of the fibre in the wood, but generally produces a lower grade paper product. High-quality paper is normally made in the Kraft process which uses chlorine or chlorine dioxide. Peroxide bleaching of the CTMP paper, however, has given the brightness levels needed for this product to penetrate the high-value paper markets traditionally supplied by the Kraft mills. And of course the mill effluent doesn't have the level of dioxins and chlorinated compounds which the kraft mills have.

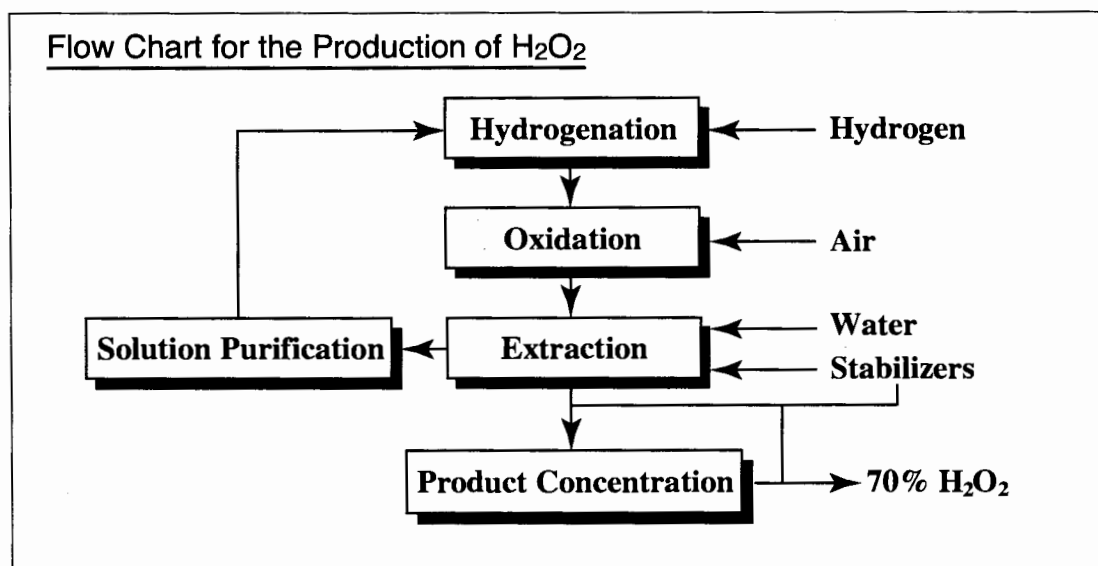
With the increase in production has come a decrease in cost, and this, along with its well-earned reputation as a safe oxidant, has made hydrogen peroxide the chemical industry's oxidizer of choice. In addition to bleaching wood pulp, applications include treating ground water, detoxifying industrial wastes, synthesizing chemicals, rinsing silicon wafers, and processing textiles.

Industrial Preparation

There are a number of processes used to produce H₂O₂: the electrolysis of ammonium bisulfate, the reaction of barium peroxide and sulfuric acid, and the oxidation of isopropyl alcohol to name a few.

The hydrogen peroxide plant in Prince George, opened in 1990 by FMC of Canada, is capable of producing 41,000 tonnes of peroxide per year of various concentrations (depending upon the application) from 31 to 70% by mass. The method used by FMC is the oxidation of ethylanthraquinone, a process developed in Germany and used there during the Second World War. A flow chart, and equation for the basic reactions are shown in the figures.

The work solution consists of ethylanthraquinone (EAQ) and a mixture of solvents; aromatic solvents to dissolve the quinone and polar solvents to dissolve the hydroquinone (hydro EAQ) produced in hydrogenation. Dissolved EAQ and hydrogen are introduced into the top of the hydrogenator and conversion of the quinone to hydroquinone is carried out on the catalyst beds. Unreacted hydrogen is recovered in a degassing section at the bottom of the tower. The work solution then passes to the **oxidation** tower where air is pumped through it (at 65°C and 3.4 atm), converting the hydroquinone back to quinone and producing H₂O₂, which remains dissolved in the solution. The peroxide is separated from the work solution by **extraction** with deionized water in a sieve tray extractor. The aqueous phase, having a higher density, sinks to the bottom of the extractor while the work solution rises to the top. The pH of the peroxide solution is adjusted with phosphoric acid to help in stabilizing the product as well as improving the separation. The work solution is recycled back to the hydrogenation tower and the peroxide is withdrawn from the bottom of the tower and is sent to the product **purification**



Description of the Process

The first step in the process is **hydrogenation**, carried out in fixed beds with a palladium catalyst plated on a carrier of alumina, Al₂O₃. Temperatures and pressures at this

section. Product purification involves cooling and filtering out finely dispersed organic impurities from the crude extractor product. **Concentration** of the product from 25% to strengths up to 74% is carried out by vacuum distillation.

— continued on page 7

21st C₃ Conference

Wine and Cheese Reception

Hosted by the Open Learning Agency, which has been described as the most innovative post-secondary institution in Canada. It combines distance education, educational technology and flexible transfer credit policies to provide a wide variety of certificate, diploma and degree programs. Through its Open University, it offers first year General Chemistry and 2nd year Organic Chemistry courses. The Knowledge Network (B.C.'s educational television network) is also part of the OLA. Join us at the OLA for wine, cheese, good music and a tour of this unique facility.

Program Venue

BCIT has a provincial mandate to provide technical training that meets the needs of BC's industry and economy. In the new IBM Building at BCIT is the BC Tel Theatre — a fully equipped, multi-media presentation arena, where all the conference papers will be delivered. Tours of BCIT will be held on late Saturday afternoon.

Exhibition

We have invited a variety of suppliers and publishers to display their products while coffee and muffins are served, twice daily.

Lunches

Lunches on Friday and Saturday will be provided free and hosted by BCIT and other sponsors. This year's C₃ student award will be presented at Friday's lunch.

Banquet

Friday night's banquet will provide good food and good entertainment to conference participants.

Fun Run

Bob Browne promises one of the best 5 km runs you'll ever have participated in. He will lead you around the "spongy" trails of nearby Burnaby Lake (see Swamp Trot article

by Bob Browne below). You'll be able to sign up for the fun run when you arrive.

Vancouver Restaurants

On Saturday evening, we'll help you to find your way to some of the finest restaurants in North America. We'll be giving you a list of our favourites, but there are many to choose from, representing cuisine from almost anywhere in the world.

Accommodation

We recommend the following hotels nearby:

The Burnaby Villa,
4331 Dominion Street, Burnaby, B.C.
V5G 1C7
(10 minutes walk to BCIT/OLA)
\$65.00 plus taxes (Courtyard),

\$75.00 plus taxes (Tower)
(Free Parking, 2 pools, Restaurant, Lounge, Pub.)
Tel: (604) 430-2828;
Fax: (604) 430-8556
(Quote the OLA/BCIT Chemistry Conference for these special rates.)

Holiday Inn (Metrotown)
4505 Central Boulevard, Burnaby, B.C.,
V5H 4M3
(25 minutes walk to BCIT/OLA)
Room Rate: \$82.50 plus taxes.
Close to Skytrain, Shopping Malls, parks.
Tel: (604) 438-1881
Fax: (604) 438-1883

If you need more information on hotels in Burnaby and Vancouver, call Alan Davis at (604) 431-3219 and you'll receive an Accommodation Guide for B.C.

Swamp Trot

by Bob Browne

The 1990 C₃ Conference, hosted by Capilano College, featured a fun run around the sea wall in Stanley Park. The five kilometre course took participants through the zoo, and past totem poles, and around the lighthouse at Brockton Point. The snow-capped north shore mountains provided a splendid backdrop for the ships passing under Lions Gate Bridge to their anchorage in the inner harbour. Organizers, however, felt that this setting provided too much of a distraction for runners, especially those from the east. Some were actually seen laughing, talking, and pointing during the race, instead of attending to the business of getting to the finish line in the shortest possible time. This year's organizers have taken steps to eliminate these distractions. Welcome to the Swamp Trot.

Nestled in the heart of Burnaby lies the 300 hectare Burnaby Lake Regional Park, home to birds, beavers, ducks, and over 15 kilometres of soft level trails. How, you say, could this large area remain undeveloped in the centre of a bustling community? In a word, swamp. Unlike Florida, there's no market here for bog, so the developers have left it intact. Lucky for us. The trails are easy on the knees, and if you get tired, you can always take a detour to one of the lookout areas and watch the beavers, or feed the ducks.

At stake is the coveted J. Willard Gibbs Memorial Fun Run Trophy, last won by the speedy Rinjite Raap from Camosun College. (Maybe we could get some friends of figure skaters to slow him down a little this year). Reflecting the trend of the nineties to reduce, recycle and reuse, the trophy features a bronze figure bearing a striking resemblance to a golfer teeing off. All of the great sports trophies have at one time or another gone missing (the Stanley Cup was left on a street corner once), and this one is no exception. In fact, nobody admits to having seen it since the Capilano conference. There have been unconfirmed reports that it was seen being smuggled aboard a Montreal-bound aircraft. Any information leading to its recovery will be appreciated and, of course, treated in strictest confidence.

So, bring your running shoes to the conference, and plan to run, or walk, in the 1994 Swamp Trot. It is scheduled for 7:00 am Saturday morning. Win or lose, you will have that feeling of superiority as you sit among your bleary-eyed friends at the breakfast table.

21st College Canada Chemistry Conference — Preliminary Program

Thursday, June 9th, 1994

- 5:00 – 6:00 pm **Registration**
 6:00 – 10:00 pm Wine and Cheese and Tours of the Open Learning Agency.

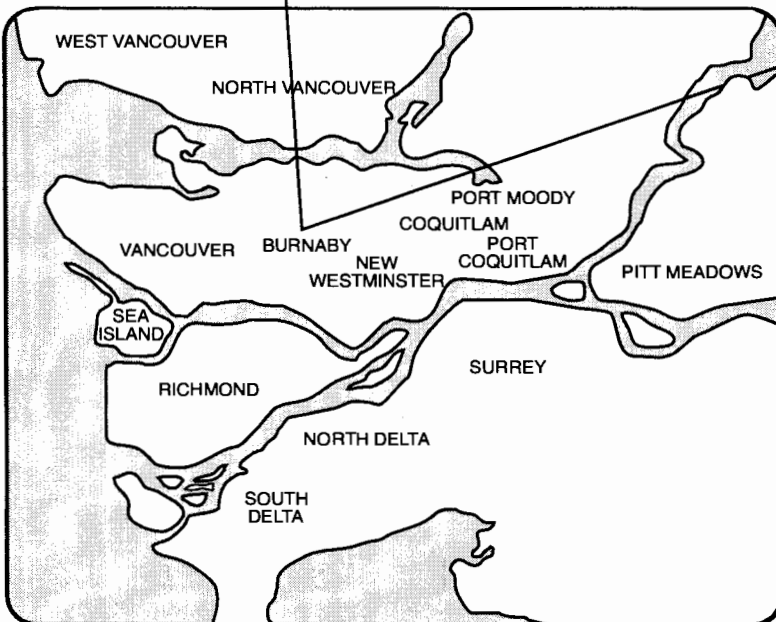
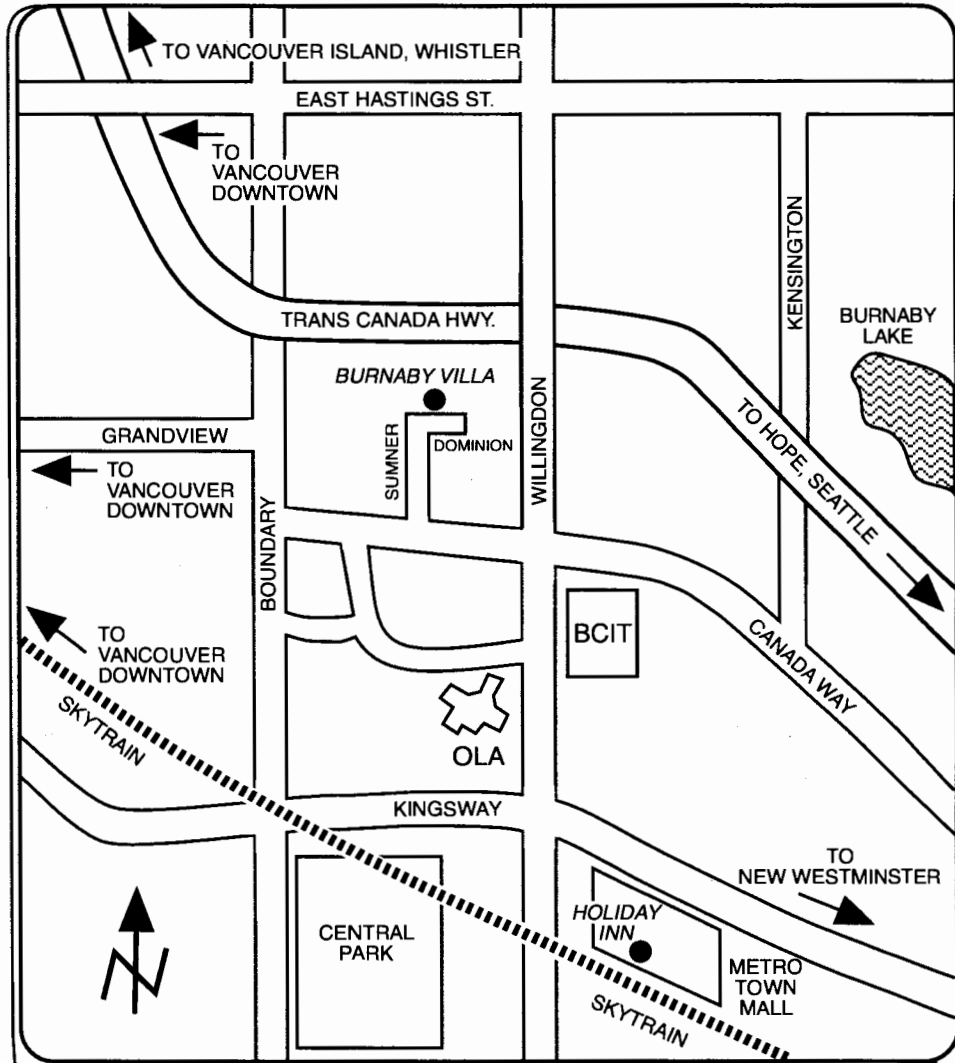
Friday, June 10th, 1994

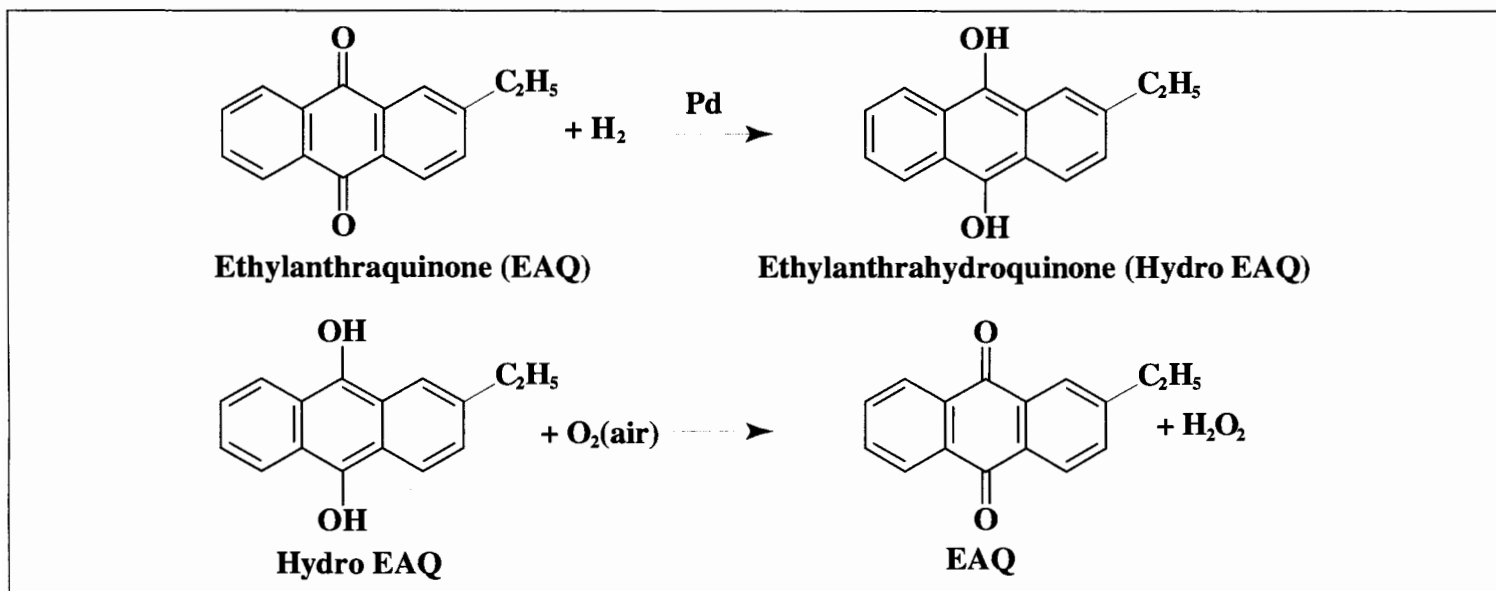
- 8:00 – 9:00 am **Registration**
 9:00 – 9:30 am Opening — BC Tel Theatre, British Columbia Institute of Technology
 9:30 – 10:30 am *Developing Totally Chlorine Free Bleaching* by Tom Murphy, MacMillan Bloedel Research
 10:30 – 11:00 am Coffee and Exhibits
 11:00 – 12:00 Noon *TBA* Dr. David Dolphin, The University of British Columbia
 12:00 – 1:30 pm **Lunch**
 1:30 – 2:30 pm *Forensic Chemistry**, Alexander Beveridge, OLA/RCMP
 2:30 – 3:00 pm *Adapting Course Requirements to Include a Skill Component*, Prof. Vivienne Whitworth, Ryerson Polytechnic University
 3:00 – 3:30 pm Coffee and Exhibits
 3:30 – 4:30 pm *Applying Distance Techniques to On-Campus Courses**, Dr. Stephen Lower, Simon Fraser University
 4:30 – 5:00 pm *The Delivery of Chemistry Labs at a Distance: The Athabasca Model*, Dr. Dietmar Kennepohl, Athabasca University
 5:00 – 6:00 pm C₃ AGM in the B.C. Tel Theatre at B.C.I.T.
 7:00 – 10:00 pm **Banquet**

Saturday, June 11th, 1994

- 7:00 – 8:00 am Fun Run/Swamp Trot — Burnaby Lake
 8:00 – 9:00 am **Registration**
 9:00 – 10:00 am *Introducing Operation Chemistry: A Model of Teaching Chemistry to Teachers at All Educational Levels*, Dr. Stuart Baum, State University of New York (Plattsburgh) and Dr. Paul Kelter of University of Nebraska (Lincoln).
 10:00 – 10:30 am *TBA*, Dr. David W. Klein, Kansas City Kansas Community College
 10:30 – 11:00 am Coffee and Exhibits
 11:00 – 11:30 am *FACTOIDS: PASSING THE FINAL EXAM! or "Don't give me the theoretical (conceptual) run-around, just give me the answer!"*, Dr. Dave Woodcock, Okanagan University College
 11:30 – 12:00 Noon *Environmental Studies of Burnaby Lake.**, Dr. Joffrey Berry, British Columbia Institute of Technology
 12:00 – 1:30 pm **Lunch**
 1:30 – 2:00 pm **Session A:** *TBA*, Shirley Reynolds, British Columbia Institute of Technology
 1:30 – 2:00 pm **Session B:** *Teaching Multiculturalism in Chemistry*, Prof. R. Max Ferguson, Eastern Connecticut State University.
 2:00 – 2:30 pm **Session A:** *Favourite Demonstrations in Organic Chemistry and How these are Integrated into the Course*, Prof. Gordon Hambly, John Abbott College
 2:00 – 2:30 pm **Session B:** *TBA*, Lock Gibbs
 3:00 – 3:30 pm Coffee and Exhibits
 3:30 – 4:00 pm *ABCDEF – Analysis Based Course Diagnostic Evaluation Format**, Dr. Subbanna Vadlumudy, Dawson College
 4:00 – 4:30 pm *Fun and Games*, Dr. Harold Wilson, John Abbott College
 4:30 – 5:00 pm *Microchemistry Techniques in Organic Chemistry,** Dr. Guy Lamoureaux, Simon Fraser University
 5:00 – 6:00 pm Tours of the British Columbia Institute of Technology
 7:00 – 10:00 pm Restaurant Tours

(*indicates titles to be confirmed)

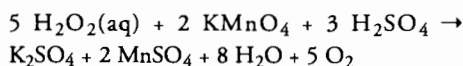




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Analysis

A trip through the FMC lab with chief chemist Ian Hyslop revealed the usual array of analytical equipment: ICP plasma spectrometer, HPLC, and scaled-down versions of various parts of the plant process (used for trouble shooting). But, front and centre were a couple of burettes filled with KMnO₄. The KMnO₄ is standardized by titration with potassium oxalate (kept in its own furnace for drying), and then used to titrate samples of peroxide which come from the plant:



The burettes are digital, but only because more consistent results are obtained by less experienced technicians, since the meniscus-location problem is eliminated with these burettes.

Shipping and Storage

The main concern in shipping and storing peroxide solutions is the danger of catalytic decomposition. The rate of decomposition is increased by contamination, alkalinity, increasing temperatures, and contact with certain metals. To reduce this, storage tanks and transfer pipes are constructed of a high purity aluminum alloy which has been cleaned and passivated by washing with detergents, rinsing with purified water, and then treating with 35% nitric acid solution. FMC claims a rate of decomposition of less than

1% per year in bulk storage tanks at ambient temperatures.

Transportation is certainly a big cost since peroxide trucks and tank cars are on a one-way trip. Nothing can be shipped back from the mill in these carriers, and since the peroxide is in solution, much of the cost is for shipping water! Location of the plant close to the customer is one obvious solution. There are three pulp mills within sight of the FMC plant in Prince George. Another solution is to produce the hydrogen peroxide on site, an experiment tried by H-D Tech Inc at the Abitibi-Price mill in Thunder Bay.

Conclusion

As a physical chemist, I was initially curious about why the quinone/hydroquinone reaction scheme was used in the production of H₂O₂. Surely there must be a nice clean physical process for doing the same thing. The answer can be found by examining the table showing materials required per tonne of peroxide. All reactants, working solutions, and catalysts are recycled so that only H₂, air, and water are consumed in the process.

Materials required per tonne of 25% H ₂ O ₂	
Oxygen	164 m ³
Hydrogen	183 m ³
Ethylantraquinone	Mechanical losses only
Solvent	Mechanical losses only
Palladium (catalyst)	Mechanical losses only
Water	752 L

It is also reassuring to find that some of the techniques we teach in the first year chemistry laboratory are actually used in the real world. Every first year student has struggled with the KMnO₄ redox titration, and it is encouraging to see that this technique is still the analytical method of choice in the peroxide industry.

References

1. FMC Corporation, *Hydrogen Peroxide Technical Bulletin*, 1989.
2. *Chemical and Engineering News*, 1991, 69, page 10.
3. Mullinder, John, *Pulp and Paper Journal*, February 1989, 39-41.
4. Chowdhury, Jayadev, *Chemical Engineering*, June 20, 1989, 1-4.
5. Faith, W.L. et al. *Industrial Chemicals*, 3rd edition, Books Demand, 1965. p 458-465.
6. *Chemical Week*, Feb 17, 1993 v 152, n 6 page 42.

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