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**FIGURE 1:**
Figure Legend: Fractionation of end labeled DNA markers on 3mm thick 0.8% agarose by the VAGE apparatus and transfer to Duralon—UV™ membranes using the PosBlot pressure bloter.
A. Ethidium stained gel showing high resolution.
B. Same gel after pressure blotting.
C. Autoradiogram of membrane after pressure transfer.
The PosiBlot™ positive pressure bloter permits the transfer of nucleic acids in 1/3 the time of vacuum bloters and 1/50 the time of capillary blotting (Figure 2). Pressure blotting does not dehydrate gels as do other methods. This allows the use of substantially higher pressure differentials, compared with vacuum blotting, without gel collapse. The PosiBlot apparatus reduces blotting time to 15 minutes.

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The Stratalinker™ UV Crosslinker fixes nucleic acids to solid supports such as nitrocellulose or nylon membranes, in less than one minute. This compares favorably to vacuum baking, which requires 2 hours. The Stratalinker actually monitors the ultra violet energy flux and deactivates the light source upon reaching the user-programmed energy level (Figure 4). Figure 3 shows an autoradiogram of a human genomic Southern blot performed using the VAGE, PosiBlot and Stratalinker all in 2.5 hours.

Stratogene offers a full selection of nitrocellulose, reinforced nitrocellulose and nylon membranes. Each membrane is stringently lot tested to ensure consistency when performing Northern and Southern blotting. Please call Technical Services for detailed information on Stratogene's time saving blotting systems and membranes.
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Desalination of Brackish and Marine Waters

The existence of a huge, spreading oil slick in the Persian Gulf raised concern about potable water supplies for Saudi Arabia and other Gulf states. These countries obtain most of their drinking water from desalination. The oil slick may cause moderate curtailment of water supplies, but the inconvenience will not be much greater than that experienced in some California cities during the region's drought. Below is a discussion based on a sampling of the extensive literature on desalination.

About 60% of the world's desalination capacity (or about 2 billion gallons per day) is located on the Arabian Peninsula. Potable water is produced by many plants, and per capita supplies are comparable to those consumed by urban dwellers in the United States. The principal process employed is multi-stage flash (MSF) distillation. An important second-ranking process is reverse osmosis (RO). In most instances MSF is operated in conjunction with thermal electric power plants. Energy liberated by combustion of hydrocarbons is used to make high-temperature, high-pressure steam which in turn drives turbines. Condensate at about 120°C and 3 bars constitutes the energy input into the MSF plant. There, saltwater is distilled in stages at successively lower temperatures and lower gas-phase pressures. Condensing steam from a higher level stage provides heat for the next lower stage. The net output of water is 6 to 10 times that which would be obtained from a single distillation step.

In practice there are problems of corrosion and fouling. These are minimized by treating the seawater before it enters the MSF. The pretreatment includes a filtration process designed to remove inorganic and organic suspended matter. Intakes for the raw seawater are located several meters below the surface of the sea. At that depth, if shielded from an aging oil slick, the amounts of dissolved hydrocarbons present are likely to be on the order of parts per billion. This was the experience in Prince William Sound, and elsewhere. Crude oils contain thousands of compounds and differ mainly in relative proportions of the various constituents. All have low-boiling fractions that quickly evaporate. Other fractions are quite insoluble in water or are nonvolatile. The principal components of concern are the polycyclic aromatic hydrocarbons naphthalene and phenanthrene, which are more soluble than straight-chain hydrocarbons of similar molecular weight. However, the amounts of hydrocarbons in the MSF feed after preliminary treatment of the raw seawater would be tiny, and their boiling points are high. Thus contamination of the product water should be minimal.

Saudi Arabia is not completely dependent on desalination for its supplies. Wells are present on the land surface. Some of these have brackish water that is not potable. This deficiency has been ameliorated by installation of RO plants. In this process, water under high pressure is forced through membranes, leaving behind most of the content of inorganics and organics and all large entities such as viruses. In Saudi Arabia, the DuPont Company alone has provided membranes for 22 RO brackish water plants having a total capacity of 230 million gallons of water per day. Dow Chemical is also active in production of RO membranes. A recent press release from Dow tells of supplying its products to the U.S. Army. The membranes are now an integral part of the Army's mobile purification units, which supply virtually all of the drinking water for U.S. troops in Saudi Arabia.

The total costs of producing potable water from seawater are on the order of $4 per 1000 gallons. Reclamation of moderately polluted water by RO costs on the order of 50 cents per 1000 gallons. To a thirsty person the $4 number would present no barrier. However, the numbers would be dismaying to a farmer. The energy required for RO is about half or less that required for MSF. The theoretical requirement for RO is 3 kilowatt-hours per 1000 gallons. In practice, 15 to 30 kilowatt-hours are required. Other major costs arise from amortization of capital and the processing of feed waters to minimize fouling of membranes.

Use of desalting equipment is not confined to the Arabian Peninsula. Worldwide, nearly 4000 plants are involved in scores of countries producing a total of about 3.4 billion gallons of potable water per day.

In advanced temperate countries having adequate rainfall, RO is destined to have a major future role in such applications as treatment of municipal wastes, agricultural runoff, textile wastes, and wastes of industries using large quantities of water. RO is also useful as a step in preparing highly purified water. It can serve to reduce the level of salts and organic substances to low levels as a preliminary to final purification by ion-exchange resins.

—Philip H. Abelson
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hour is for a package of reflectors, lamps, ballasts, and controls applied to tubular-fluorescent lighting, not for replacing incandescent with compact fluorescent lamps.

2) The five new insulation materials for refrigerators and the like are not “hundreds of times” but only about two to ten times as efficient as freon-filled foam.

3) We would never say or think that failure to capture 100% of efficiency’s technical potential “shows how irrational consumers are.” Consumers are canny and sensible, but lack sound information and convenient access to the best packages of modern technologies. They are served by utilities that are often misguided by perverse regulation and (as Cherfas rightly says) price electricity with a discount rate tenfold lower than customers apply to efficiency, thus diluting price signals tenfold. Like other practitioners’ work, our work emphasizes proven, practical ways to correct such market failures, not blaming their victims.

4) We analyze “maximum technical potential” savings for the same reason mineral economists analyze reserves (identified resources profitably producible with present technology): as a basis, not a substitute, for production plans. Although reserves are never actually 100% produced, some utilities have shown that most of the potential in particular efficiency “micromarkets” can be quickly and cost-effectively captured (1) at empirical costs consistent with our calculations.

5) Potential savings from 35 improvements to motor systems (not just motors) might be as high as “nearly 60%,” but we claim, and colleagues at the Electric Power Research Institute (EPRI) concur with (2, p. 68), only a 50% potential with about a 16-month payback—still enough to save more than a fourth of the world’s electricity.

Our detailed engineering-economic analyses of electric efficiency potential, documented from measured cost and performance data, are so far unrefuted and their acceptance is growing. Differences remain—EPRI’s supply curve shows potential savings that are several times smaller and costlier than ours (2, 4)—but the difference is mainly methodological, not substantive, and is less important than our consensus that the cost-effective potential is many times what utilities now plan to capture.

The latest data are strongly supportive: for example, on 14 January, five engineering firms competing to retrofit a 1900-square-meter part of Pacific Gas & Electric’s research office submitted conceptual designs (5) with calculated cost-effective savings of 67 to 87% using commercially available technologies. One design was calculated to save 85% of electricity (with greatly improved esthetics, comfort, and productivity) at an average cost of about 2.1c per kilowatt-hour, about a 3-year payback. Fine-tuning now under way should do even better.

There is a similarly striking potential to save oil: in the United States, about 80% at a few dollars per barrel (6). The most important step would be “feebates”—revenue-neutral, sliding-scale fees for inefficient, and rebates for efficient, new cars (7).

In practice, energy efficiency won’t all be done, or done right. But its potential appears larger than is needed, with chlorofluorocarbon substitution and sustainable farming and forestry practices, to stabilize the earth’s climate at negative social internal cost (8).

Amory B. Lovins
Rocky Mountain Institute,
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REFERENCES

1. For example, New England Electric System captured 90% of a 200-customer commercial retrofit pilot in 2 months; Pacific Gas and Electric captured 25% of new commercial construction in 3 months and its entire 1991 new commercial target in 9 days; in the residential sector, several Iowa municipal utilities have installed air-conditioner controllers, and the Hood River Project in Oregon retrofitted...
superinsulation, in more than 90% of eligible homes in
1 to 2 years.
262, 64 (September 1990).
3. COMMITTEK Hardware Reports (Rocky Mountain
4. EPRI's curve is for potential savings achievable by
the year 2000, while Rocky Mountain Institute's (RMI's)
is long-term asymptotic. EPRI's excludes, but RMI's in-
cludes, a further 9 to 15% savings that EPRI believes
will occur spontaneously by 2000. EPRI's curve is near
the lower end of a 20-percentage-point range of uncer-
tainty (E. Hirsh, Possible Effects of Electric-Utility DSM,
1990 to 2010 (ORNL/CON-312, Oak Ridge National
EPRI's excludes, but RMI's includes, credit for mainte-
nance costs saved by customers. And EPRI's drive-
power savings are about three times smaller and about
five times colder than is agreed in (2, p. 66).
5. Information on this "ACT" project is available from
Pacific Gas & Electric's Research and Development
Department, 3400 Crow Canyon Road, San Ramon CA
94583, 415-866-5330. The cost-effectiveness limit used a utility perspective—96 per
kilowatt-hour, levelized over 30 years at a 6½% per
year real discount rate. Several designs were project-
ed to cost far less.
December 1990, p. A15; documented in The World
Petroleum Market in the 1990s, R. Reed and F.
Pesharaki, Eds. (Wrenn/Bohlender, CO, 1989); supply
curve in (8).
7. The California Legislature passed such a "Drive +" mea-
ure by a 7 to 1 margin in August 1990. It was veteded,
but the new governor is expected to sign a repassed
version later this year. "Feebates" could also be applied to heavy transport, buildings, appli-
ciances, and so forth and could encourage early scrap-
age of inefficient stocks.
8. A. B. Lovins and L. H. Lovins, Least-cost climatic
stabilization (Rocky Mountain Institute, Snow-
mass, 15 October 1990).

Ribozyme Technology Patents

Ann Gibbons, in her article "Molecular
scissors: RNA enzymes go commercial" (Research News, 1 Feb., p. 521), refers to
Innovir Laboratories having purchased "lic-
ensing rights" to a ribozyme technology
from Sidney Altman. I would like to clarify
that it is Yale University that has filed appli-
cations for patents on ribozyme technology
on behalf of Altman and his colleagues. This
technology is not dominated by Thomas
Cech's patent. Yale, in turn, has licensed
rights to Altman's technology to Innovir, a
company whose purpose is to develop ri-
bozymes as antiviral therapeutics and which
has applications for patents pending on its
own distinct ribozyme technology.

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Venus Lightning

In his Research News article "Catching
Venus in the act" (17 Aug., p. 742), Rich-
ard A. Kerr commented on the connection
between Venus lightning and active volca-
noes. Kerr further clarified the credibility of
this connection in his response to the letter
"Venus phenomena" by Paul A. Cloutier
(12 Oct., p. 191). The physics of lightning
in Earth's atmosphere is a complex phenom-
emon and is not well understood. However,
the establishment that terrestrial lightning is a
(global phenomenon, and the frequency of
lightning occurrence is known to increase with
the injection of volcano plumes in the
terrestrial atmosphere. These facts led Fred
Scarf and Chris Russell, who analyzed the
electric field detectors data aboard the Pio-
neer Venus Orbiter (PVO), to suggest to-
ographical clustering of orbiter electric
field detector (EOFD) signals over volcanic
highlands on Venus (1).

Cloutier, in his letter, makes the statement
(without justification) that, "in 1986 Rus-
sell working with R. N. Singh changed the
definition of Venus lightning" (2). LIGHT-
nishing is produced by electrical discharges
from clouds to a planet's surface or between
clouds; it has a broadband frequency distri-
bution, with a well-defined amplitude peak-
ing at a certain frequency and falling ampli-
tudes at lower and higher frequencies. Signals
not conforming to such an amplitude
distribution are generally not attri-
uted to lightning. Harry Taylor and Cloutier
attributed these signals to telemetry interfer-

Assessing Higher Order Thinking in Mathematics
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Teaching higher order thinking is essential in
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$4.00 postage/handling per order. Please specify item #89-275. For shipments to California, add applicable sales tax.
ence spikes (3). Cloutier makes special mention that “our comment (3) was published without a reply from Singh and Russell.” One should not interpret absence of a simultaneous reply to mean that no reply was published. In fact, we did publish our comments in a subsequent issue of the same journal (4). A careful reexamination of OEFD signals aboard the PVO showed a temporal clustering of signals in the late afternoon and evening hours. In view of the tenfold decrease of sulfur dioxide concentration in the Venus atmosphere from late 1978 to 1986, the observed clustering of signals was attributed to local dynamical processes (4). The telemetric interference and spacecraft discharge hypotheses remain to be substantiated.

The question of whether Venus is dead or alive can likely be settled by observations from the Magellan orbiter. Electrical discharges in Venus clouds are only an indicator of dynamical processes in the dense Venusian cloud system, and their enhancement and correlation with active volcanoes can be established, if Magellan catches Venus in the act. While I have stated that “lightning is not a verdict on Venus’s life” (5), it may help us find answers to some of our questions about Venus.

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REFERENCES

Ulysses’ Wobble

In the News briefing “Ulysses: All shook up” (21 Dec., p. 1663), there is no mention of the part played by European experts in assessing and solving the space probe’s “wobble” problem. Today Ulysses is fully commissioned and operational. It is more than 120 million kilometers from Earth, and the “wobble” or precession of its spin axis has now been eliminated. Experts at the European Space Agency have developed techniques to control it in the event of any recurrence later in the mission.

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THE EMF- CANCER QUESTION

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Due to the popularity of Science’s recent three-part series by Robert Pool examining the debate over the possible biological effects of electromagnetic fields, we put the articles together in one convenient and comprehensive reprint booklet. The first article looks at the epidemiological evidence for a link between electromagnetic fields and cancer. The second article deals with cell and animal studies, and the third examines policy questions and the politics behind the research.

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cannot provide predictive capabilities. The case is often made that most of the world’s fisheries yield comes from coastal LMEs, and fisheries management is necessarily a localized activity for political if not strictly scientific reasons. However, events at times and places very distant from any single LME (such as an El Niño–Southern Oscillation event) may well control a fishery by modifying productivity and sequential timing of food chain events over thousands of kilometers. Ecologists, I believe, would prefer to subdivide the single world ocean ecosystem into its major component LMEs at the outset and not merely those readily recognizable as someone’s fishery management problem at the ocean margins.

Coastal LMEs will be subject to the consequences of global climate change, concerning which much research is currently being planned and implemented. Programs such as GLOBEC (Global Ocean Ecosystems Dynamics) in the United States and its international counterparts are poised to begin process-oriented studies designed to understand and predict ecosystem change. It would be ideal if a network of LMEs could be developed to formalize a continuing program of background data collection and long-term observation to provide a historical context for such international research programs. It is high time to organize such a concerted program involving both LME managers and scientists of interested nations to make use of the massive influx of data and models on how the ocean works that will be forthcoming from global change programs.

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Books Received


Courses in Techniques for Separation and Characterization of Complex Carbohydrates

Two courses will be offered at the Complex Carbohydrate Research Center (CCRC) of the University of Georgia. The first course (May 13–17, 1991) will focus on the separation and characterization of oligosaccharides isolated from glycoproteins and is intended for those who have no experience with carbohydrate analysis. The second course (May 20–24, 1991), intended for scientists with some experience with glycoconjugates or for those who have completed the first course, will cover aspects of structural analysis of oligosaccharides and will focus on techniques of composition and linkage analysis. Both courses will consist of hands-on laboratory work as well as demonstrations and lectures. A lab manual including selected analytical techniques and references will be provided. Each course is limited to 10 participants. Experience with basic biochemical techniques is a prerequisite for participation. The cost of registration per course is $250 for individuals from nonprofit institutions; $500 for others. The cost of lodging and food is not included.

The courses are sponsored jointly by the DOE/NSF/USDA Plant and Microbial Carbohydrate Center and the NIH Biomedical Carbohydrate Resource Center of the CCRC. For further information and application forms for the courses contact: Dr. Roberta K. Merkle, Technical Director for Biomedical Carbohydrates, Complex Carbohydrate Research Center, 220 Riverbend Road, The University of Georgia, Athens, Georgia 30602. Facsimile: 404-542-4412. Phone: 404-542-4405.


Plasma Dynamics. R. O. Dendy, Carendon (Oxford University Press), New York, 1990. x, 161 pp., illus. $63; paper, $27.95.


