

January 29, 1980

Exxon's View and Position
on "Greenhouse Effect"

Mr. M. E. J. O'Loughlin
Exxon Corp. - Directors
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H. N. WEINBERG

JAN 30 1980

Dear Morey:

This letter is in response to your inquiry about Exxon's position and activity in connection with the "greenhouse effect."

Science & Technology feels that the build-up of carbon dioxide in the atmosphere is a potentially serious problem requiring the results of a huge worldwide research effort before quantitative predictions can be reached on the probabilities and timing of world climate changes. We feel that the magnitude of the research effort required is beyond the resources and responsibility of any single company or industry, and must be addressed by the combined coordinated efforts of government, industries and academia.

The DOE, through the Office of CO₂ Effects, is trying to provide this coordination plus a focus for data synthesis and analysis for the national and international projects underway. A central objective of the Office of CO₂ Effects is to provide predictions for government policy-making. The objective of Exxon's current research program in this area is to play a prominent role in critical components of the research program, actively follow the results of the overall program and to critically evaluate predictions of CO₂ effects as they are developed. Science & Technology Department feels that this is the proper stance for Exxon at this time. We support Corporate funding of this effort. The following paragraphs and attachment provide some additional background on what is known about the CO₂ effect and Exxon's participation in the research program.

Reliable data show that CO₂ in the atmosphere has increased approximately 5% since 1957 and it is thought that this is due to fossil fuel burning and forest clearing. This increase represents about 50% of the CO₂ generated by fossil fuel combustion or from 50-250% of the CO₂ released by forest cutting and burning. However, the relative contribution of each of these sources is not accurately known or even that they are the major reason for the increases in atmospheric CO₂. In addition, the ultimate disposition of the CO₂ that does not remain in the atmosphere is not known, although most authorities agree that the oceans are the probable sink.

The major questions that need to be answered in a more definitive way in order to evaluate the significance of increasing CO₂ concentrations are: first, what is the contribution of fossil fuel combustion emissions to the atmospheric CO₂ build-up; second, what happens to the CO₂ that does not remain in the atmosphere; and third, how will the continued increases of CO₂ in the atmosphere affect the world climate?

Exxon Research & Engineering Company has an ongoing Exxon funded \$600k per year research program to help determine whether the primary cause of atmospheric CO₂ is from fossil fuel or from forest clearing and to estimate the net global CO₂ flux into the oceans. This program is summarized in the attached letter from E. E. David, Jr. to George T. Piercy. In addition, Exxon is helping to fund two outside research organizations working on the CO₂ effect at approximately \$20k each per year. One is the Marine Biological Lab at Woods Hole, investigating the overall CO₂ effect with emphasis on forest clearing and the other is the Scientific Committee on Problems of the Environment (SCOPE), studying the effects of fossil fuel emissions and other changes on global climate and the life support system.

The research program necessary to understand the "greenhouse effect" is a very large, complex undertaking, being conducted on an international scale primarily with government funding. In early 1978, Exxon Research & Engineering considered an independent research program but concluded that the amount of effort required and the scope of disciplines involved made it impractical for a single institution to attack this problem alone. Instead, it was decided to use Exxon's unique resources to research critical components of the overall program and to follow research being conducted by others through participation in seminars, steering committees and government research activities. In addition, Science & Technology feels that it is desirable to obtain the consulting services of a world recognized expert in this area. As a result, we are formulating a consulting agreement with Professor W. S. Broecker of Columbia University. We consider him the most outstanding researcher, actively involved in studying the carbon dioxide problem.

Science & Technology feels that Exxon's active participation in the international research program, plus the services of Professor Broecker, position us to assess the significance of the CO₂ "greenhouse effect" as soon as the required research results become available and to critically evaluate conclusions drawn from the program which might be biased for political or other reasons. We recommend continuation of our current program of selected research projects in critical areas of this complex question supplemented by consulting advise from highly respected experts.

We would be glad to arrange a technical review of the CO₂ "greenhouse effect" and the Exxon funded research programs if you so desire.

Very truly yours,

Walt

WRE:cc
Att.

cc: (w/att.) E. E. David, Jr., A. M. Natkin, S. Stamas, G. T. Piercy

bcc: (w/att.) P. J. Lucchesi, H. N. Weinberg

PROPRIETARY INFORMATION

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Column
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EDWARD E. DAVID, JR.
President

Telephone: 201-765-1257

November 9, 1979

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W. R. ...
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- please
give me cc
thanks

Mr. George T. Piercy
Senior Vice-President
Exxon Corporation
1251 Avenue of Americas
New York, New York

Dear George:

This eighth in our series of President's Letters outlines work we have initiated to help evaluate the so-called "greenhouse effect" -- a potential future global warming caused by the accumulation of CO₂ in the atmosphere. The "greenhouse effect" is receiving widespread attention, based in part on dramatic claims and dire predictions that are appearing in the popular press. It is being cited, for instance, as an argument in opposition to any major U.S. synfuels program. Good, solid data are sorely needed, along with better climatological models. The work we have initiated to date should help provide a small part of the data. It focuses on past and future growth of atmospheric CO₂ concentrations, rather than on the resulting effect of CO₂ on climate. Our data could well influence Exxon's view about the long-term attractiveness of coal and synthetics relative to nuclear and solar energy.

ER&E'S "GREENHOUSE EFFECT" PROGRAM

The Knowns and the Unknowns

It is known that the CO₂ content of the atmosphere is increasing. Hard data are available from an atmospheric monitoring program begun in 1957. It has been assumed that the increase began coincidentally with the Industrial Revolution in the middle of the last century. Two sources of CO₂ are believed responsible: combustion of fossil fuels, and the clearing of virgin forests. The latter results in less photosynthetic uptake of CO₂ as well as formation of more CO₂ through oxidation of the cleared biomass. Evidence for the relative contribution of each of these sources is largely missing. It is important to resolve this matter because the worldwide combustion of fossil fuels could increase dramatically over the next 50 years while additional forest clearing is inherently far more limited.

It is also known that the amount of CO₂ accumulating in the atmosphere is less than the amount released by fossil fuel combustion alone. That means a very large amount of CO₂ is being absorbed from the atmosphere. The ocean acts as the

major net CO₂ absorber. The ultimate capacity of the ocean to store CO₂ far exceeds any projected CO₂ production, but it is known that mass transfer from the atmosphere into the deep ocean controls the rate at which CO₂ can be absorbed. Sufficiently accurate quantitative measures of the mass transfer characteristics are not available. Data are needed to calculate net projected oceanic CO₂ absorption rates and thus the residual atmospheric CO₂ accumulation resulting from any projected CO₂ production.

Fossil Fuels or Forest Clearing?

See Appendix article

We expect to establish the contribution of each of the two possible sources to the annual increment of atmospheric CO₂ by measuring the carbon isotope ratios in a series of vintage wines. Carbon-fourteen (C-14) is an unstable isotope created from nitrogen in the atmosphere by cosmic radiation or nuclear explosions. The C-14 is captured by oxygen to form CO₂. Through photosynthesis, it is incorporated -- along with the stable isotopes of carbon -- in all growing matter. However, as C-14 has a half-life of only 5570 years, it has virtually disappeared from all fossil fuels. Thus, while CO₂ generated by forest clearing returns C-14 to the atmosphere, CO₂ from the combustion of fossil fuel does not. Knowledge of changes in the carbon isotope ratios in the atmosphere over time -- prior to the start of the atomic age in 1945 -- would therefore help determine the relative annual contribution of fossil fuel combustion and of forest clearing to the atmospheric CO₂ inventory.

Our wine measurement program is aimed at unravelling this aspect of the past. The higher the C-14 content of atmospheric CO₂ in a given year, the higher the C-14 content of grapes grown that year and of the resulting wine. Vintage wines thus represent a stored record that can presumably be tied to the C-14 content of the CO₂ in atmospheres of years gone by. We intend to obtain some 100 bottles of wine with well-documented histories, probably from a single chateau in France. Initial investigations have indicated we can procure a set of non-marketable vintage wines dating back more than a century. We expect to start the experimental work later this year.

Mass Transfer at Air/Sea Interface

We are going to address this problem in two parts: (a) determination of the local driving force for mass transfer set by the air and ocean CO₂ concentrations, and (b) determination of the local mass transfer coefficient. The results of (a) and (b), suitably integrated, can be used to estimate the net global CO₂ flux into the ocean.

Part (a) involves the measurement of CO₂ in the air and in the ocean at numerous locations repetitively over several seasons. With the assistance of Exxon International's Tanker Division, we have placed suitable instrumentation and two ER&E technicians aboard the Esso Atlantic, a 500,000 DWT tanker plying the Persian Gulf/Caribbean route. This route was chosen because it crosses several upwellings around the equator, oceanographic areas of particular relevance to the global carbon cycle.

Running expenditures for this part of the CO₂ Program are estimated at K\$300/tanker-year and are currently Exxon-funded. We expect that Exxon funds will continue to be available to permit operating at the one tanker level for the two

years necessary to validate the technique. Meanwhile, we are preparing a formal proposal to DOE for Government funding of future expenditures and are optimistic about receiving federal support beginning no later than fiscal year 1981. We are proposing a five-year program at the one tanker level. Once the data acquisition techniques are well established, DOE may find it desirable to expand the data base by using additional instrumented tankers on other routes of oceanographic significance. Academic and Government research vessels cannot compete economically with tankers in obtaining such information because the operating cost of the tankers does not have to be borne by the research program.

For Part (b), we intend to measure the mass transfer coefficient at the air/sea interface as a function of weather conditions and sea state using naturally occurring radon-222 as a tracer. Rn-222 is generated at a constant rate in the ocean and is continuously depleted by loss to the atmosphere and by radioactive decay. The atmospheric concentration is effectively zero. Knowing the profile of Rn-222 concentration down from the sea surface should permit us to calculate the mass transfer coefficient. We expect to carry out the sampling and analyses from an Exxon drilling ship offshore Australia. Preliminary discussions have been held with Esso Exploration concerning this phase of the program.

In view of the desirability of integrating our CO₂ results into global climatological modeling programs, we intend to work closely with key university and government researchers as well as with cognizant international organizations. We believe that Exxon is in a unique position to provide leadership in a scientific subject of high significance to ourselves, the nation, and the world.

Very truly yours,

A handwritten signature in cursive script, appearing to be the name "Ed".