

PERSPECTIVE

After oil and gas: methanol economy

George A. Olah

Oil and natural gas (together with coal composing our fossil fuels) are not only our main energy sources but they are also the raw materials for the great variety of products (ranging from gasoline and diesel oil to varied petrochemical and chemical products including synthetic materials, plastics, pharmaceuticals, etc.). What nature gave us as a gift, built over the course of eons, is however used up rather rapidly. These natural resources continue to be significantly depleted and become increasingly costly. Thus we need to search for new sources and solutions.

All fossil fuels are mixtures of hydrocarbons, composed by varying ratios of carbon and hydrogen. Upon their combustion carbon is converted into carbon dioxide and hydrogen into water. Consequently when burned they are irreversibly used up. In addition, the increase of the CO₂ content of the atmosphere is considered a major man made cause for global warming.

Without diminishing natural resources and the difficulties connected with using atomic or alternate energies, there is urgent need to find and develop feasible new and safe ways for energy storage and distribution, as well as to produce man made hydrocarbons efficiently.

Much is said recently about the future “hydrogen economy”. The main source for hydrogen is presently natural gas, but it can be generated by electrolyzing water. The combustion of hydrogen is indeed clean, giving only water and releasing energy. However, hydrogen is not a natural energy source on our planet earth (in contrast to the sun and stars of the universe) and it must be generated using much energy (from natural gas or by electrolytically splitting water). Producing hydrogen is only a way of storing energy. Handling of this volatile and explosive gas is difficult, dangerous and costly necessitating high pressure equipment and the use of special materials. No infrastructure exists for it and its cost would be prohibitive. Even with the greatest care any leaks would represent extreme explosion hazards, limiting wide use by consumers. Our government and some of the major industries regardless seem to be committed to develop the “hydrogen economy” (see for example the Department of energy’s November 2002 “National Hydrogen Energy Road

Map” and statements in President Bush’s January 2003 State of the Union message). It is clear, however, that to achieve it new ways must be found to make it feasible.

I suggest a reasonable and practical alternative to overcome the mentioned difficulties by converting hydrogen with carbon dioxide to methanol (methyl alcohol, CH₃OH) a convenient liquid product. Methanol is a bulk commercial chemical made presently from natural gas, but under proper conditions it can also be made from atmospheric carbon dioxide by its reaction with hydrogen.

Methanol is an excellent fuel on its own right and it can be blended with gasoline. It is also used in the pioneering “direct methanol fuel cell” we developed jointly with the Jet Propulsion Laboratory of Caltech. In this fuel cell methanol is directly combined with air producing electricity without the need to first cleave it to give hydrogen. This greatly simplifies fuel cell technology and makes it available to a wide scope of applications. These include providing power to cellular phones, computers (already under commercialization) to motor scooters, cars, etc. (under development) or even large power stations. Further it was found that methanol can be conveniently converted to ethylene, the key material to produce hydrocarbon fuels and their products, presently obtained from oil and gas. It is thus realistic to say that if we can produce methanol efficiently from non-fossil fuel source, it will be able to replace oil and gas as both as a fuel and chemical raw material. Such solution indeed exists in the mentioned conversion of carbon dioxide with hydrogen to give methanol. Atmospheric carbon dioxide is available to everybody on earth and the “methanol economy” eventually can liberate mankind from reliance on fossil fuels. The needed hydrogen can be obtained from water (an unlimited source of the oceans) but as mentioned this necessitates much energy. This can come from atomic energy (albeit made safer and solving problems of radioactive waste disposal) as well as by using all alternative energy sources (sun, wind, hydroelectric, etc.). For all the reasons discussed I believe it is reasonable to start to consider the “methanol economy” as well as practical and feasible approach to answer the question what will replace

oil and gas. It would provide a feasible and safe way to store energy, make available a convenient liquid fuel, and assure mankind an unlimited source of hydrocarbons while at the same time mitigating the dangers of global warming. Before we spend untold billions in developing a still unproven and potentially unsafe hydrogen infrastructure a modest effort to

explore the methanol economy alternative would be warranted.

George A. Olah is a Professor of Chemistry and Director of the Loker Hydrocarbon research Institute at the University of Southern California in Los Angeles. He won in 1994 the Nobel Prize in Chemistry for pioneering work on hydrocarbons.