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Fuels and Chemicals

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1. Introduction

At the very beginning of the brainstorming sessions the question was brought up: how do we define «fuels»? The agreement has been that: «a fuel is considered to be a substance which is produced by a substantial endergonic reaction». Products of premium value, fine chemicals, are in the following treated as «chemicals».

The essence of the statements brought forward by the participants has finally been organized for presentation in a subsequent plenary session into four sections: photochemistry, thermochemistry with solar process heat, photosynthesis and related biotechnology, ocean technology.

There have been a few statements of general importance, which may be summarized as follows:

- Synergisms of solar specific developments and applications of conventional technologies often provide beneficial effects in economy. The importance of the search for such synergisms has to be stressed.
- Demonstration plants have to be built to make the public aware of the progress in the field and of the special features of «renewable energy sources». Field experiments are necessary for bridging the gap of experience levels between a laboratory-scale investigation and the final commercial projects.
- Energy costs should be made transparent for the sake of being realistically comparable between the various sources, where the energy has come from, e.g. fossil based or solar based energy resources. All costs connected to energy conversion should be internalized.
- Some industrial processes are conceivable to be profitably substituted by invoking renewable resources.

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To clarify the investigations anticipated into the new fields, the proposal of a future hydrogen technology was taken as an example in a brainstorming group. The experience needed for such a technology concerns all elements of production, storage, transportation, and of end use of hydrogen. It was felt that the assessment of priorities for research and development in this field should be reviewed periodically.

The high standards of expertise of the participants present, representing physics, chemistry, biology, and engineering guaranteed qualified discussion of many and various aspects of «renewable energy resources». In particular, it is worth mentioning that «solar chemistry» turned out to be one of the major topics at the workshop. In the field of biotechnology a strong and rather unexpected interest appeared which led to the creation of the separate section: photosynthesis and related biotechnology. Ocean technology other than biomass production has been a subject of discussion too. This item is, therefore, collected in a separate section.

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2. Condensed Suggestions from Brainstorming

2.1. Photosynthesis and Biotechnology

- Biomass and biotechnology have environmental implications.
- Is biomass renewable?
  - Establish parameters for what is «renewable».
  - Renewable: inexhaustible, reversible, restorable.
- Greenhouse effect with CO_2:
  - Closed CO_2/CH_4 (biogas) systems are to be considered.
  - Plant breeding for photosynthesis improvement and speciality products.
- Follow nature in type of photosynthetic systems used.
- Biomass fraction in garbage (25%) as resource.
- Manipulation of biological systems: enzymes for disintegration of lignine.
- Crash program for transformation of biomass into synthesis gas.
- Photosynthesis:
  - In vitro systems.
  - Multiphoton process for better yields.
- Marine biomass:
  - Algae plantations; sugar-rich foods.
  - Fast growing, no fostering, easy accessible for harvesting 1500 gC/m^2 a.

2.2. Photo-Chemistry

- Pay appropriate attention to production of premium, fine, high-value chemicals:
  - Vitamin D (beads floating on ponds).
  - Production of stereo-specific compounds.
- Cheap solar photons; use all of the spectrum in combined reaction schemes.
- Concept of combined high temperature/high photon flux density:
  - Decomposition of HCl, HBr and recombination of H_2, Cl_2, Br_2 in fuel cells.
  - Combination of HT, PV and thermionics by application of IR-reflectors.
- Heterogeneous systems with semiconductor particles: water photolysis.
- Photochemical reactor designs to be developed.
- Hot electron fast chemistry, 32%→66% efficiency approximately.
- Proton pumping via membranes by IR:
  - Source for subsequent chemical reactions.
  - Source of electricity.
- Photochemical production of amino acids.
- Photochemistry of CO_2 to C, CO, CH_4, CH_3OH, HCOOH.
- Potential of photodetoxification.
- Unwanted chemical products. Research needed e.g. for:
  - Water-impermeable soil by photochemical action.
  - Skin cancer.
- Positive chemical reactions, contrasting to the previous point:
  - Solarization of soil: reduction of use of herbicides.
  - Healing of skin cancer by insolation.
- Development of solar exposure sensitive photochemical dosimeter.

2.3. Thermo-Chemistry

- Process heat for conversion to liquid fuels for transportation.
- Proposal for an IEA assessment of alternative fuel production (the great amounts needed will have environmental impacts).
- High-temperature electrolysis to be coupled to other heat absorbing processes.
- Process heat for distillation of mercury from amalgams.
- Process heat for extraction of perfume oils.
- Hydrazine as a fuel with decomposition to N_2 and H_2O only.
- Pilot experiments for solving solar-specific and process-immanent problems:
  - Continuous versus batchwise operation.
  - Storage of heat or of chemical pre-products.
- R&D in energy storage by means of chemical reactions:
  - Low (around 100 °C) and high (up to 1500 °C) temperatures,
  - Fast charging and discharging: rates of heat transfer are important.
- Process with toxic materials permissible:
  - Yes: in the process plant itself.
  - No: in the distributed fuel.
- Efficiencies and transients: search for fast and direct processes, which are less affected by transients.
- Development of thermionic converters:
  - Supply of electricity together with heat for high-temperature water electrolysis.
- Importance of high-temperature carbochemical reactions, e.g. because of their good kinectics.

2.4. Ocean Technology

- Ocean: concentrator of solar energy by means of waves.
- Wave energy conversion to electricity by magnetohydrodynamics.
- Magnesium-rich salt extraction (sea water as a resource).
- Combination of electricity from ocean and its use in processing ocean-specific products.
- Electrochemical magnesium production.