Industry's Participation in Climate Change Problem

- ○ Introduction
- ○ Technological Approaches to Climate Change
- ○ Natural Energy
- ○ CO_2 Ocean Sequestration

Profile of Lecturer

- Masahiko Ozaki
  Manager of Ship & Ocean Engineering Lab.
  Nagasaki R & D Center
  MITSUBISHI HEAVY INDUSTRIES, LTD.
- Background : Ocean Engineering
- Research Area :
  Floating structures
  Line structures in water
  Mooring system
- Project :
  Mega – float
  Deep ocean drilling
  CO_2 ocean sequestration

MITSUBISHI HEAVY INDUSTRIES, LTD.

(As of 2001 Fiscal Year)

- Employees : 38,000
- Sales : 2.6 trillion yen
- Overseas Offices : 11
- Domestic Offices : 10
- R & D Centers : 6
- Factories : 9

MAIN PRODUCTS of MHI

Transportation Systems	○Ships ○Aircraft ○Launch Vehicles (Rockets) ○Airport System ○Parking Facilities ○Bridges
Power Systems	○Thermal Power Plants ○Hydraulic Power Plants ○Geothermal Power Plants ○Wind Power Plants ○Nuclear Power Plants ○Diesel Engines
Industrial Machineries	○Iron & Steel Manufacturing Machinery ○Chemical Plants ○Construction Machinery ○Printing Machinery ○Diesel Engines
Environmental Systems	○Waste Treatment ○Water Treatment ○Air Pollution Prevention
Heating & Cooling	○Air Conditioners ○Refrigeration Machinery ○Cogeneration Plants ○Waste Heat Utilization

etc.etc.

Basic Standpoint of Heavy Industry Manufacturer such as MHI

- ○ Develop high-performance products and necessary technologies
- ○ Gain customers' satisfaction and receive a proper profit
- ○ Contribute to the society through their products

Stance to Environmental Problem

- ○ Do not pollute environment through the enterprise activities
- ○ Develop, manufacture, and sell the products whose loads to the environment are smaller
- ○ Develop and commercialize environmental technologies

Consideration to the Environment

- is NOT cost increase
- is added value and competitiveness

Technological Approaches to Climate Change

CO_2 Reduction Technologies

1) Emission Reduction
2) Recovery & Fixation

1) Emission Reduction

◇ Energy conservation

◇ High efficiency of fossil fuel power generation

◇ Shift to hydrogen richer fuel
(e.g. coal to natural gas)

◇ Non carbon energy use
(e.g. natural energy, nuclear)

2) Recovery & Fixation

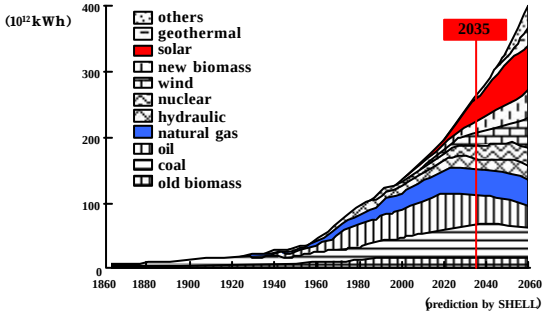
◇ Absorb from the atmosphere
(e.g. afforestation)

◇ Capture and Sequestration

Natural Energy

○ Wind Power Generation
○ Solar Cells
○ Biomass Fuels

Changes of Energy Sources in the world



OZAKI-13

Wind Power Generation (As of End of 2000)

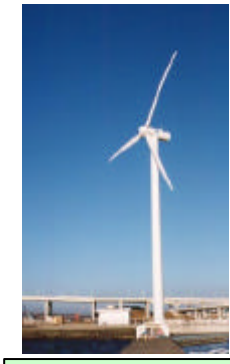
①	Germany	6,113 MW
②	USA	2,555 MW
③	Spain	2,402 MW
④	Denmark	2,297 MW
⑤	India	1,220 MW
⋮	⋮	⋮
⑫	Japan	150 MW

OZAKI-14

Technology for Wind Power Generation

- ○ Prediction of Wind Condition at Site
- ○ Development of Technology of Windmill
- ○ Future Development
  - — larger size
  - — offshore location

OZAKI-15



1 MW windmill [Muroran]

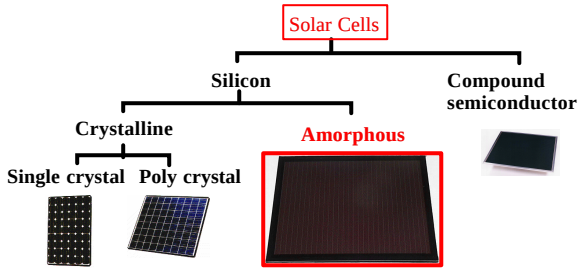
Proto-type of 2MW [USA]

OZAKI-16

Offshore Wind Farm in Denmark

OZAKI-17

Categories of Solar Cells



OZAKI-18

a-Si型太陽電池の特徴

- **年間発電量が多い**
  - 夏季に差をつけ結晶型より約10%多い発電量
- **大面積・大量生産による低価格化**
  - 大面積ﾓｼﾞｭｰﾙの大量生産により電池ｺｽﾄを削減
- **地球環境保全への配慮**
  - CO_2の削減効果が大きく、製造時に投入するｴﾈﾙｷﾞｰも少ない（結晶型比）
- **安定した原料供給**
  - 原料不足の問題がなく、安定した生産が可能

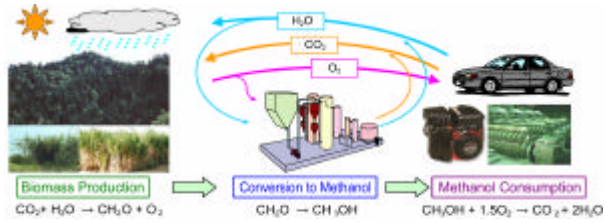
太陽電池工場全景

大面積・大量生産による低価格化
低コスト化が可能な技術

外形寸法（m）	1.4×1.1
出力（Wp）	110
重量（kg）	約20

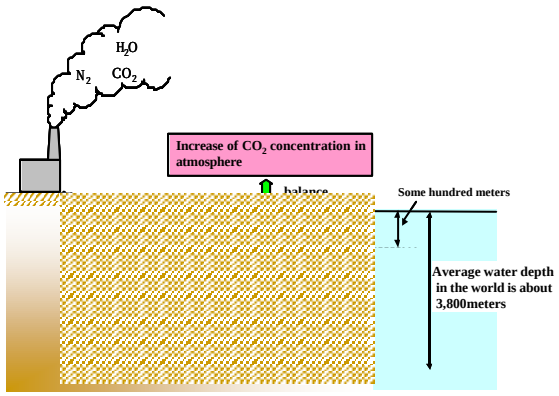
※新ｴﾈﾙｷﾞｰ・産業技術総合開発機構
平成12、13年度太陽光発電ｼｽﾃﾑ
普及促進型技術開発事業にて開発

Carbon Recycle by Biomass Energy



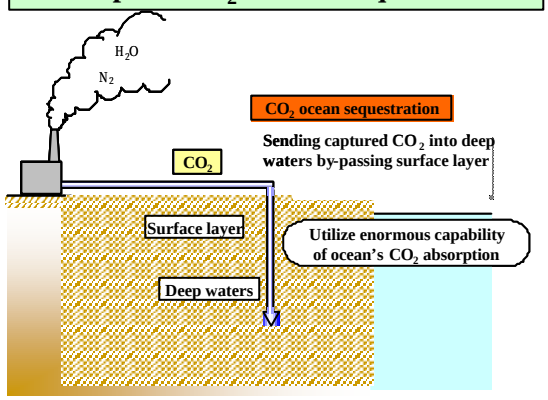
grass | **pilot plant（50 kg/day）** | **methanol**

CO_2 Ocean Sequestration



OZAKI-25

Concept of CO_2 Ocean Sequestration



OZAKI-26

Features of CO_2 Ocean Sequestration

1) There are no needs to make a drastic change in the energy supply system, that allows us gradual shift to carbon free energy. It is practical from the point of keeping the economical continuity.

2) Huge amount of CO_2 can be isolated from the atmosphere for sufficient long time in relatively low cost, if it is acceptable from the oceanic environmental influences.

OZAKI-27

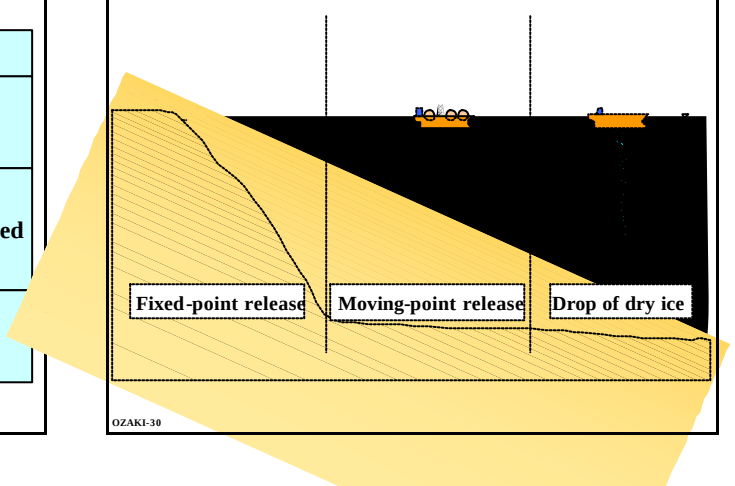
CO_2 Ocean Sequestration

- Dissolution Type
- Storage Type

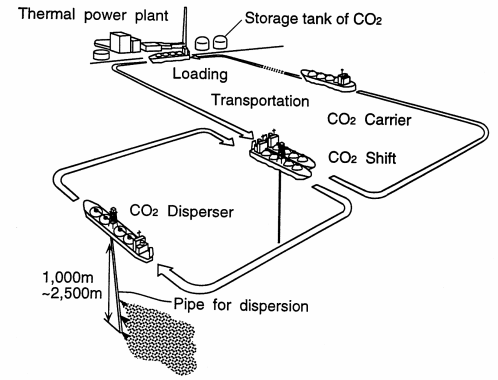
OZAKI-28

	Dissolution type	Storage type
Concept	Dilution of dissolved CO_2 in large volumes of seawater	CO_2 storage in a hollow of deep sea
Hypothesis	Sufficiently diluted CO_2 in deep water would be permissible	Impact would be limited to a localized area
Influence	low, broad	high,local

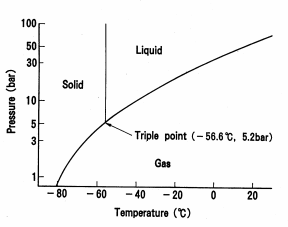
OZAKI-29



OZAKI-30



CO_2 transportation by ship



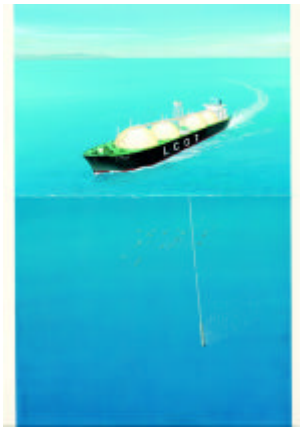
phase diagram for CO_2

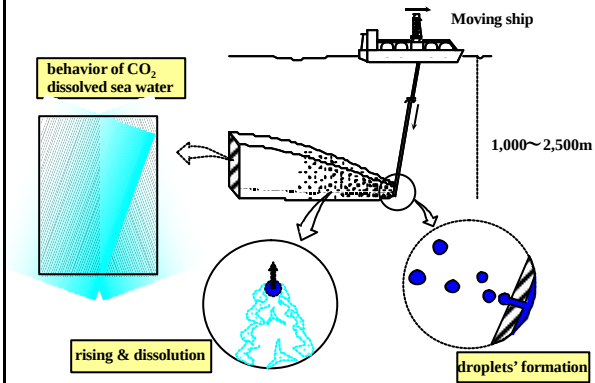
Rough Estimate of CO_2 Transportation Feasibility

- Total amount of CO_2 emission in Japan
  $\approx 1.2 \times 10^9$ ton/year
- Target of Kyoto protocol for Japan = ▲6%
  ⇨ Effective amount of CO_2 reduction, for example
  $\approx 1.2 \times 10^7$ ton/year(▲1%)
- CO_2 emission from a 1.0GW-class coal burning power plant $\approx 5 \times 10^6$ ton/year
  ⇨ Application to 2～3 power plants is meaningful
- Capacity of LNG Carrier = 120,000～140,000m3
  ⇨ 50,000ton CO_2 Carrier would be feasible
- 50,000ton×5ships×1cruise/week
  $= 1.25 \times 10^7$ ton/year
  ⇨ corresponding 1% of CO_2 emission in Japan

Rough Estimate of CO_2 Injection

- 50,000ton/ship/cruise
  if releasing duration is 5 days,
  then 50,000ton/5days/24hours/3,600sec=116kg/sec
- Target of CO_2 Injection Technology;
  - ◆ Injection Depth ; 1,000m～2,500m
  - ◆ CO_2 Flow Rate ; 100～150kg/sec
- Inside diameter of pipe ; 300mm
  Flow speed in pipe ; 3m/sec
  ⇨ 210kg/sec
- Hanging from ship a 300mmφ×2,500m pipe is not extraordinary in Ocean Oil/Gas Development

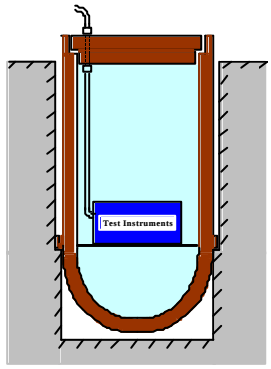




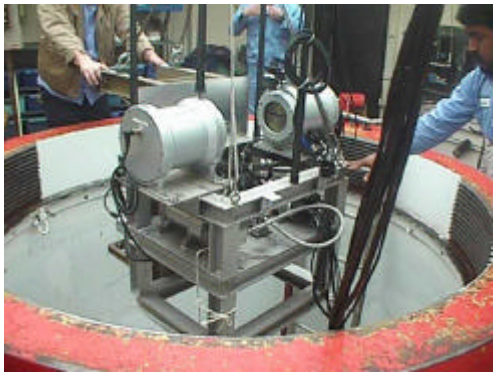
Direct observation and measurement of behavior of CO_2 droplets in high-pressure tank

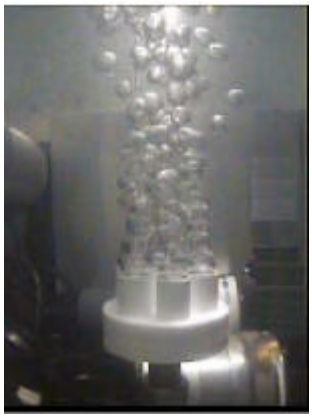
- can avoid the influence from a tank wall
- can restrain the increase of CO_2 concentration in water during test
- can simulate real conditions of pressure, temperature and salinity

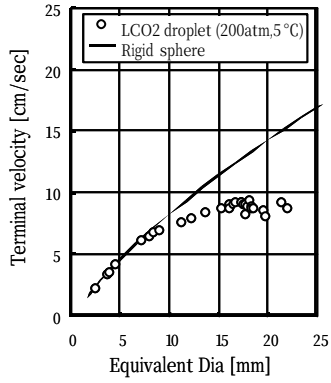
High-pressure tank

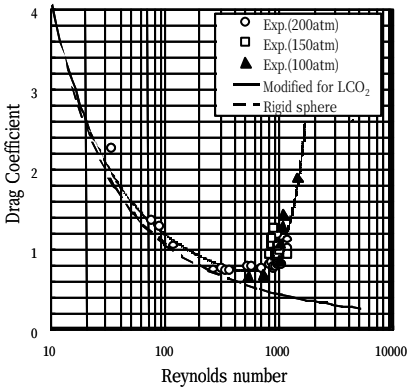


- Southwest Research Institute (San Antonio,Texas)
- Vertical cylindrical
- Maximum pressure 28MPa (corresponds 2,700m water)
- Inside Dia. 2,280mm
- Depth 5,840mm
- Volume 23m^3

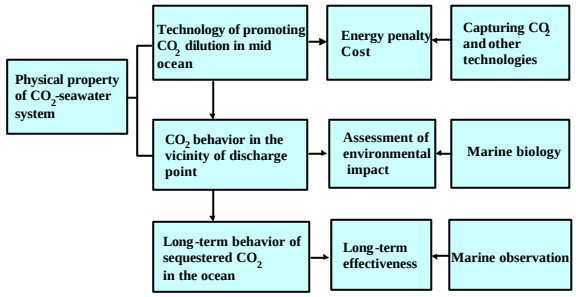








OZAKI-43



OZAKI-44

Concluding Remarks

- Various approaches and cooperating works among wide fields are necessary towards the solution of climate change problem
- Net workings should be expanded
  - inter-departments of a company
  - domestic
  - international

OZAKI-45

Homework subject

It is said there exists enormous amount of Methan-hydrate under the sea bed in the worldwide ocean including the adjacent sea of Japan.

Assuming that you are to investigate this Methan-hydrate and try to get a budget for it, make the applications with relating to the climate change problem.

OZAKI-46