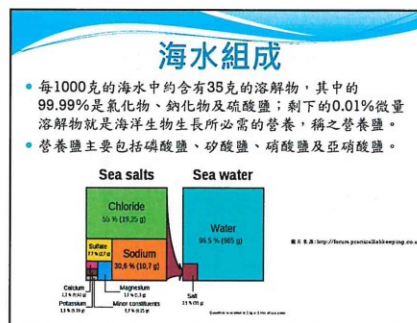
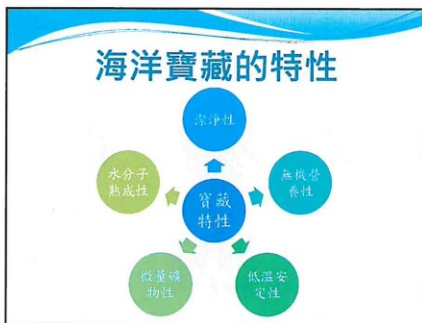


臺北市松山工農國際教育課程「化學寶藏在海洋」教學簡報

(中文版)

2022/7/4



現有海洋的利用	說明
海水淡化	• 利用蒸發、逆滲透等法使水與鹽分開
海水直接利用	• 引進海水直接當工業用冷卻水及民生用水
海水化學	• 海水中開發的經濟物質



海洋營養鹽

- 海水與血液的組成比例，極為相似。血液中55%都是血漿，而血漿的含水量約為92%；除了水之外，就是鈉、鉀、鈣、鎂、氯等成分。
- 海水與血漿的組成比例相近；两者的主要成分都是鈉及氯離子，而鎂、鈣、鉀等的成分比例也非常接近。

圖 8-8-2 <http://www.nhct.com.tw/article/10454.html>

海洋營養鹽

- 磷酸鹽與硝酸鹽是海洋植物行光合作用合成有機物的原料。
- 海洋浮游植物的分布與硝酸鹽的濃度有關。當海水表層的浮游植物增長，則硝酸鹽濃度降低；深海的硝酸鹽濃度高且穩定。
- 硝酸鹽是氮肥的來源。
- 矽酸鹽是矽藻細胞壁的主要構成材料。
- 硝酸鹽在海洋中的含量遠低於磷酸鹽，是浮游植物生長主要的限制因子。

氮循環示意圖

圖 8-8-3 <http://pds.bgs.org/2011/pds.asp>

磷循環示意圖

在自然循環中，風化作用將岩石裡的磷釋放出來，進入土壤，被植物吸收後，再進入食物鏈，並在萬物之間循環。這些磷的化學型態通常是磷酸根離子 (PO₄³⁻)，是生命不可或缺的成分。

Phosphorous Cycle

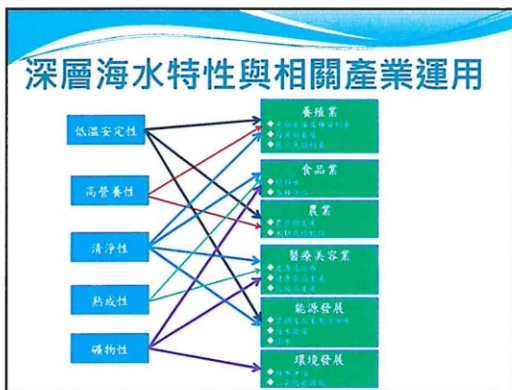
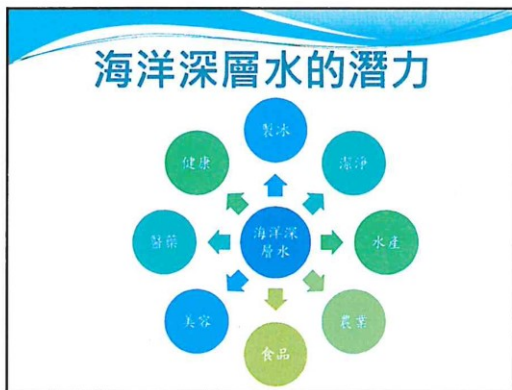
圖 8-8-4 <http://www5.eric.com/education/teach/teachbase/teachbasebookcycle.html>

磷礦的重要性

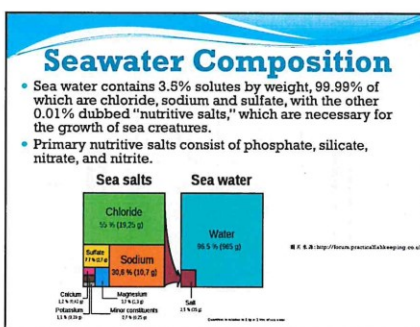
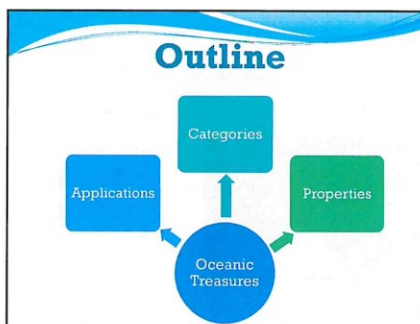
- 農作物生長的三要素：氮、磷、鉀。缺乏時將造成人類的糧食危機。
- 氮可從空氣中獲取，磷和鉀卻必須從土地中採。
- 磷是生物細胞質的重要組成元素，也是植物生長必不可少的一種元素。世界上84%~90%的磷礦用於生產各種磷肥，3.3%生產飼料添加劑，4%生產洗滌劑，其餘用於化工、輕工、國防等工業。
- 全世界的鉀存量足堪使用數個世紀。全球磷礦預計在一世紀內開採完畢，磷礦資源的分佈比原油還不平衡，全球磷礦有將近40%蘊藏在北非的摩洛哥。
- 現代農耕方式讓土壤裡的磷元素還流排入水體以後，水裡的磷含量太高會造成藻華，消耗魚類所需要的氧氣，形成「死區」。

磷礦耗竭的新契機-鳥糞

- 海鳥糞 (Guano) 又稱鳥糞石，鳥糞石通常產於低緯度的海島，主要為海鳥所產生的大量糞便與未被消化的魚骨等食餘。
- 從成分上講，海鳥糞是多種磷酸鹽的混合物，包括鈣磷礦 (CaHPO₄·2H₂O)、三斜磷鈣礦 (CaHPO₄)、白磷鈣礦 (Ca₂(Mg,Fe)[HPO₄](PO₄)₆) 以及各類磷灰石、磷酸鹽和有機物等。
- 海鳥糞經過極長期的累積所形成，因含有豐富的磷，為製作磷肥的良好原料，具有經濟價值，台灣包括棉花嶼、貓嶼、草嶼、太平島與東沙島這幾個曾經盛產鳥糞石的島嶼，在日據時期就被開發殆盡。

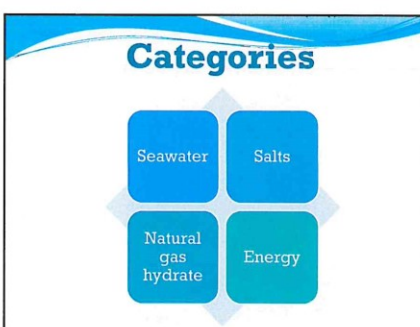


Chemical Treasures in the Ocean



Current Utilizations of Seawater

Desalination	• Separate water and salt by means of evaporation and reverse osmosis approaches.
Direct utilization	• Utilize seawater as industrial cooling water and water for people's livelihood.
Seawater chemistry	• Extract chemicals with economic values from seawater.



Salt Refined from Seawater

- Solar Evaporation
- Electrodialysis

圖 8.8.8: <http://www.uswest.net.gov.tw>

圖 8.8.9: <http://www.uswest.net.gov.tw>

Solar Salt Manufacturing Procedure

大板池 220,655
小板池 60,171
結晶池 50,174

圖 8.8.10: <http://ack.ncp.gov.tw>

Principles of Electrodialysis

圖 8.8.11: <http://www.pcc.gov.tw/technology/press/technology/technology/>

Salt: Mother of Chemical Industry

圖 8.8.12: <http://ack.ncp.gov.tw>

Salt Applications in Chemical Industry

圖 8.8.13: <http://mcp.gov.tw>

Seawater: Cradle of Life

- A woman's womb contains a small ocean—the amniotic fluid that abounds with nutrients necessary for fetuses.
- Water accounts for 97% of seawater's composition, and the remaining 3% includes nutritive salts, minerals, microelements, etc.
- Water also accounts for 98-99% of amniotic fluid. The ratios of sodium, potassium and chlorine in seawater and in amniotic fluid are nearly identical.
- Amniotic fluid tastes as salty as seawater! It is far from exaggerating to deem the ocean as the origin of lives.

Diverse Marine Energies

- The global marine energy reserves are expected to exceed 75 billion kilowatt.
- Categories of marine energy
 - Wave power
 - Tidal power
 - Ocean thermal energy
 - Marine current energy
 - Osmotic power

Wave Power

- Ocean waves are generated through the conversion of solar energy. The uneven heating of solar radiation, the cooling of the crust, and rotation of the earth may work together to form wind. As wind blows across the surface of the ocean, the continual disturbance creates waves. Hence, the wave-driven energy is to certain extent proportional to the wind speed.
- The circular motion of waves lead to water movement. The potential energy, reciprocal force, or buoyant force arising from water movements can be used to generate electricity.


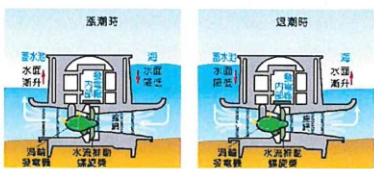


圖 8.8 <http://www.austlianelectrical.com.au>

Tidal Power

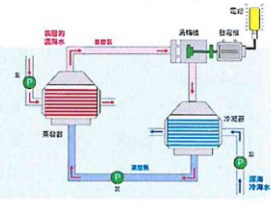
- Tidal power refers to the kinetic power arising from the rise and fall of tides to generate electricity, which is similar in principle to hydroelectric power generation. In flood tides, the offshore seawater flows in pushing the specialized turbine to generate electricity, while in ebb tides, the seawater flows back pushing the turbine again to generate electricity.



<http://193.32.48.8/teacher/teacher/teacher/teacher/>

Ocean Thermal Energy

- Ocean thermal energy uses temperature differences between the surface and deep-sea water to vaporize the working fluid to drive the turbine generator.
- The ocean is the largest solar energy collector and reservoir. Generally, in tropical regions, the temperature difference between surface water and undersea water as deep as 1000 meters may come at 25° C.
- The higher the temperature difference is, the higher efficiency the ocean thermal energy conversion enjoys with the lower cost.



<http://www.appon.com/ta>

Ocean Current Energy

- Current power is extracted using ocean currents to drive turbine generators. In general cases, caissons with an interceptor culvert are installed at stream locations, where one or more turbine generators are installed.
- The Kuroshio (Black Stream) beside Taiwan flows at a depth of about 30 meters and a velocity of about 1 m/sec. At a preliminary estimate, the Kuroshio near the Green Island alone is able to generate 1-3 GW per annum, roughly tantamount to the total amount of electricity generated by three nuclear power plants combined a year.




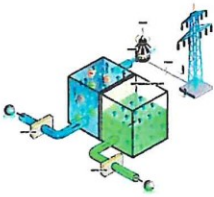
圖 8.9 <http://china.sagepub.com/97875300>

Osmotic Power

- Osmotic power is the salinity gradient energy available from the difference in the salt concentration between seawater and river water. Where the fresh water and seawater converge is the ideal location to create brackish water.
- With careful calculations, scientists have confirmed that at 17° C, when 1 mole of salt diffuses from a concentrated solution to a dilute solution, there shall be 5,500 Joules of energy released.

Principles of Osmotic Power Generation


- When two salt solutions at different concentration levels are poured into the same container, the salt-based ions in the concentrated solution will spontaneously diffuse into the dilute solution until their concentration levels are equal.
- The basic idea is to convert the chemical gradient energy achieved from different concentration levels of seawater into water potential energy, hence driving the turbine generators.



資料來源: <http://china.sciencetechnology.com/technology/jqweb-11>

The Definition of Deep Seawater

- Deep seawater refers to water at 200-300 meters below the surface level, where sunlight cannot penetrate and the contact with atmosphere does not exist. In the deep seawater zone, the photosynthesis and the plant plankton reproduction are impossible, creating a nearly aesthetic environment and a source of the least contaminated water on earth.



資料來源: <http://www.lawkyee-dow.com.tw>

Water Quality Comparison between Deep Seawater and Surface Seawater

General Analysis Items		Surface Seawater	Deep Seawater
Water Temperature	°C	21.0	13.1
pH		8.19	7.87
DO	mg/L	8.33	7.28
TOC	mg/L	1.60	0.93
Bacteria Count	CFU/mL	103-104	*

資料來源: <http://140.96.175.52/Upload/QUARTC/00010731-7.pdf>

Deep Seawater vs Surface Seawater

Analysis of Major Elements	Surface Seawater	Deep Seawater	Remarks
Na %	0.97	1.00	
Mg %	0.13	0.133	
Ca mg/L	421	426	
K mg/L	406	419	
Br mg/L	79.1	80.8	
Sr mg/L	7.91	8.03	
B mg/L	4.75	4.69	Insufficient B element may result in bone loss
Ba mg/L	0.025	0.045	
F mg/L	0.53	0.50	

資料來源: <http://140.96.175.52/Upload/QUARTC/00010731-7.pdf>

Deep Seawater vs Surface Seawater

The Analysis of Microelement	Superficial Water	Deep Seawater	Remarks
Pb µg/L	0.099	0.111	
Cd µg/L	0.009	0.029	
Cu µg/L	0.32	0.173	Human hematopoietic function elements
Fe µg/L	0.371	0.281	Human hematopoietic function elements
Mn µg/L	1.214	0.153	Reactive oxygen species
Ni µg/L	0.33	0.376	
Zn µg/L	0.66	0.71	Required for DNA synthesis and cell division
As µg/L	0.33	0.41	
Mo µg/L	7.81	7.73	

資料來源: <http://140.96.175.52/Upload/QUARTC/00010731-7.pdf>

Deep Seawater vs Surface Seawater

Analysis of Salt Nutrients	Surface Seawater	Deep Seawater
NO ₃ -N µg-at/L	1.49	25.9
PO ₄ -P µg-at/L	0.34	1.65
SiO ₂ -Si µg-at/L	13.6	64.2

資料來源: <http://140.96.175.52/Upload/QUARTC/00010731-7.pdf>

