

MOHAMMED ABDUL-KAREEM AL-SOFI

EXPERIENCES & CONTRIBUTIONS

1. EDUCATION

- Dhahran College of Petroleum & Minerals (CPM) 1st Accepted Student + 2nd Name on 1st Honor List -1964-7;
- B. Sc. in Chemical & Petroleum Refinery Engineering from the Colorado School of Mines - 1967-70; and
- Graduate Diploma + M.E. of Mechanical & Desalination Engineering from the University of Glasgow-1977-78;

2. OVER 45 YEARS OF ENGINEERING EXPERIENCE, 1970-2017;

3. OIL REFINERIES; 1970-1976:

- a. Process Engineer, b. Operation Supervisor;

4. SALINE WATER CONVERSION CORPORATION (SWCC):

- Research & Development Technical Advisor-up to 2001;

5. CONSULTANT: APPLIED DESALINATION RESEARCH PROFESSOR IN PRACTICE:

- Arabian Consulting Engineering Centre Co. Vice Chairman & Executive Managing Partner- to Date;

6. REGIONAL & INTERNATIONAL ASSOCIATIONS:

- Board member of IDA⁽ⁱ⁾ from inception in 1985 to 1991 also 1995 to 1997; also
- Founding Member of WSTA⁽ⁱⁱ⁾ as well as Member of Boards of Directors:
 - a. Interim Board Treasure 1987-88, b. Vice President - 1988-95,
 - c. President - 1995-97, and d. Secretary General 1997-99;

7. PARTICIPATIONS:

- Arab League Co-Chairman, of Desalination Technology Committee to the Arab-European Dialogue 1983-87;
- Representative of SWCC in GCC Committees 1983-91; and
- Desalination Journal, Science & Technology Advisory Editorial Board Member 1993 to 2009;

8. SCIENTIFIC CONTRIBUTIONS:

- Conferences & Workshops Participations, Management and Papers Review (& for Desalination Journal);
- Over one hundred papers as Sole, Principal or Co-Author; as well as
- Concepts Originator in Hybrid Desalination & Design Improvements, + Patent Application to KACST⁽ⁱⁱⁱ⁾, 1991; and

9. AWARDS:

- First Author of Best Paper Award in WSTA 1994 conference (on Fuel Cost Allocation);
- Principal Author of Best Paper Award in IDA 1999 conference (on Tri-Hybrid); and
- Two Awards as Co-worker in Distinguished Research work from MAREI^(iv)/KACST, 2001 & 2002 (on Tri-Hybrid & Scale Control respectively).

(i) IDA stands for International Desalination Association;

(ii) WSTA stands for Water Science & Technology Association (in GCC);

(iii) KACST stands for King Abdul-Aziz City of Science & Technology; and

(iv) MAREI stands for largest Dairy Company in Saudi Arabia!



WATER & ENERGY INTEGRATED HYBRIDS

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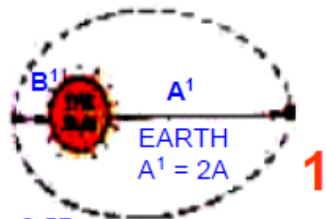
WATER & ENERGY INTEGRATED HYBRIDS

ABSTRACT

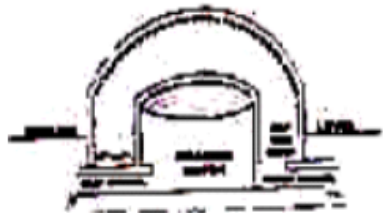
The presentation will propose schemes of Water, Heat, Electricity and Renewable Fuel Production which are to meet rationalized demands. Such schemes will propose integrated processes with hybridization. This will particularly look into the utilization of renewable solar energy integrated with conventional fossil fuel.

WATER & ENERGY INTEGRATED HYBRIDS

Figures - 1 to 6



$B^1 = 0.5B$



4 DOUBLE WALLED WATER CAVERN 3RD MILLENNIUM B.C.



2 AL-GHUMSAH



5 DISTILLATION ABOARD SHIPS 2ND MILLENNIUM B.C.



3 AN ANCIENT SAMAWAR 3RD MILLENNIUM B.C.



6 ARISTOTLE CITATION 1ST MILLENNIUM B.C.

WATER & ENERGY INTEGRATED HYBRIDS

Figures - 7 to 12



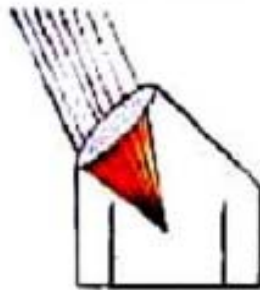
7 THE OLDEST ANCESTOR OF DUAL PRODUCTION OF HEROIC
1ST MILLENNIUM B.C.



8 PERFUME DISTILLATION OF ARABIAN CIVILIZATION
1ST MILLENNIUM A.D.



9 THE HOLLOW WAX BALL
1ST MILLENNIUM A.D.



10 DESALINATION USING DAMASQUAIN GLASS
2ND MILLENNIUM A.D.



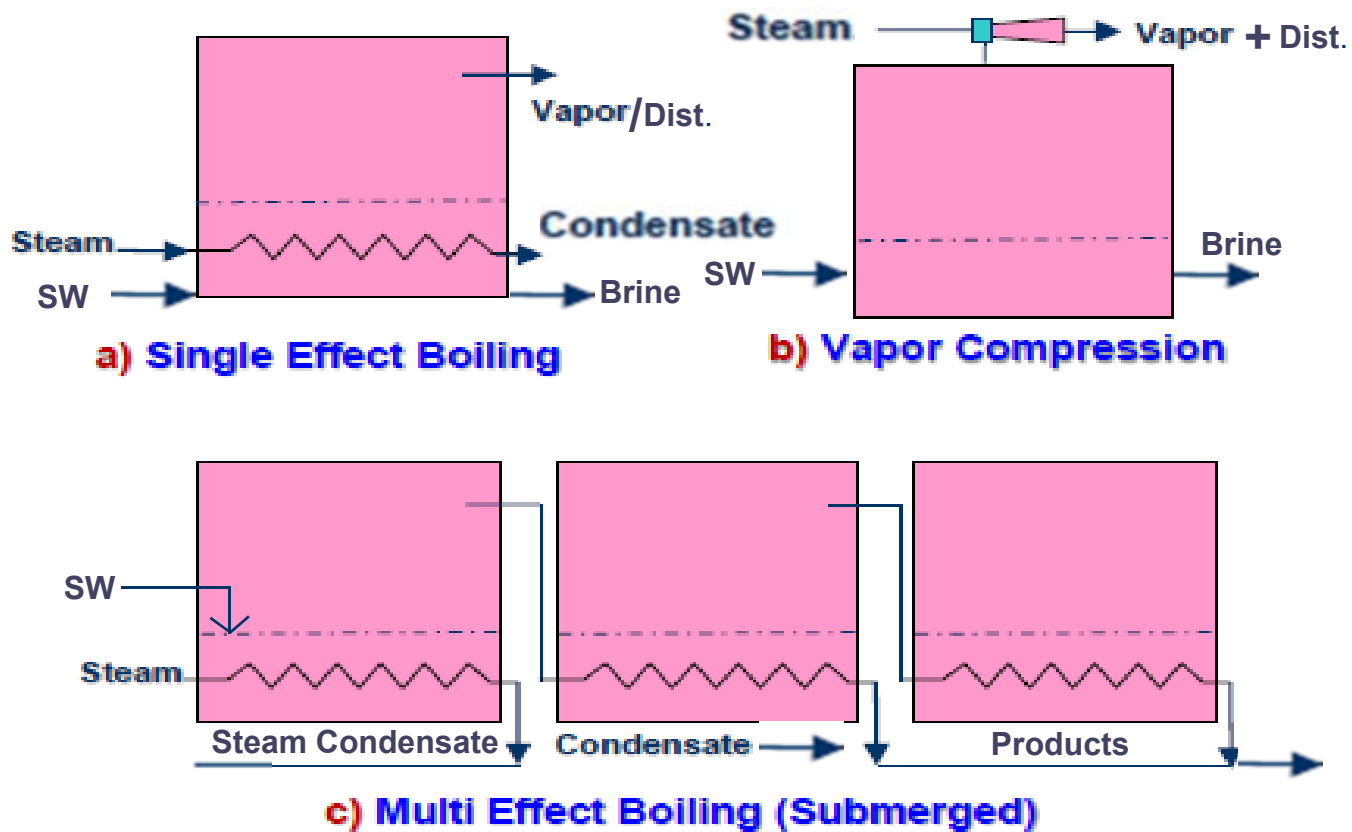
11 LEONARDO D'VINCI CITATION
2ND MILLENNIUM A.D.



12 THE TALE OF DANIEL DAVO
2ND MILLENNIUM A.D.

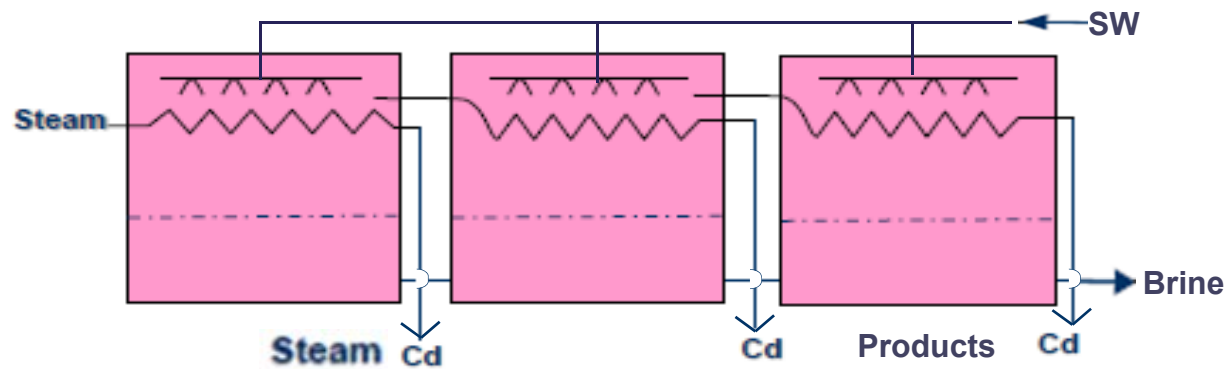
WATER & ENERGY INTEGRATED HYBRIDS

Figure 13 : Distillation Development (a, b, c)

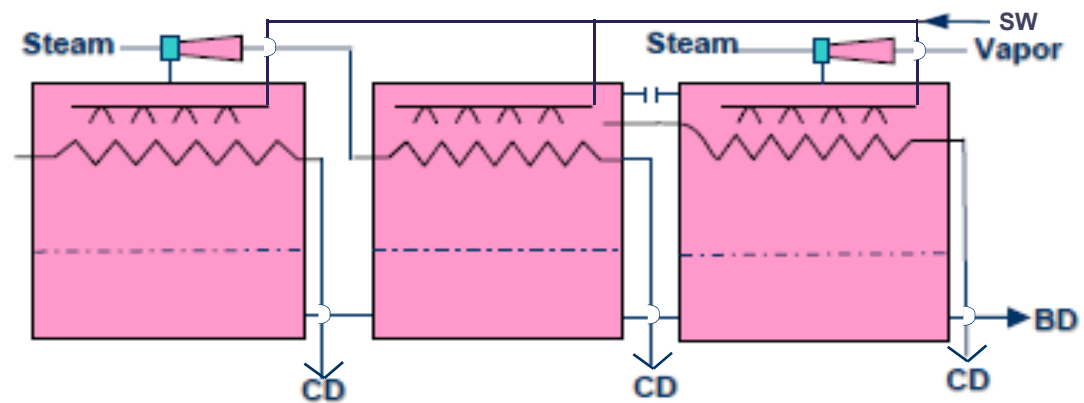


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Figure 13 : Distillation Development (d, e)



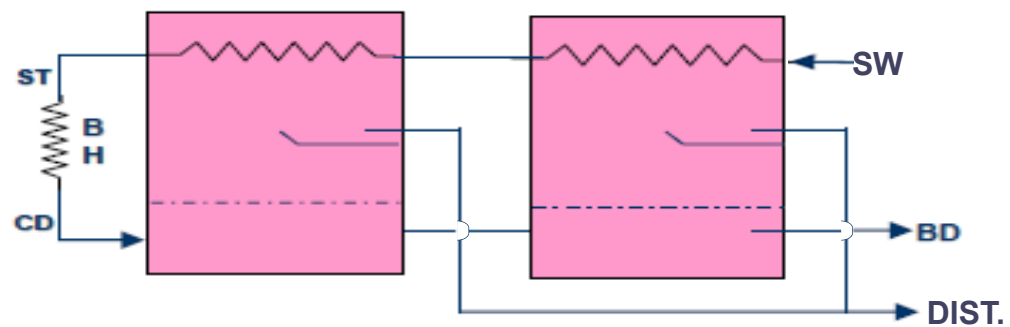
d) Multi Effect SW Spray



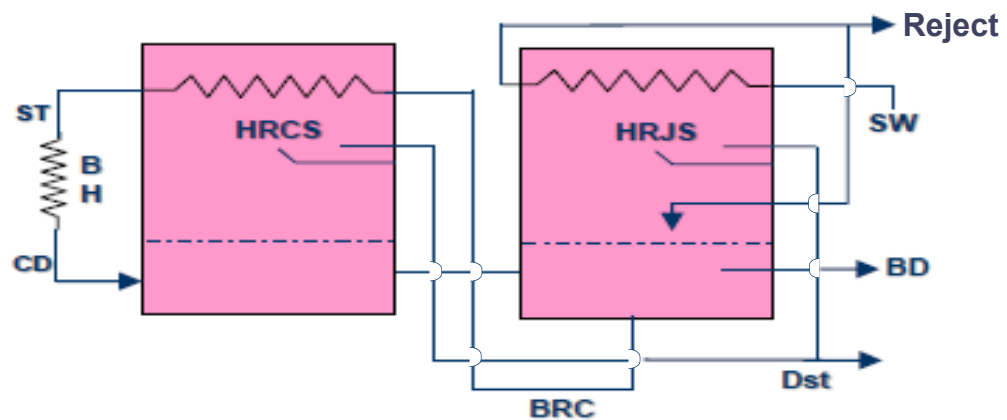
e) Multi Effect SW Spray/VC (MED)

WATER & ENERGY INTEGRATED HYBRIDS

Figure 13: Distillation Development (f, g)



f) Once Through Multi-Stage Flash (OT-MSF)



g) Brine Recycle (Heat Regain) BR-MSF

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During the 20th Century other Desalination Processes started to mature. These were:

1. FRZ

2. IXD

3. ED

4. EDR

5. BWRO

6. SWRO

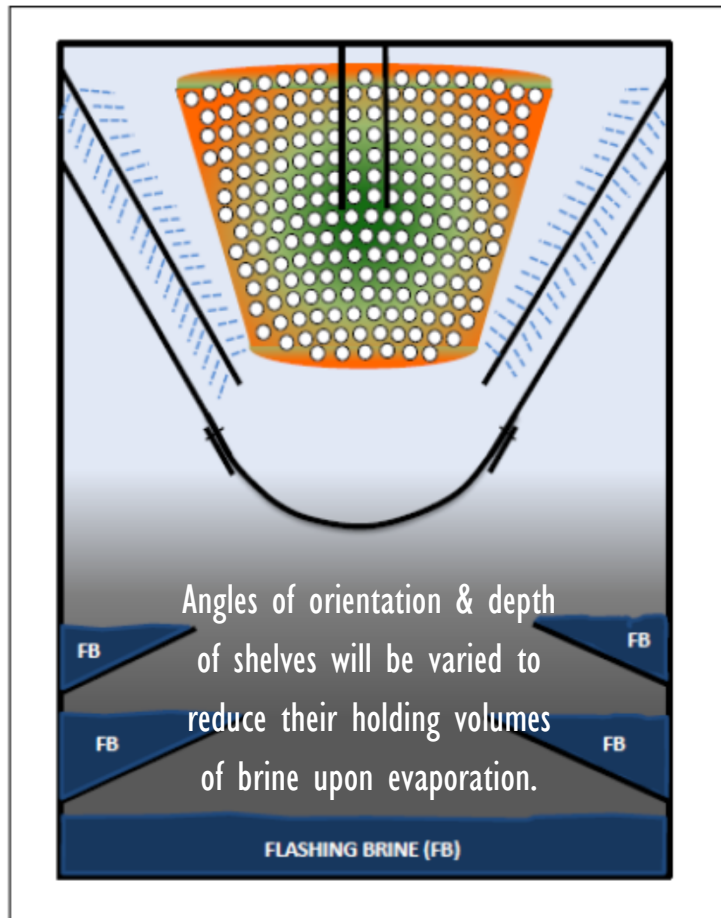
7. MDPV

8. NFSIS

9. FOD

WATER & ENERGY INTEGRATED HYBRIDS

Figure 13.1: Innovative MSF



1. **Shelved FBS**
(extended surface area)
2. **Slanted MSP**
(increased surface area)
3. **Self Draining MSP**
(returning brine to FBS)
4. **Simplified MSPM**
(shortened downtime)
5. **Cup STB**
(maximizing area utilization)
6. **Successive JOV**
(improved venting)
7. **BH in DC Service**
(serving back pressure turbines)
8. **Split Flow RJTB**
(utilizing heat for NF/SWRO)
9. **Dual Service Brine Pump**
(substituting single purpose stand-by)

ABBREVIATIONS:

FBS–Flashing Brine Stages	MSP – Mist Separator
JOV–Jump Over	MSPM – MSP Mounting
DC–Dump Condenser	RJTB – Heat Rejection Tube
STB–Shaped Tube Bundles	Bundle

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Figure 13.2:
Innovative MSF (BH in DC Service)

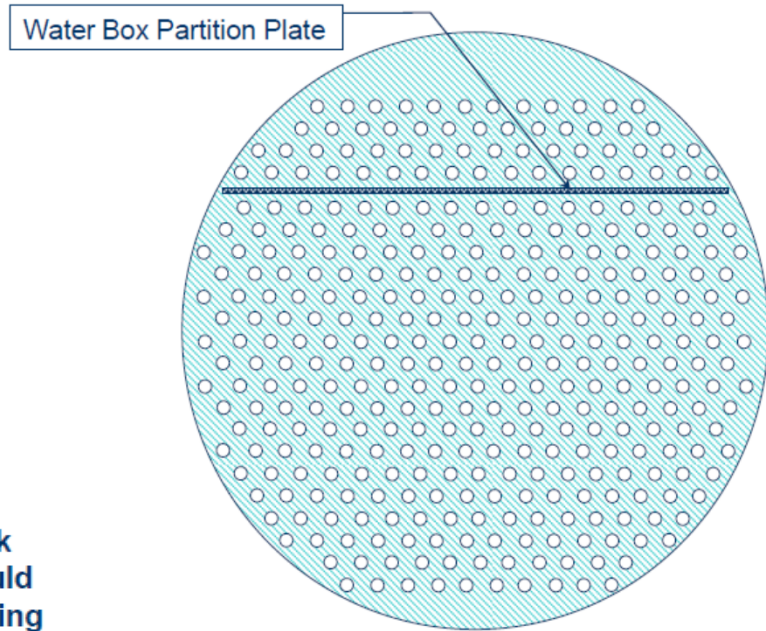
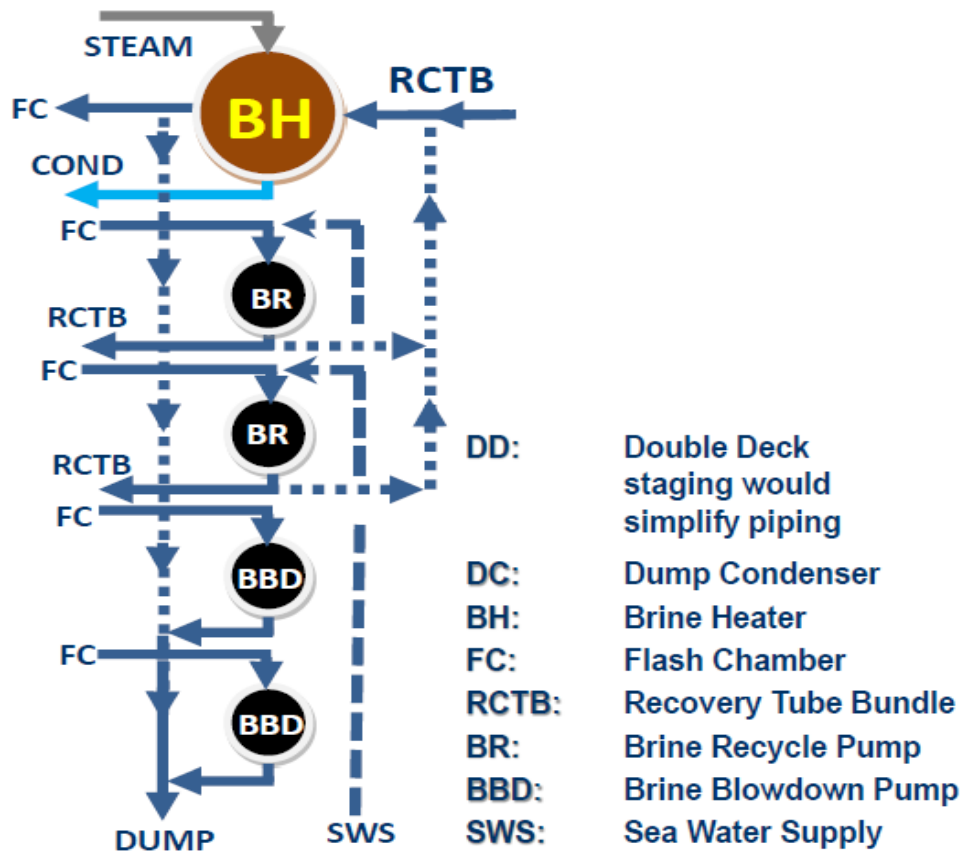
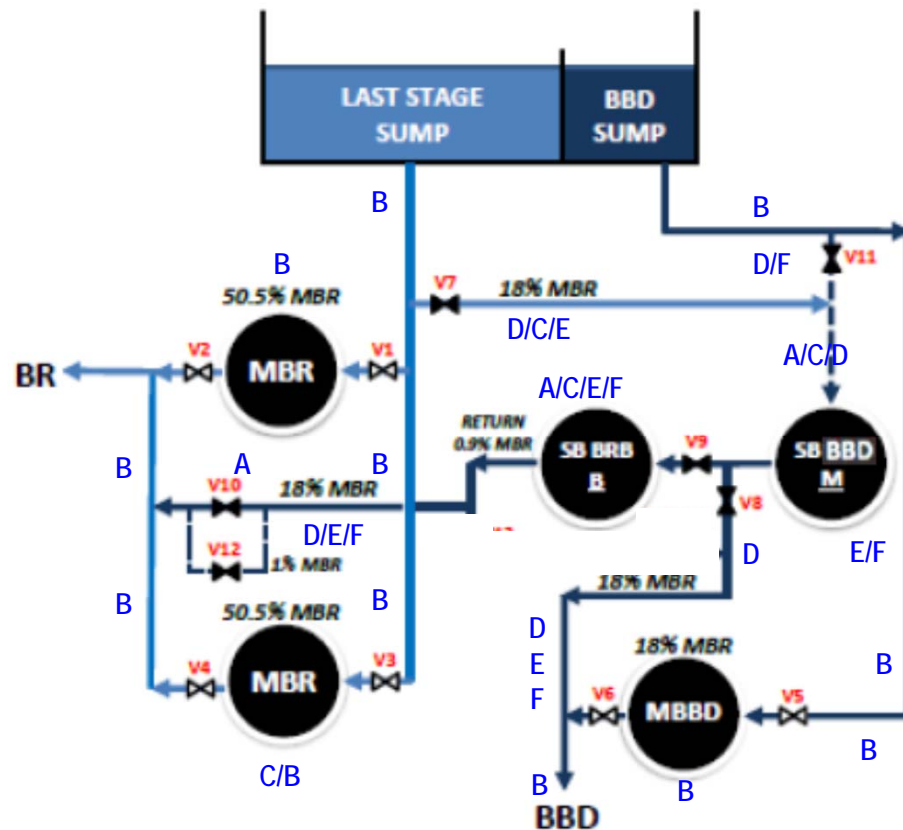


Figure 13.3:
Heat Rejection Tube Bundle,
Water Box Partition

WATER & ENERGY INTEGRATED HYBRIDS

Figure 13.4: Innovative MSF (Dual Service Brine Pump)



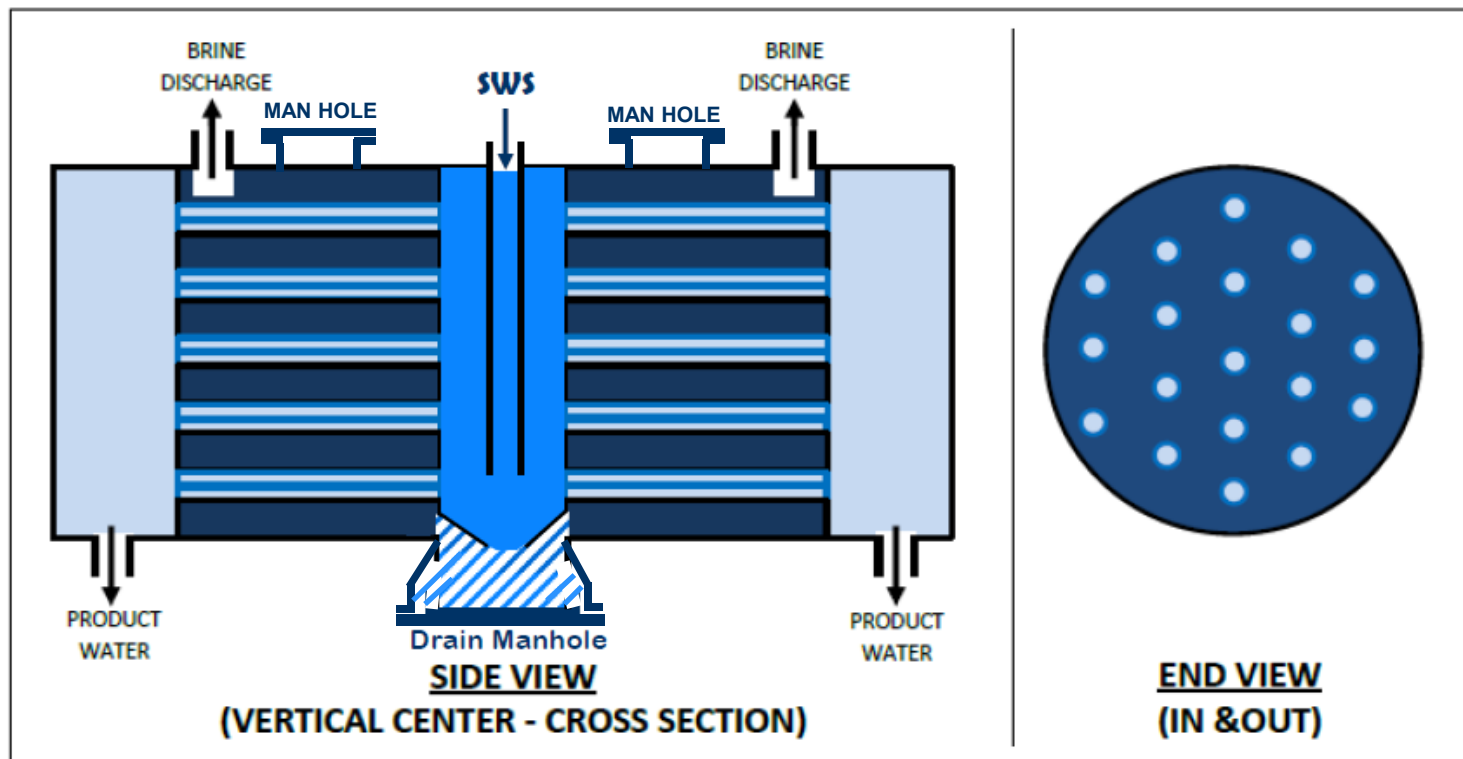
VALVE SETTINGS & ABBREVIATIONS

- V1 & V2: BR PUMP 1 SUCTION & DISCHARGE (50.5% MBR)
 - V3 & V4: BR PUMP 2 SUCTION & DISCHARGE (50.5% MBR)
 - V5 & V6: BBD PUMP SUCTION & DISCHARGE (18% MBR)
 - V7 & V8: STAND-BY BBD PUMP (M) SUCTION & DISCHARGE (18% MBR)
 - V9 & V10: STAND-BY BR PUMP (B) SUCTION & DISCHARGE (18% MBR)
 - V11: STAND-BY BBD PUMP (M) ISOLATION (18% MBR)
 - V12: STAND-BY BACKFLOW FROM BR (M) LOOP (1% MBR)
 - V13: STAND-BY BACKFLOW THROUGH BBD LOOP (0.1% MBR)
- BR: BRINE STREAM OR PUMP
 BBD: BRINE BLOWDOWN
 SB: STAND BY
 MBR: MAX. BR.
 MBBD: MAX. BBD

A= 1st BR, B=Normal, C=2nd BR, D=BBD, E=Bw(B) & F=bW(D)

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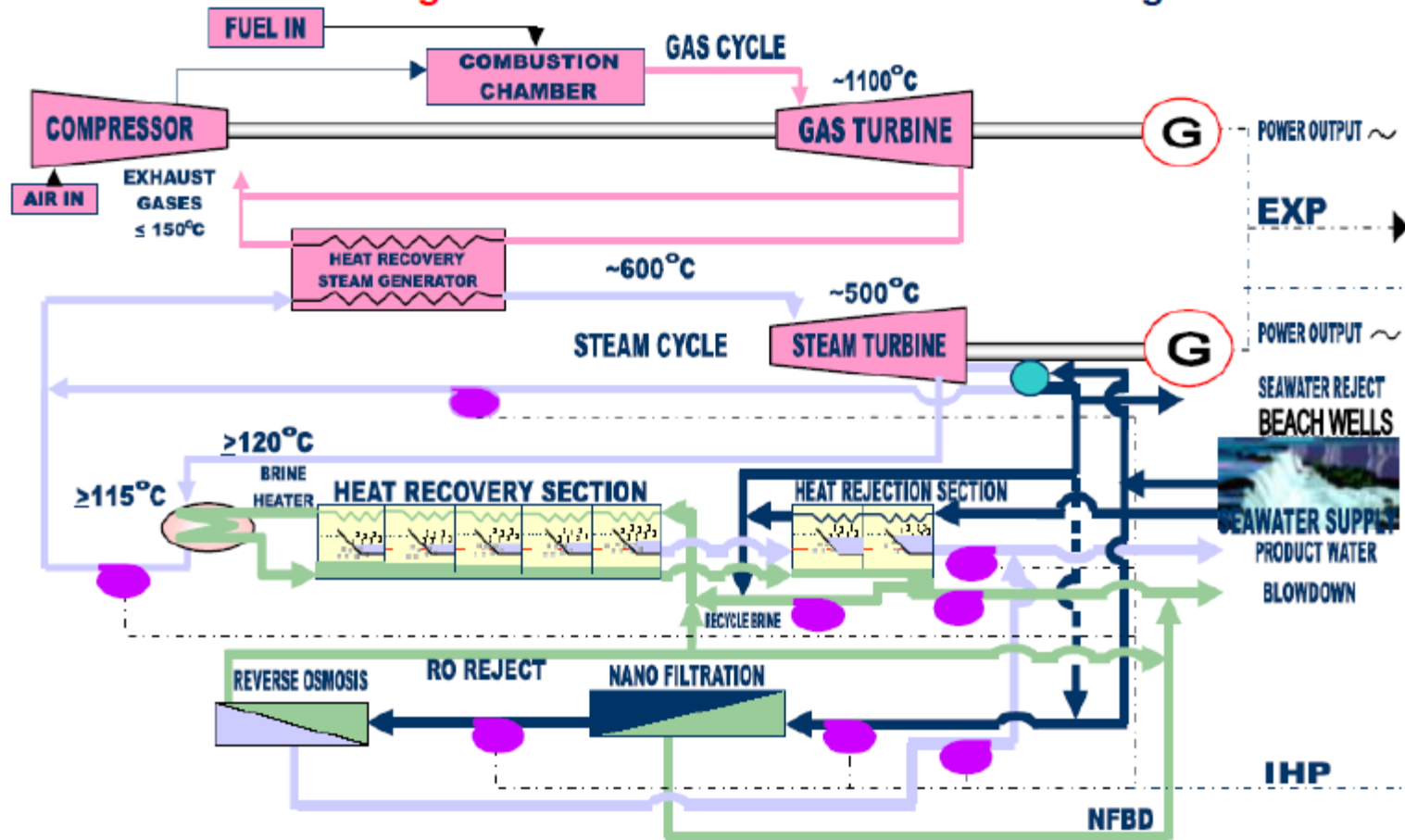
Figure - 13.5 Multi Cartridge Membrane(s) Vessel Design



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Part I: Conventional Process Integrated Hybrid

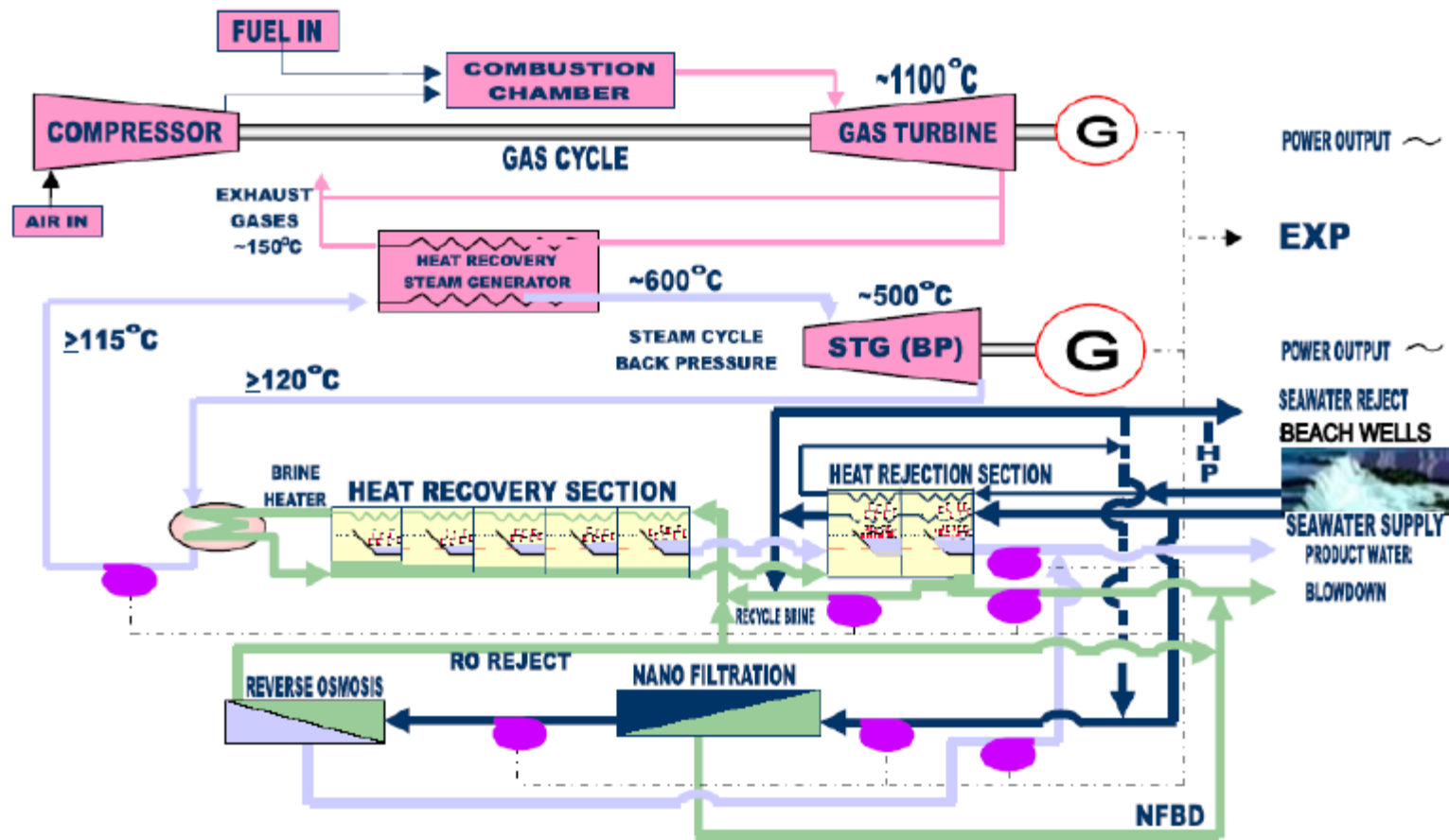
Figure 13.6: Part I - Extraction/Condensing CC / MNR



WATER & ENERGY INTEGRATED HYBRIDS

Part I: Conventional Process Integrated Hybrid

Figure 13.7: Part I - Back Pressure; CC / MNR



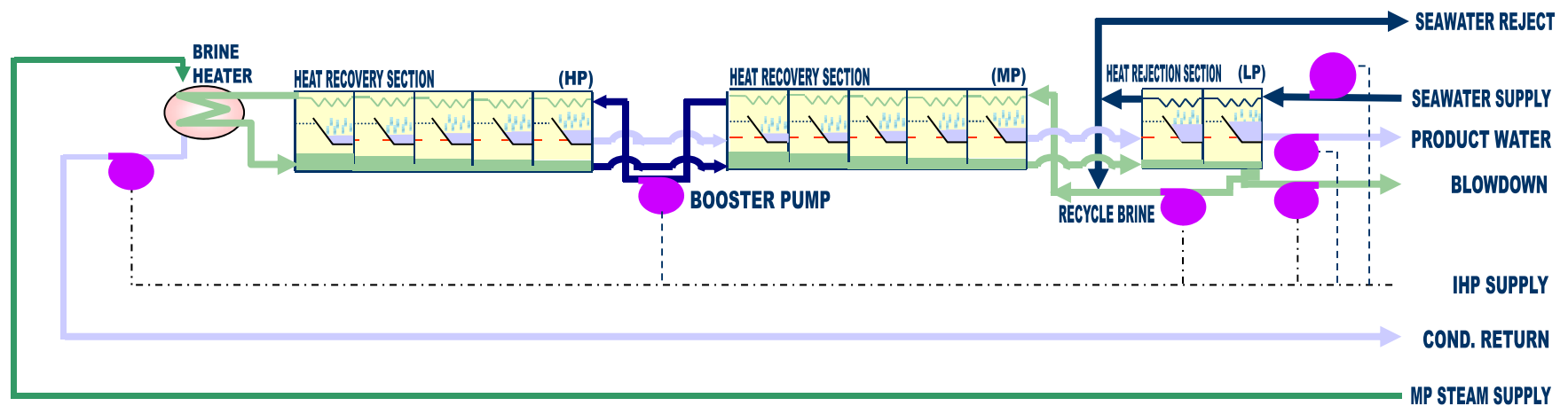
WATER & ENERGY INTEGRATED HYBRIDS

Table 1: Average Dissolved Species & M-Alkalinity of Sea Water, Nano Filtration Product & Reject (NFP & NFR), RO Product and RO Reject

Parameter	Units	Sea Water	NFP	NFR	RO Product	RO Reject
TDS	ppm	45,550	33,500	67,235	780	61,410
Chloride ions	ppm	23,838	19,498	31,648	382	35,420
Sulfate ions	ppm	3,309	75	9,129	ND	128
Calcium ions	ppm	491	154	1,097	1	281
Magnesium ions	ppm	1,556	225	3,951	2	406
Bi-carbonate ions	ppm	156	57	163	4	102
Total Hardness as CaCO ₃	ppm	7,633	1,310	19,012	7	2,350
M-Alkalinity	ppm	127	47	134	3	83

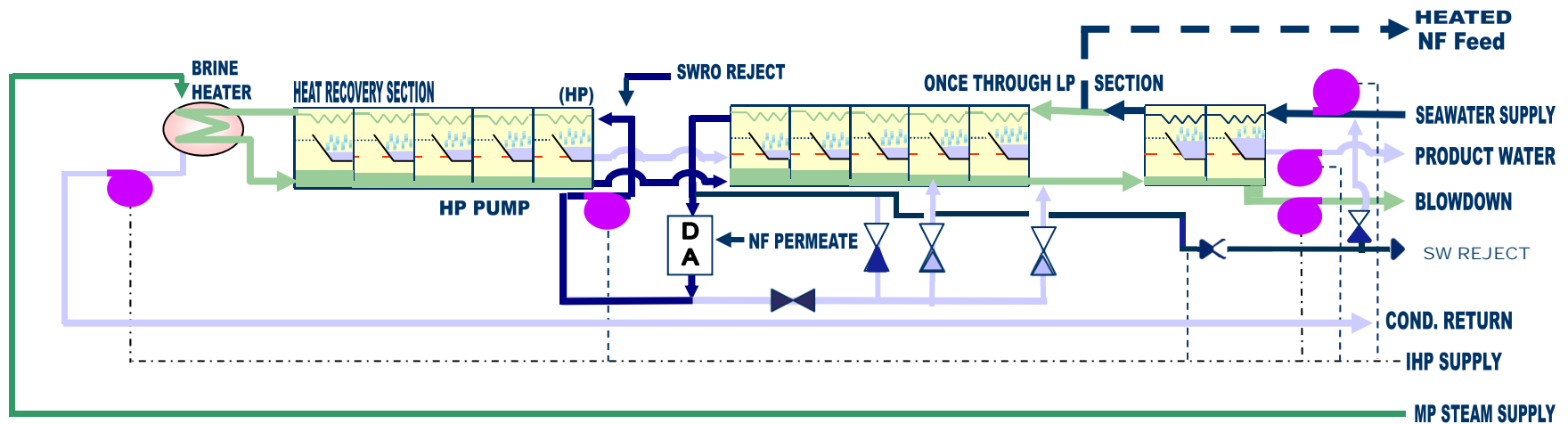
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Figure - 14
Proposed MSF Design Concept



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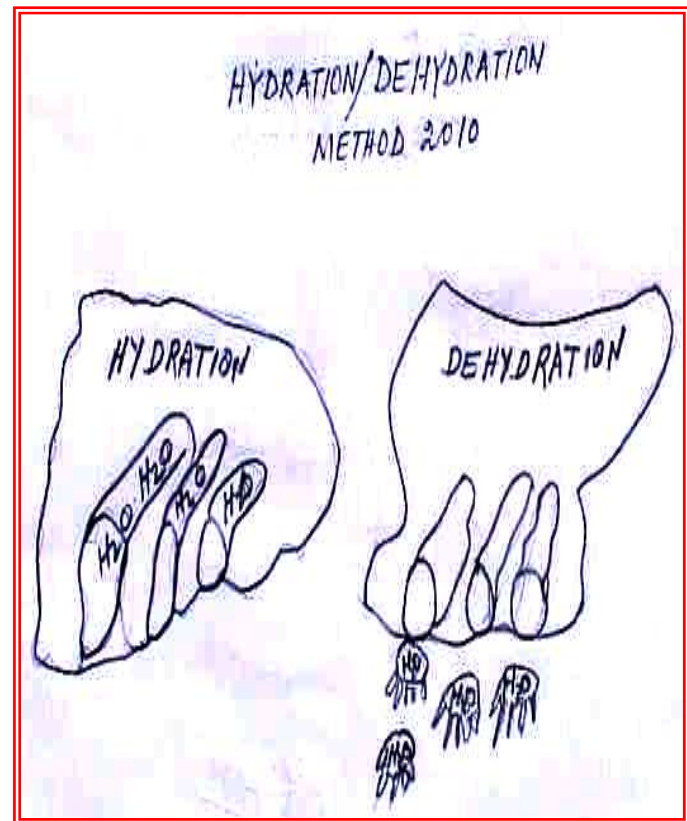
Figure – 14A
Proposed MSF Design Concept (Once Through LP Section)



WATER & ENERGY INTEGRATED HYBRIDS

Hydration/De-hydration (HDH)

This dream calls for applying the process through exposing sea water to a bed of hydrate forming substances which could be placed in plastic or glass covered Ponds. Then removal of the brine solution followed by a dehydration process by mild heating such as exposure to sun rays. I.E. Cyclic night and day time process of nighttime soaking then flushing followed by daytime yielding then extraction and so on.



WATER & ENERGY INTEGRATED HYBRIDS

Salt Precipitation Method (SPM)

This concept calls for enhanced seawater salts precipitation. I.E. Salt Crystal Formation. This could also be in plastic or glass covered Ponds.

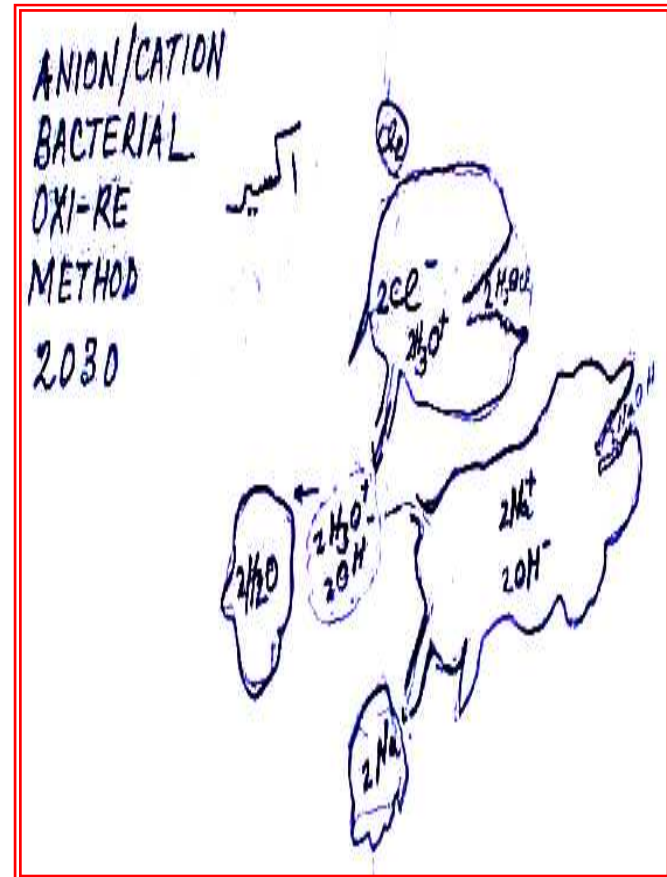
(Note this dreamed up vision comically proposes **BUTTING OF HORNS**, thus refer to misinterpreted translation see paragraph 3 on page 1b).



WATER & ENERGY INTEGRATED HYBRIDS

Bacterial Oxidation – Reduction (BOR)

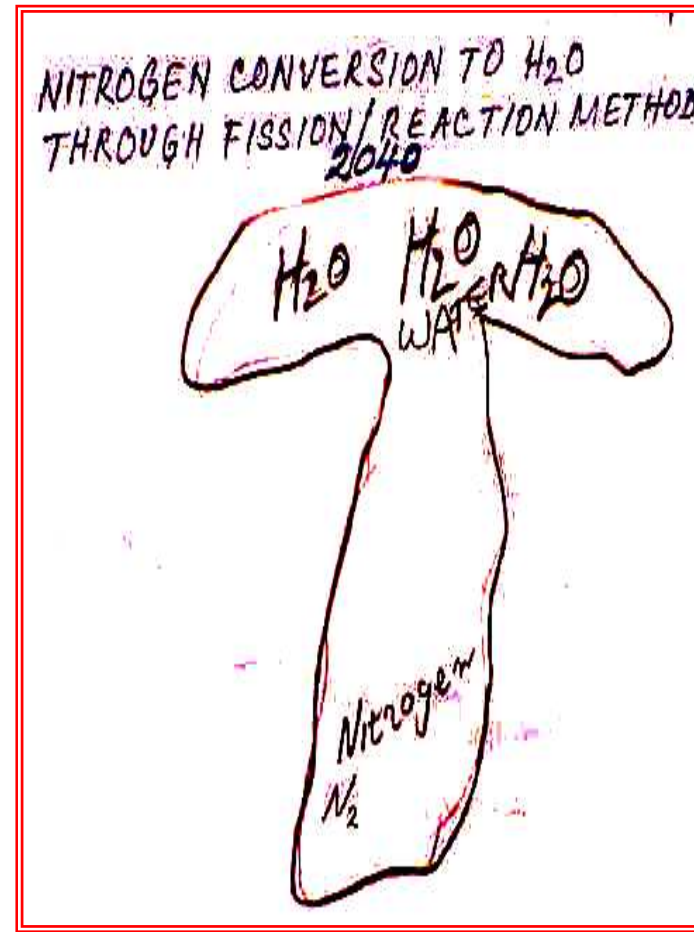
Based on the known fact of Sulfur Oxidizing & reducing Bacteria, hence engineering genetic could lead to or discover such organisms that would play a comparable role on seawater dissolved ions. Thus, oxidize and reduce seawater dissolved ionic contents. (Reference is made to Oyster Shell Formation.) Possibly in a similar way in covered Ponds to separate salt slurry by removal from the bottom and product water from the top. Moreover, it is worth saying that this separation scheme could be used for the above two processes of HDH & SPM.



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Atomic Reaction Production (ARP)

The scheme suggested here is not desalination as it is a water formation by atomic splitting of N_2 (Nitrogen) into Oxygen & Hydrogen, then combining the two as water. (As time went by the proposed dream had digressed into shifting away from N_2 (Nitrogen) to Carbon Dioxide (CO_2) atomic dissolution to provide oxygen with carbon splitting into Hydrogen for the two newly formed active atoms to combine into H_2O with surplus Hydrogen as fuel.)



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Dialytic / Osmotic Permeation (DOP)

This dream suggests having a packed straw containing ion exchange resins with semipermeable membranes. So as to directly suck pure water from a glass of salt solution be it brackish or even seawater (reference is made to description on page 2 and presented in Figure 9 on page 3 of Chapter 1).

Such scheme could be developed as regenerative STRAWS. That is to say that these straws could thereafter undergo a

“REGENERATION PROCESS”.



WATER & ENERGY INTEGRATED HYBRIDS

ENAMORED

*Water gives thyself nourishing, knowledge and arts
Thou be fountain of sustenance & the delight of eyes
Thyself do adore and to thou express my sentiments
Thou gives my skin silky touch of compassionates
A comrade in my solitude thou share my joy sets
And reminds thyself with a lured of time of pasts
Such lures persist to dawn in adoration of nights
As monk's hermitage submission in tranquilities
Thyself wonder if be my chain of Imprisonments
Oh sea be my grave where body lays and rests
Oh God protect such passion & descending blesses*

عاشق

الماء زادي ومعارفي وفنون
فذاك منهل رزقي وقررة العيون
وأنا به متيم أشكيه الشجون
وملامساً جنبي للحريرحنون
ونديم خلوتي أشاطره المجون
ذكرتني بأبي العتاهية المفتون
وأين ليلى من نشوتي ومناجات الدجون
وصومعاً لراهب الخشوع في سكون
أتراك ياماء قيدي في السجون
أيايم لبيتك لحداً أكون به مدفون
رعى الله عشقاً ونازلاً من المزن ميمون