Zero Liquid Discharge (ZLD)
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When the well’s dry,
We know the worth of water
Benjamin Franklin

Part 1: Terrawater in general
Part 2: Zero Liquid Discharge with TerraSaline
Part 3: Applications for ZLD with TerraSaline

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nature as guide

Terrawater...
... is based on the natural principle of evaporation (<100°C).
... uses Geo-, Solar thermal and Waste heat
... defies the roughest ambient conditions
... produces Distillate

Terrawater works in the fields of...
- Desalination
- Drinking Water
- Process Water
- Waste Water
- Concentration ZLD

Principle Terrawater: Humidification / Dehumidification

Water production on oil platform with TWBasic

Heat in  Heat out
Heat exchanger
Humidifier
Condenser
Ventilator
Brine out  Distillate out  Feed in

Nicolas Heyn
Terrawater GmbH
**Zero Liquid Discharge (ZLD)**

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Terrawater GmbH

**Boundaries of Terrawater Technologies**

- **Salinity in ppm**
  - 500
  - 1500
  - 2500
  - >30 T

- **Hardness in mg/l**
  - 5
  - 20
  - 250
  - 500
  - 3000

- **Solids**
  - 30T
  - 250T
  - 150T

- **Scaling-up to version mid and max is in progress**

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**Water is easy to distribute, to pick it up again - difficult**

*China, unknown*

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**Part 1: Terrawater in general**

**Part 2: Zero Liquid Discharge with TerraSaline**

**Part 3: Applications for ZLD with TerraSaline**
Advantages:

- Reduction of fresh water requirement
- Reduction of waste water
- Increase of energy efficiency
- Resource recovery from waste water
- No chemicals used

Useful for industries which, for example, have waste heat and waste water and require process water.
Extraction of distillate by humidification / dehumidification

Leaned on the nature water cycle, Terrawater works internally with temperatures of max. 95°C.

As high saline waters are very aggressive to metal, Terrawater builds all components from synthetics.

Condenser  Water-water heat exchanger  TerraSaline Modules

Extraction of solids by sedimentation and crystallization

The TerraCrystalizer inside TerraSaline is designed for the extraction of the solids.

The solids can be evacuated manually or automatically.

Produced salt  TerraCrystallizer

Nicolas Heyn  Terrawater GmbH

04-9  04-10
Control of saturation limits and temperatures

Terrawater ZLD system avoids any use of chemicals.

As a consequence, the fall out places of solids inside the TerraSaline must be controlled so that they could be extracted online.

So, controlling the ZLD-process means controlling the individual saturation limits as a function of temperature.

In addition to that, the different cleaning and solid extraction technologies available along with TerraSaline helps to realize this real Zero Liquid Discharge system.

Water is not everything, but everything is nothing without water

unknown

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Part 2: Zero Liquid Discharge with TerraSaline

Part 3: Applications for ZLD with TerraSaline
**Zero Liquid Discharge (ZLD)**

**ZLD example 1:**
**brine re-use**

**Task:**
- + raising output of existing desalination system
- + reduction of brine
- + reduction of fresh water needs
- + production of process water
- + reducing disposal costs

**Step 1:**
- brine water intake
  - regardless of the salinity

**Step 2:**
- TerraSaline
  - Concentrating brine to saturation limit
  - Producing distillate
  - extracting wet solids

**Step 3:**
- deposit wet solids, reducing brine

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**Step 1:**
- Test facilities brine re-use from RO reject of a power plant, Thailand

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**ZLD example 2:**
**wells**

**Task:**
- well has limited yield
- + recovery rates of other desalination - systems are too low for the drinking water demand
- salinity is too high for other desalination
- + brine injection is forbidden

**Step 1:**
- Well water intake
  - regardless of the salinity

**Step 2:**
- TerraSaline
  - Concentrating well water to the saturation limit
  - Producing distillate
  - Producing solids

**Step 3:**
- deposit wet solids, no brine injection

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**Solar desalination from limited well in Akutsima, Namibia**
Step 1: Feed water intake

Step 2: TerraSaline

- Concentrating sea water to the saturation limit
- Producing distillate
- Producing salt/solids for industry purposes
- Producing concentrated liquids like fertilizers

Step 3: drying drum and sieving

Zero Liquid Discharge (ZLD) example 3: resource recovery

Task:
- Metals and/or salts will be recovered
- Waste water will be concentrated to a further product

Sea salt production from north sea water on the island Sylt, Germany