DME S-006-2013 – Lecture 03

DME
GERMAN DESALINATION

Saline Water Purification Shetpe Cement Plant, Kazakhstan

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WWWS world wide water systems ag

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HEIDELBERG TECHNOLOGY CENTER
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DME - Seminar

Key Solutions for Key Markets

December 03rd, 2013

Jeddah – Saudi Arabia

1-3 DECEMBER 2013, JEDDAH HILTON, SAUDI ARABIA
SWPF 2013 المنتدى السعودي للمياه والطاقة SAUDI WATER & POWER FORUM

Saline water purification and discharge Shetpe

Plant Overview

- 800.000 tonnes of cement per year from 2014 onwards
- Located in western Kazakhstan, semi arid environment
- Plant will be operated with up to 300 shift personnel

Water demand overview

- Average fresh water consumption 190.000 m³/a thereof 75% technical and 25% social
- 46.000 m³/a brine generated in total
- 17.000 m³/a for salt road construction, rest evaporated

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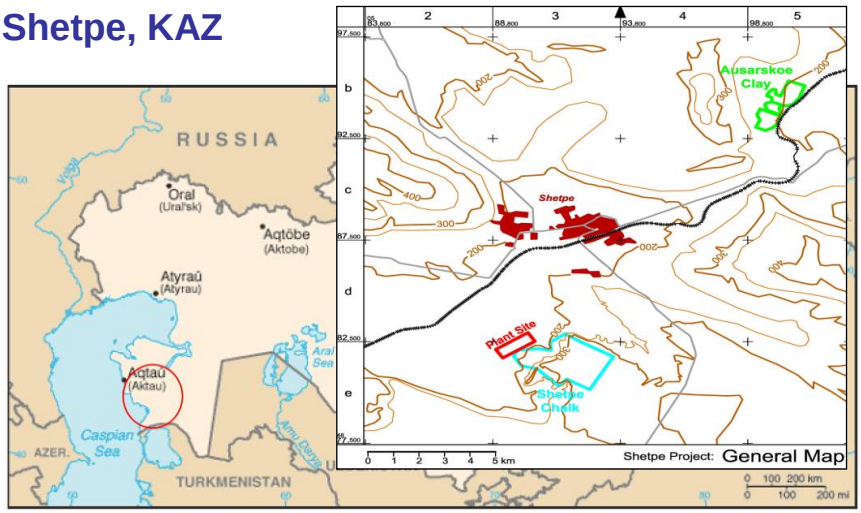
Shetpe, KAZ



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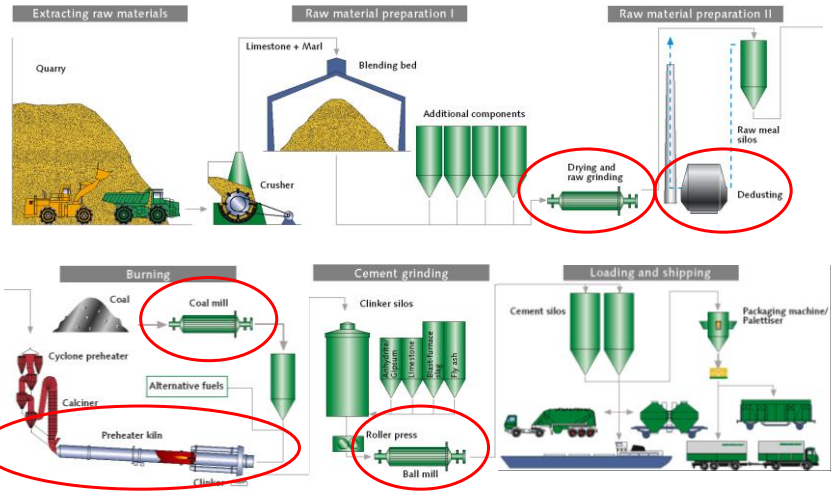
Typical Cement Plant Process – Water use



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Water demand calculation Shetpe

Area of use in production process	Max. Consumption 2.600 tpd cement (800 ktpa)	Winter & Wet Season Design 2.600 tpd cement (800 ktpa)	Summer & Dry Season Design 2.600 tpd cement (800 ktpa)	Summer & Dry Season Design 6.500 tpd cement (2.000 ktpa)
	m^3 of fresh water consumed per day 24h/24h			
Water Cooling System	68	0	61	136
Coal Mill	48	24	44	88
GCT	373	102	133	250
Finish Grinding	84	84	103	256
Social Buildings	50	50	50	50
Lab Building	40	40	40	40
Colony	80	80	80	80
Reserve / Gardening	57	20	40	0
Total in m^3/d	800	400	550	900
Specific Consumption in m^3 per ton product				
Total Consumption	0,30	0,15	0,22	0,14
Process Consum.	0,22	0,09	0,14	0,11

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Fresh water versus discharged concentrate

- First offers stated only a 60 … 70% recovery rate
- Leading to 850 m^3/d raw water and 300 m^3/h discharge
  - Water reservoir limited then to 60 years
  - and 200.000 m^2 evaporation pond demand
  - resulting in over 3 mil € cost just for the ponds
- Consequential next step: **improve recovery rate**
  - Demand > 80% recovery rate
  - 8 companies asked: 3 KAZ, 2 RUS, 1 LUT, 2 GER
  - WWWS, Erfstadt entered contract for > 80% recovery rate

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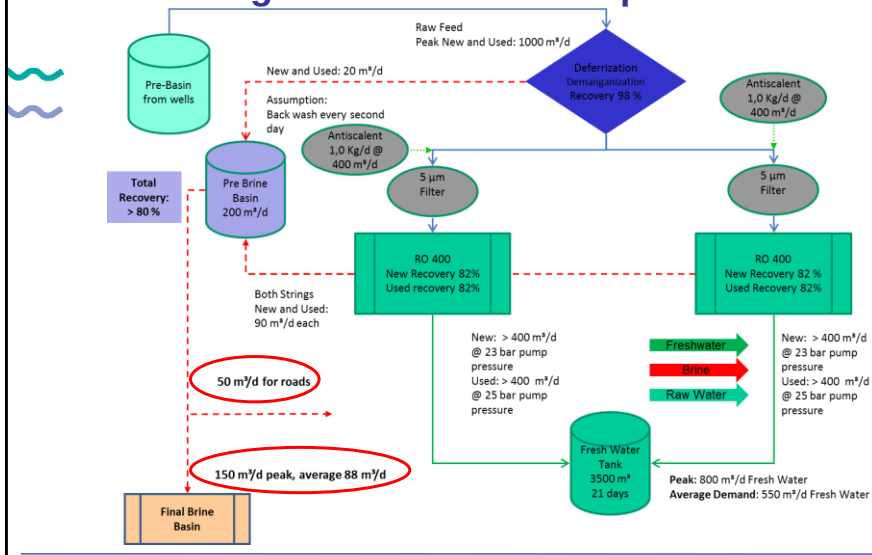
Dual string water desalination plant



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Raw water, fresh and brine composition

Pass Streams (mg/l as Ion)						
Name	Feed	Adjusted Feed		Concentrate	Permeate	
		Initial	After Recycles	Stage 1	Stage 1	Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00
K	92.00	92.00	169.90	453.08	1.82	1.82
Na	1732.00	1732.00	3209.29	8580.95	21.03	21.03
Mg	220.00	220.00	409.11	1096.92	0.87	0.87
Ca	302.00	302.00	561.62	1505.88	1.16	1.16
Sr	17.00	17.00	31.61	84.77	0.07	0.07
Ba	0.00	0.00	0.00	0.00	0.00	0.00
CO3	1.56	1.56	6.53	36.30	0.00	0.00
HCO3	244.00	244.00	442.95	1142.46	5.21	5.21
NO3	2.00	2.00	3.61	9.47	0.14	0.14
Cl	2200.00	2447.45	4534.97	12125.47	29.75	29.75
F	6.00	6.00	11.07	29.49	0.13	0.13
SO4	1815.00	1815.00	3374.72	9047.60	7.68	7.68
SiO2	136.00	136.00	252.95	678.30	0.49	0.49
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO2	7.00	7.00	7.46	17.30	9.72	9.72
TDS	6767.56	7015.02	13008.34	34790.69	68.36	68.36
pH	7.60	7.60	7.76	7.68	6.04	6.04

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Further use of brine in the plant internal

- Salt road construction and & dust control for 50 m³/d
- Substitute cooling circuit evaporation fluid - 30 m³/d, next
- Salt generation up 2500 t/a, not a commercial reasonable sized business especially respecting local regulations

Outside production process and core plant

- Caspian sea – too far
- Absorption wells – no permit
- **Evaporation in solar ponds:** permit for ~ 45.000 m²

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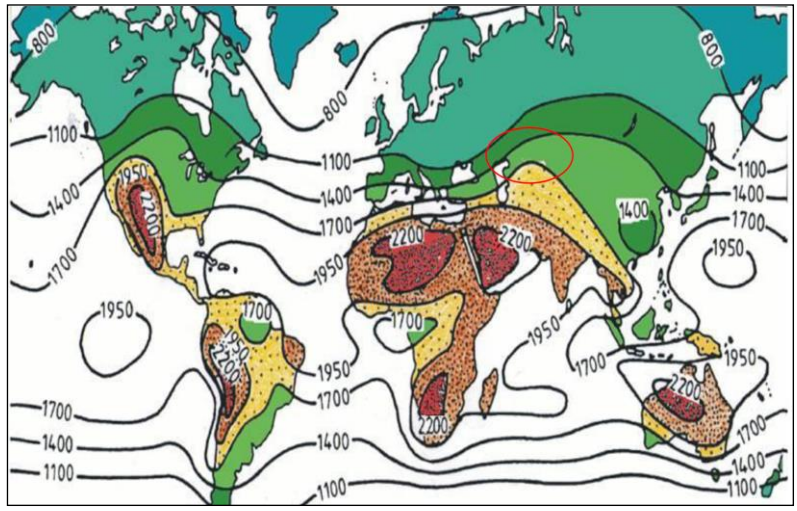
Solar radiation world and Kazakhstan



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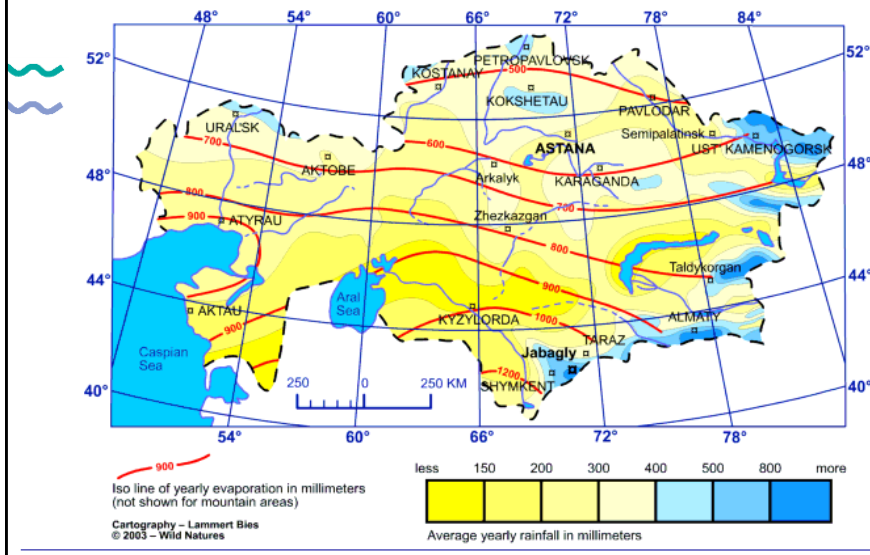
KAZAKHSTAN – AVERAGE RAINFALL AND EVAPORATION



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Evaporation pond demand size

- **Precipitation & Evaporation = 700 … 800 mm/a**
- **1st cross check for solar radiation energy input**
  - explains 1/3rd of the evaporation and the other 2/3rd?
- **Factors positively influencing evaporation rate**
  - Temperature up 45°C
  - Ambient moisture 46% summer (but 75% autumn to spring)
  - Wind blowing year around with average ~ 4 m/s
- **Factors negatively influencing evaporation rate**
  - Salt content depressing vapour pressure
  - Icing up of ponds surface as temperature is as low as -21°C
  - Reflection due to precipitating salts

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Evaporation pond arrangement

- A **single large pond** would have increasing high salt content and subsequently a **sinking evaporation rate**
- **Solution** is to establish a **evaporation pond cascade**
  - 1st: deep & dark, low salt, no salt precipitation
  - 2nd: deep & dark, medium salt, Ca based salt precipitation
  - 3rd: shallow & light, high salt, all finally precipitate
- **Ponds** would be **subsequently filled over the years**
  - Step by step investment
  - Allowing also to find other solutions
  - Correct the calculations if metrological data was poor

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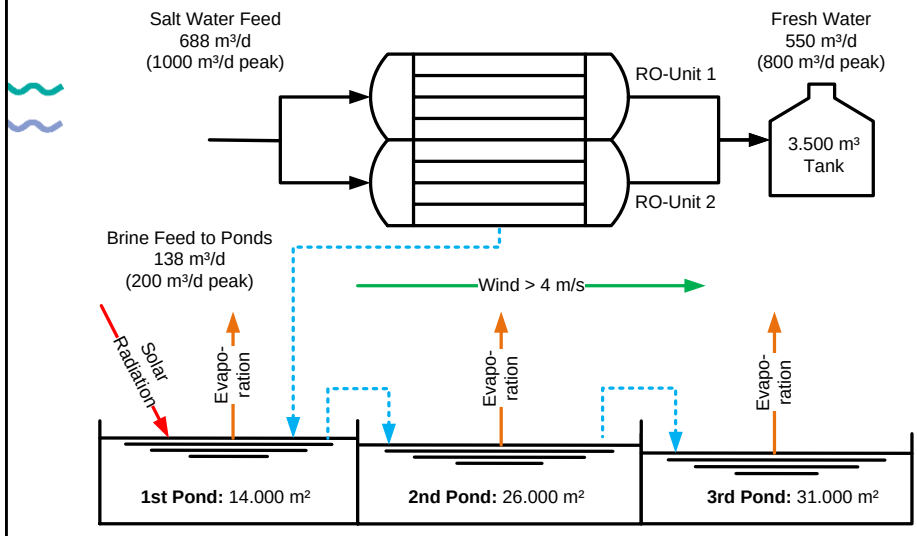

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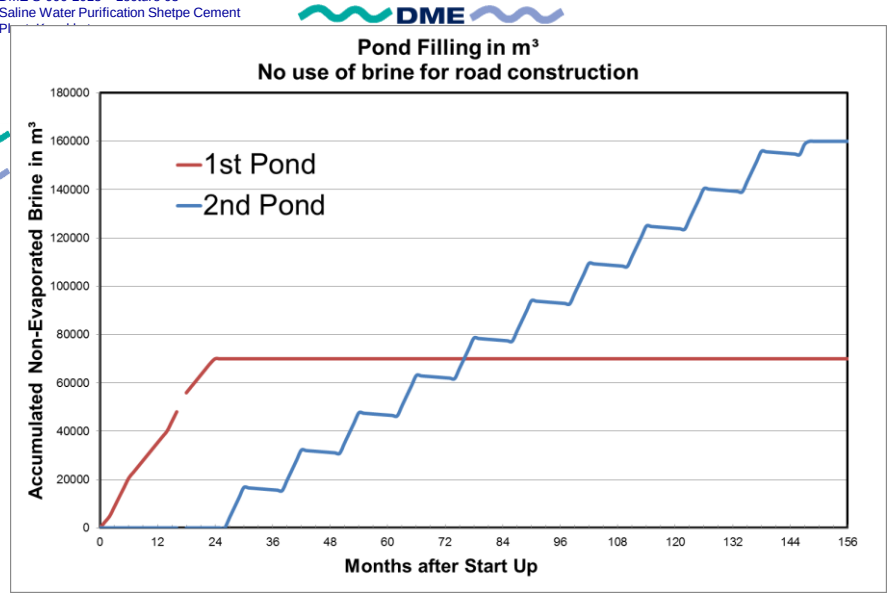

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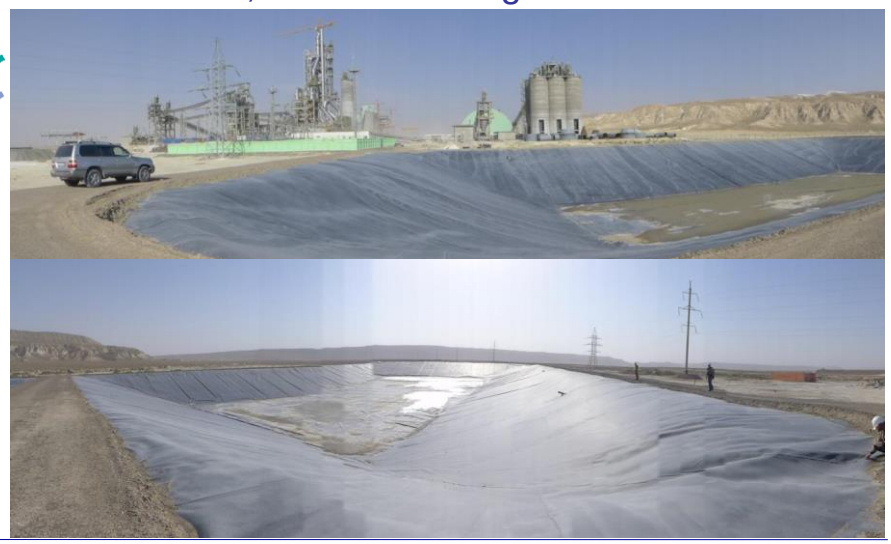
Plant, Kazakhstan

Cement Plant, 6000 m² sewage & 14.000 m² brine



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Value of the water and recovery rate

Total Costs of Operation, including depreciation		
RO system incl. civil	1,56	€/m³ fresh water generated
Brine ponds	0,69	
Power Costs	0,28	
Chemicals	0,16	
Services & Maintenance	0,27	
Manpower operation costs	0,49	
Total Ownership costs	**3,45**	

- Every 1% lower recovery rate costs ~ 0,1 €/m³
- Every m³/d of water reused, prolongs plant life for 45 days
- Despite high costs, these are still 1/2 of what locals pay

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Summary

- Water analysis and recovery rate
  - Spend time and effort on the base data
  - Check thoroughly the membrane “poisons” in raw water
- Collect local metrological data
  - If possible make a “pan test” well ahead of design
  - Reserve area and land for the basins
- Arrange in cascade
  - The more steps the smaller the area demand
  - Economical optimum: area minimisation vs dam lengths

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