THE WATER THAT BUILT DUBAI: TEN YEARS OF DESALINATION HISTORY IN JEBEL ALI

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From 1999 to 2009

Plant	AWARD	START	END
G	1999	15/03/2000	15/03/2000
K1	1999	15/11/2000	26/02/2001
K2	2000	15/04/2002	25/01/2003
L1	2003	25/05/2005	20/10/2007
L2	2005	31/08/2008	In progress
M	2007		

In the last

10 years

with common satisfaction of the Contractor and of the Client

23 MSF Units in 6 Stations

have been installed by Fisia Italimpianti in Jebel Ali industrial area


M Station
(Fisia)
L Station I + II
(Fisia)
G Station
(Fisia)
G Station
(Weir)
K Station I + II
(Fisia)
E Station
(Hang Jung)
D Station
(Ansaldo)
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Plants' size & Installed capacity

From: HOW MANY PLANTS ?

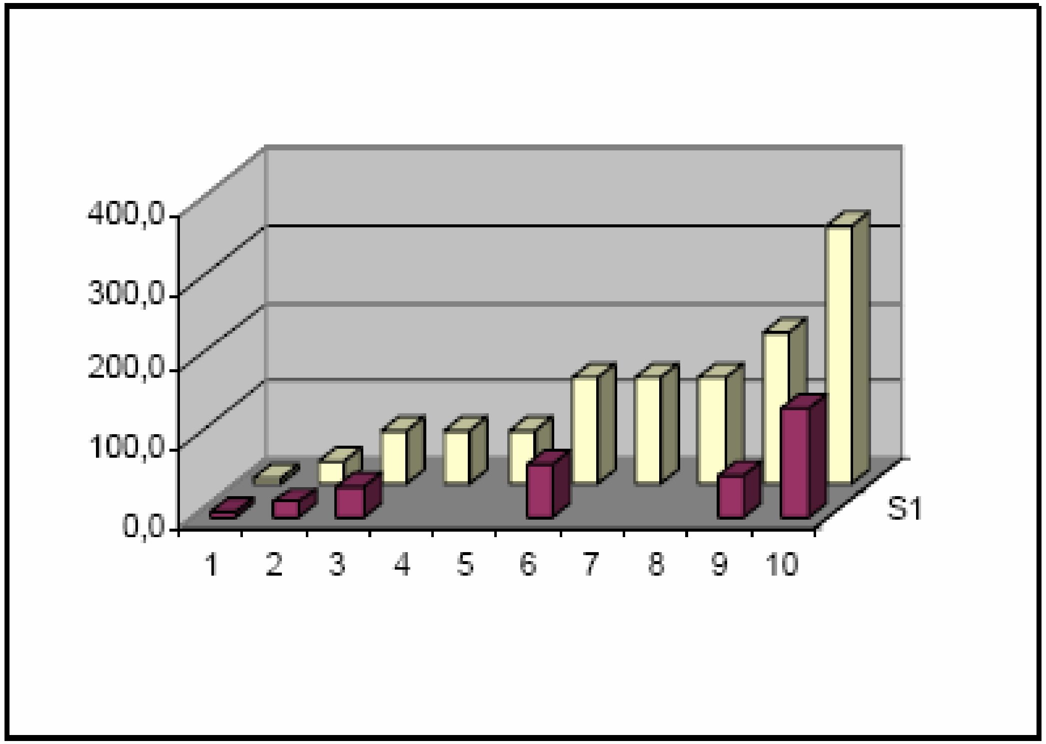
To: HOW MUCH WATER ?

Plant	YEAR	MIGD	MIGD (tot.)
G	2000	7,5	7,5
K1	2001	20	27,5
K2	2002	40	67,5
L1	2005	70	137,5
L2	2008	55	192,5
M	2009	140	332,5

10 years

1.6 millions m^3/day of fresh water

Plants' size & Installed capacity



An exponential growth

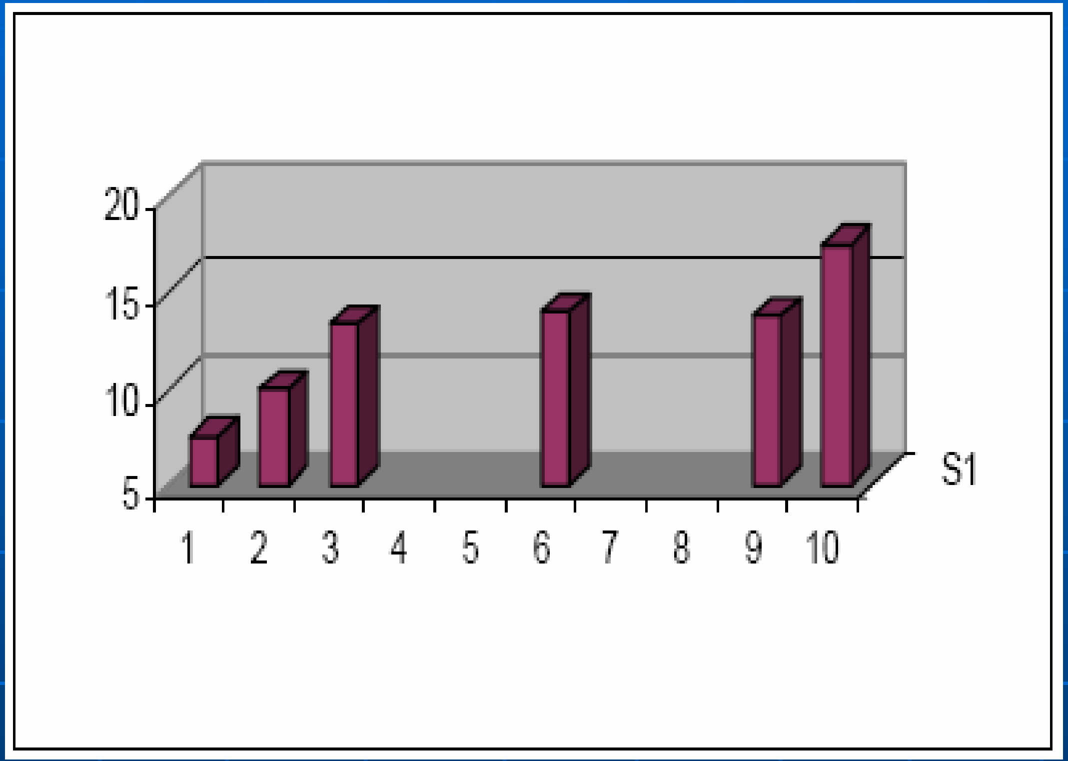
Single unit capacity

Plant	YEAR	Nr. Of Units	MIGD/unit
G	2000	1	7,50
K1	2001	2	10,00
K2	2002	3	13,33
L1	2005	5	14,00
L2	2008	4	13,75
M	2009	8	17,50

From 7,5 MIGD to 17,5 MIGD

More than double in only 10 years

Single unit capacity



The single unit size better reflects the innovation in the thermal technology field

Differences and Improvements

The main fields we are going to analyze are:

- Process
- Materials
- Equipment

Which changes and improvements have been carried out across the years?

Differences and Improvements

Process

Plant	m.u.	G	K1	K2	L1	L2	M
Distillate output	m^3/h	1420,7	1894,2	2525,0	2651,9	2604,5	3314,9
Performance Ratio	kg/2326kJ	8,7	9,0	8,0	8,6	8,4	9,0
Top Brine Temperature	°C	105	105	105	112	112	112
Sea Water Temperature	°C	30	30	30	39	39	37
Brine Recycle Flow	t/h	14100	18900	25300	25900	25300	30500
Cooling Water Flow	t/h	7600	10100	15000	18200	18400	27000
Sea Water Temperature Rise (reject section)	°C	12,0	12,0	12,5	9,5	9,0	8,0
Sea Water Salinity	g/l	46	46	45	45	45	45
Brine Specific Flow	t/h/m	1007	1062	1110	1136	1265	1320
Recovery in-tube velocity	m/s	2,07	2,13	2,10	2,22	2,16	2,09
Reject in-tube velocity	m/s	2,14	2,19	2,02	2,28	2,29	2,33

The main parameters which are indicative of the overall performances of the distillers

Differences and Improvements

Materials

TUBE BUNDLES	Recovery Section:	CuNi 66/30 instead of CuNi 90/10 in the first stages
	Reject Section:	Titanium instead of CuNi 90/10
EVAPORATOR	Shell and Internals:	Duplex SS instead of Carbon Steel
	Deaerator:	Duplex SS instead of Carbon Steel

Differences and Improvements

Tubes Materials

G			
TUBES	Recovery	first stages	CuNi 90/10
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	CuNi 90/10

L1			
TUBES	Recovery	first stages	CuNi 66/30
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	Titanium

K1			
TUBES	Recovery	first stages	CuNi 90/10
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	CuNi 90/10

L2			
TUBES	Recovery	first stages	CuNi 66/30
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	Titanium

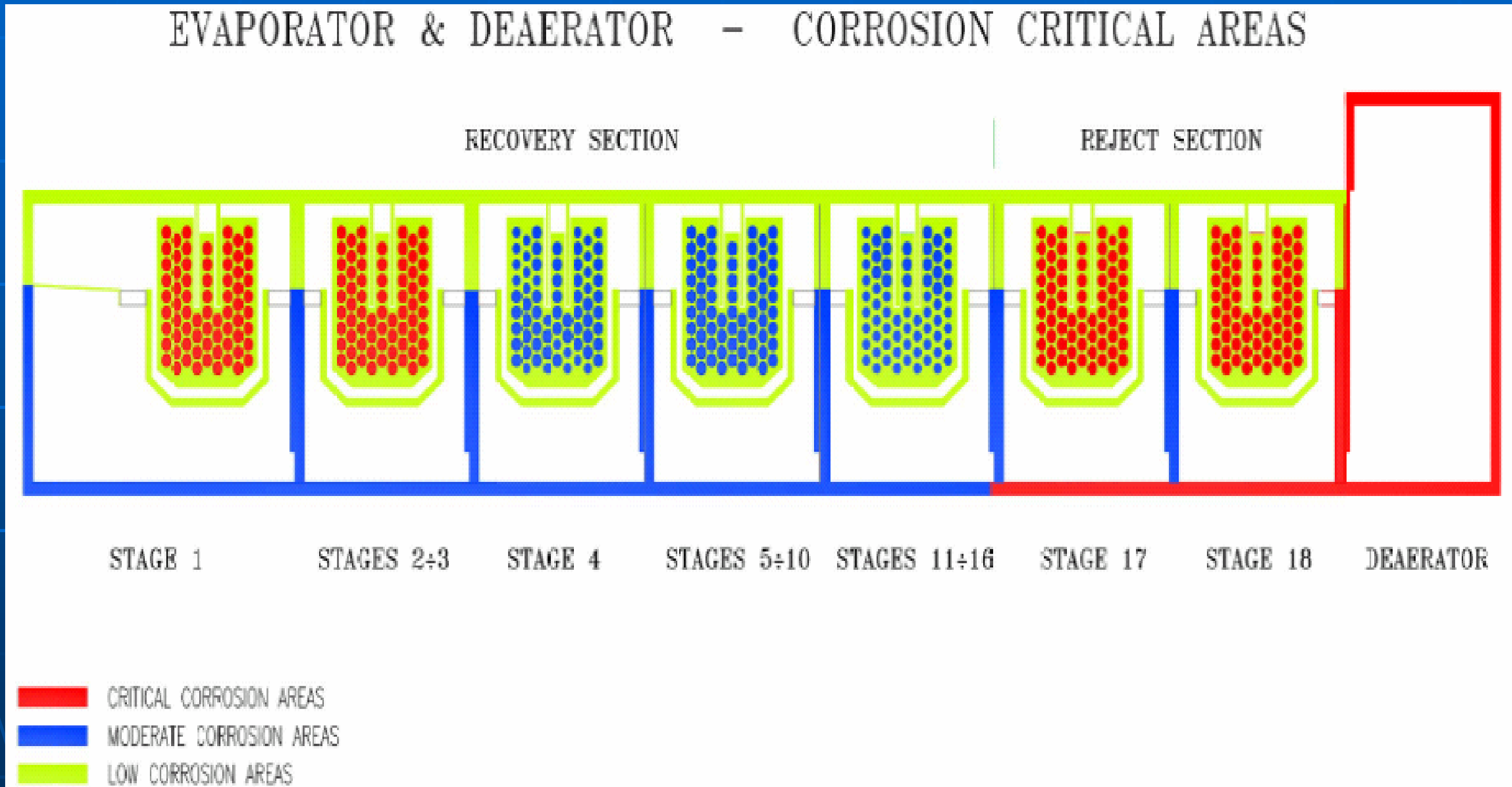
K2			
TUBES	Recovery	first stages	CuNi 90/10
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	CuNi 90/10

M			
TUBES	Recovery	first stages	CuNi 66/30
		intermediate stages	CuNi 90/10
		last stages	Al Br
	Reject	all stages	Titanium

Different materials have been used for heat exchange tubes across the last decade.

Differences and Improvements

Evaporator Materials



Materials have been used more and more tailored considering corrosion critical areas.

Differences and Improvements

Equipment

PUMPS	▪ Improved materials ▪ Size doubled in the last 10 years
VALVES	▪ Combined isolation / non return valve to reduce electrical consumption ▪ Control valves automatically actuated for better operability
CHEMICALS	▪ Antiscale: pure compound, optimized injection point ▪ Sodium Sulphite: not provided with no corrosion problems
DEAERATOR	▪ Improved materials ▪ High efficiency even without stripping steam

Differences and Improvements

Equipment

PUMP	G Flow [m^3/h]	K1 Flow [m^3/h]	K2 Flow [m^3/h]	L1 Flow [m^3/h]	L2 Flow [m^3/h]	M Flow [m^3/h]
Main sea water	-	10500	12000	18700	25600	27700
Brine recycle	6800	9100	12200	12500	12200	14800
SW recirculation	2300	2600	6500	5400	5400	7300
Potable water	-	2100	4200	4400	-	4400
Blow-down	3100	3300	4600	4800	4700	5800
Distillate	1520	2100	2560	2670	2610	3320
Condensate	190	260	340	320	340	400

Pumps size considerably increased along with the MSF units capacity growth

Differences and Improvements

Equipment

Plant	m.u.	G	K1	K2	L1	L2	M
Dosing Rate at 105°C TBT	ppm	2,4	2,4	2,3	2	2	2
Dosing Rate at 112°C TBT	ppm	3	3	2,9	2,5	2,5	2,5
Type	-	solution	solution	solution	pure	pure	pure
Injection Point	-	After BRPs	After BRPs	After BRPs	Before and After BRPs	Before and After BRPs	Before and After BRPs

the AS dosing system has been optimized in terms of dosing rate, concentration and injection location.

A Comparison Between Past and Present

- First Phase G, K 2000 – 2002
- Second Phase L 2005 – 2008
- Third Phase M 2009 – 2010

First Phase: G,K

First Phase: G,K

G: 1 Unit - K I: 2 Units K II: 3 Units

Plant	m.u.	G	K1	K2
Distillate output	MIGD	7,5	10,0	13,3
Performance Ratio	kg/2326kJ	8,7	9,0	8,0
Top Brine Temperature	°C	105	105	105
SWT	°C	30	30	30
R / D	-	9,6	9,6	9,7
F / R	-	0,54	0,53	0,59
ΔT	°C	12,0	12,0	12,5
tds	g/l	46	46	45
Ws	t/h/m	1007	1062	1110
vi	m/s	2,1	2,1	2,1
vj	m/s	2,1	2,2	2,0

- **Increased capacity** ★
- Low SWT → Low TBT
- High s.w. temperature rise

★ **= key factor for this period**

Second Phase: L

Second Phase: L

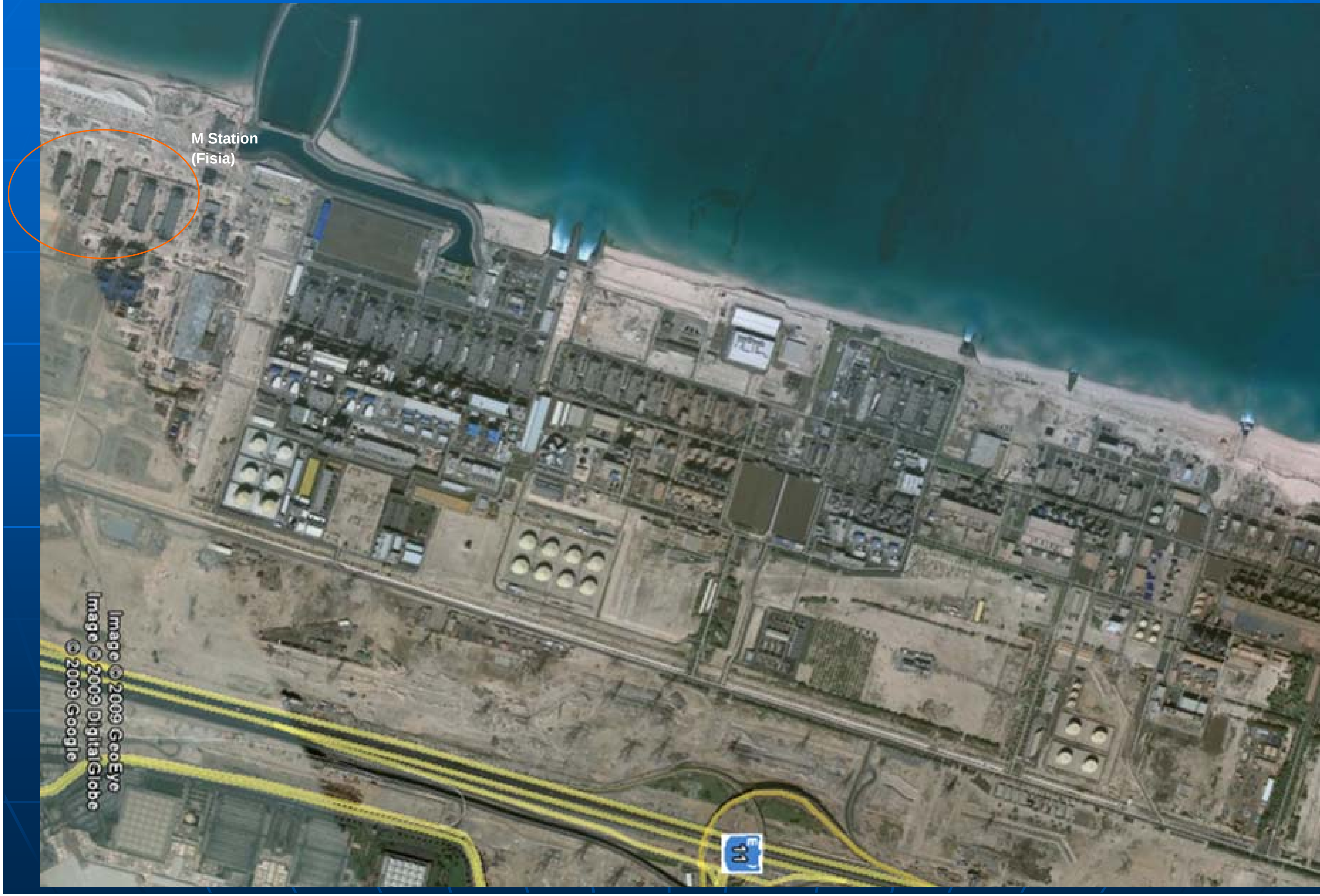
L I: 5 Units - L II: 4 Units

Plant	m.u.	L1	L2
Distillate output	MIGD	14,0	13,8
Performance Ratio	kg/2326kJ	8,6	8,4
Top Brine Temperature	°C	112	112
SWT	°C	39	39
R / D	-	9,4	9,4
F / R	-	0,70	0,72
ΔT	°C	9,5	9,0
tds	g/l	45	45
Ws	t/h/m	1136	1265
vi	m/s	2,2	2,2
vj	m/s	2,3	2,3

- **TBT up to 112 °C due to SWT at 39°C** ★
- Lower s.w. temperature rise
- Higher reject tubes velocity

★ **= key factor for this period**

Third Phase: M



Third Phase: M

M: 8 Units

Plant	m.u.	M
Distillate output	MIGD	17,5
Performance Ratio	kg/2326kJ	9,0
Top Brine Temperature	°C	112
SWT	°C	37
R / D	-	8,9
F / R	-	0,89
ΔT	°C	8,0
tds	g/l	45
Ws	t/h/m	1320
vi	m/s	2,1
vj	m/s	2,3

- Maximum unit capacity (17.5 MIGD)
- Maximum weir chamber load (1,320 t/h/m)
- **MSF design limits** ★

★ **= key factor for this period**

Operational Results

Long Term (G,K) 6 - 10 years

Process Performances →

PLANT	Guaranteed P.R.	Min P.R.	Max P.R.
G	8,7	9,8	9,9
K1	9,0	9,6	9,7
K2	8,0	8,8	8,9

- Units remain clean after several years of operation

Mechanical Performances

- Material corrosion in some internal parts of deaerator (C.S. cladded or S.S. 316/317 L) and reject section tubes →
- use of different material for the Plants of the following phase

Operational Results

Medium Term (L I) 3 - 5 years

Process Performances →

PLANT	Guaranteed P.R.	Min P.R.	Max P.R.
L1	8,6	9,1	9,3

- Optimized thermodynamic design

Mechanical Performances

- Thanks to previous plants experience →
- No corrosion problems in deaerator internals and tube bundles

Operational Results

Short Term (L II)   1 - 2 years

Process Performances

PLANT	Guaranteed P.R.	Min P.R.	Max P.R.
L2	8,4	8,9	9,0

- Satisfactory, to be monitored in the next years

Mechanical Performances

- Thanks to previous plants experience and accurate material choice

- a trouble-free life of the units and of their associated equipment is expected

Recent Ideas

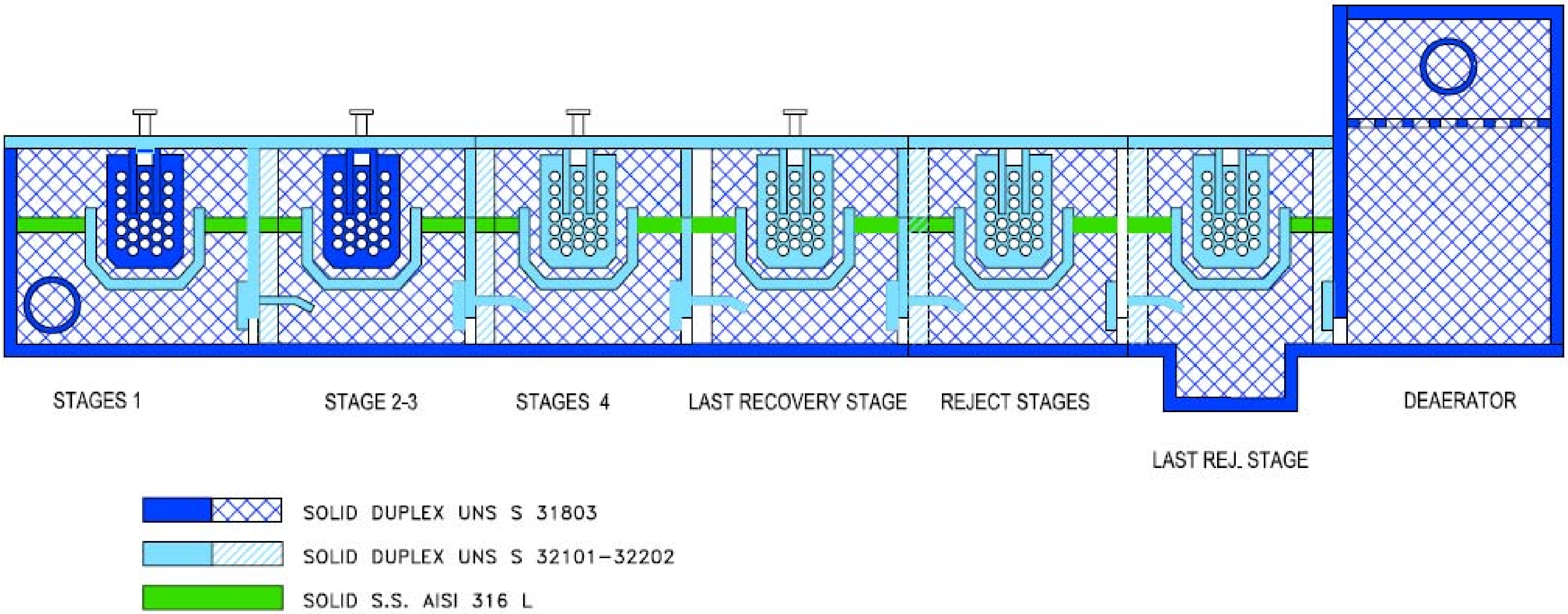
The search for MSF technology optimization by Fisia is still going on, focusing in the most recent years on:

- Materials
- Redundancies
- Design

Which improvements are possible for the plants of the next years?

Recent Ideas

Choice of materials



evaporator and deaerator main material selection applied in Jebel Ali “M”

Recent Ideas

Avoidance of useless redundancies

Some issues

- Make up filters
- Sea water recycle system
- Cranes
- Acid cleaning
- Control valves bypass

Recent Ideas

Optimized thermodynamic and hydraulic design

Some issues

- Fouling factor
- Brine chamber load
- Release rate

Into the future

We have seen how things where in the

PAST

and

We know how things are in the

PRESENT

but

How will things be in the

FUTURE

?

Into the future

Process

Fisia Italimpianti has presently in operation the largest MSF units in the world in Al Taweelah B (17.5 MIGD each), which superseded the previous record of Fisia's distillers in Shuweihat (16.7 MIGD each).

Ready for the jump to 20 MIGD Units

Some issues

- TBT > 112 °C for extreme swt
- Optimal fouling factors
- Higher brine chamber loads

Into the future

Materials

Fisia Italimpianti R&D activities are continuously going on in search of new and better materials applications.

Some issues

- Evaporator vessel
- Heat exchange tubes
- Demisters

Conclusions

- MSF technology has been applied for thermal desalination plants by today for more than 50 years.
- Though the basic principles of this way of making fresh water out from sea water remain the same, things have deeply changed.
- Fisia had the opportunity to design, build and commission all the MSF units installed in Jebel Ali from 1999 up to today.
- This overview on Fisia’s work shows how…

Conclusions

… this “old” technology is today more than ever vital and on the way to even further improvements.