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Study The Effect Of Concentration Number For Boilers Low To Medium Pressure

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Abstract

In this study, the first proposal we made was a material balance between the boiler and the production process. Through this balance, we will study the effect of the concentration number on the supply water, the feed water, and the drain water, while changing the boiler productivity more than once. The second proposal, we will explain the relationship of the condensate reflux ratio with the supply water, and we will notice this effect through the results and graphs. This relationship is very important so that the supply water is at the required values. The third proposal we will explain the relationship of the water discharge time with conductivity after knowing the amount of TDS present inside the boiler

Keywords: material balance, boiler, concentration number.

1- Introduction

All boilers will need a material balance, but the balance needs to know the conditions of the production process in terms of the pressure value to the amount of water required for the process. in the attached Figure (3.1), we find for example, at the concentration number 10, the TDS value will be 1000 PPM inside the boiler, and this will depend on the TDS value in the feed water. Therefore, it is very important to determine the value of the TDS salts coming from the desalination plant. In this study, we will study many important variables in relation to the boiler and the production process. The proposal included in this project will show the effect of the concentration number as well as the reflux condensate and determine the best value of the concentration number with the change in the productivity value of the boiler.

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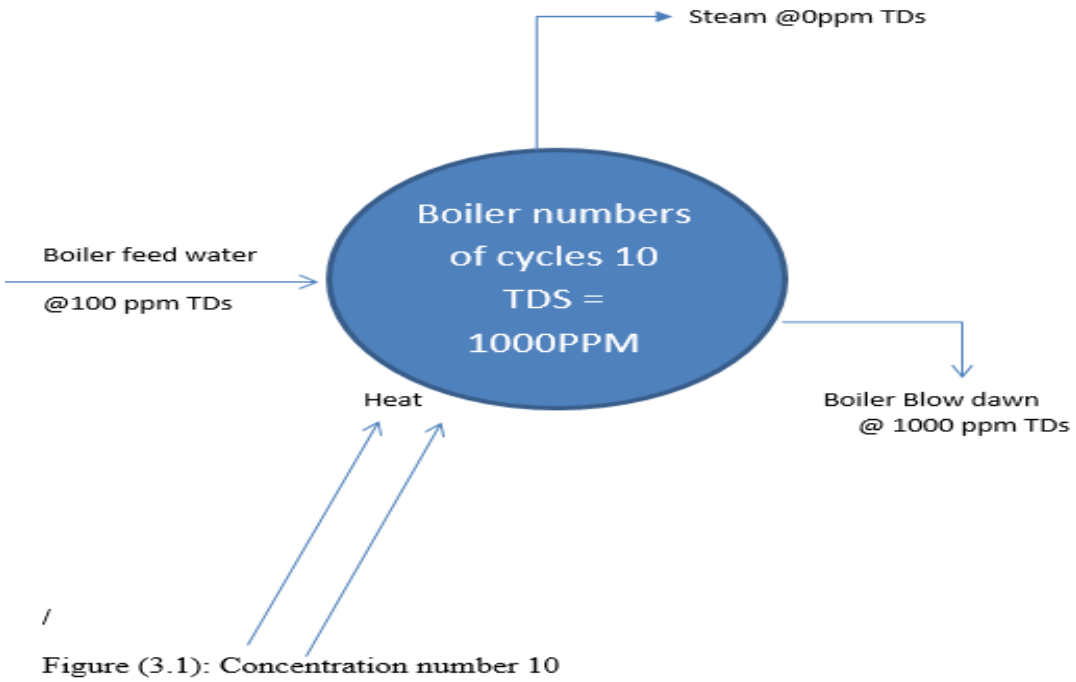

Figure (3.1): Concentration number 10

2- Material Balance

By balancing the material for the production process, figure(3.2)starting from the supply of water to the end of the process, which is the return of the condensate, and as shown in the box diagram, we will obtain the following equations, through which we will calculate all the variables, the attached tables and relationships show all the results

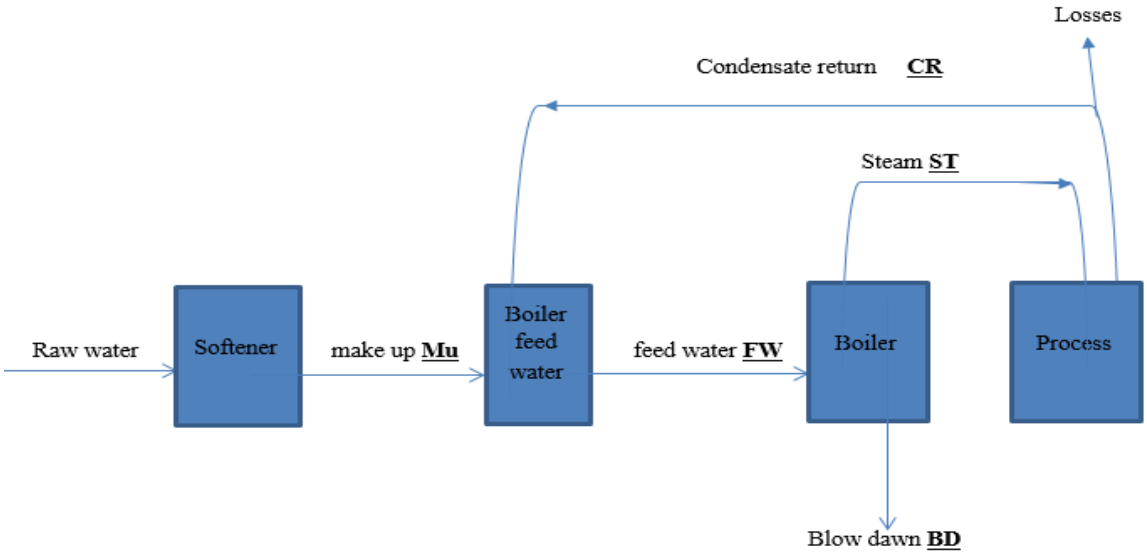

Figure (3.2): Material balance

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3- Results

We explain the effect of the concentration number on balancing the boiler water at more than the value the steam leaving from the boiler. The numbers show in tables (3.1), (3.2), (3.3), (3.4) effect of the concentration number on each of the supply water, feed water and drain water. This balance is important in each boiler to determine the number of cycles or the concentration number that gives a state of stability for the boiler in terms of the TDS value, and we also avoid any damage in the boiler.

3.4.1 Effect of concentration number on boiler water balance

Table (3.1) Effect of concentration number on boiler water balance **at steam 6 tons.**

Number of concentration	TDS Feed water (100ppm)	Steam (t/hr)	feed water (t/hr)	Blow dawn (t/hr)	Blow dawn %Fw	Make up (t\hr)	Make up (t\d)	CR (70%)
5	500	6	7.50	1.500	20	3.300	79.20	4.2
10	1000	6	6.66	0.666	9.999	2.466	59.19	4.2
15	1500	6	6.42	0.428	6.665	2.228	53.48	4.2
20	2000	6	6.31	0.315	4.998	2.115	50.77	4.2
25	2500	6	6.25	0.250	4.000	2.050	49.20	4.2
30	3000	6	6.20	0.206	3.331	2.006	48.16	4.2
35	3500	6	6.17	0.176	2.856	1.976	47.42	4.2
40	4000	6	6.15	0,153	2.499	1.953	46.87	4.2
45	4500	6	6.13	0.136	2.221	1.936	46.47	4.2
50	5000	6	6.12	0.124	2.031	1.922	46.13	4.2

Table (3.4) Effect of concentration number on boiler water balance **at steam 12 ton**.

Number of concentration	TDS Feed water (100ppm)	Steam (t/hr)	feed water (t/hr)	Blow dawn (t/hr)	Blow dawn %Fw	Make up (t\hr)	Make up (t\d)	CR (70%)
5	500	12	15.00	3.000	20	6.600	158.400	8.4
10	1000	12	13.33	1.333	9.999	4.933	118.399	8.4

15	1500	12	12.85	0.857	6.665	4.457	106.970	8.4
20	2000	12	12.63	0.631	4.999	4.231	101.556	8.4
25	2500	12	12.50	0.500	3.999	4.100	98.400	8.4
30	3000	12	12.41	0.413	3.333	4.013	96.328	8.4
35	3500	12	12.35	0.352	2.856	3.952	94.869	8.4
40	4000	12	12.30	0.307	2.499	3.907	93.782	8.4
45	4500	12	12.27	0.272	2.221	3.872	92.944	8.4
50	5000	12	12.24	0.244	1.999	3.844	92.275	8.4

3.4.2- Effect of reflux condensate percentage on supply water.

These tables (3.5), (3.6) give an idea of the importance of the return condensate ratio and the supply of water with the change in boiler productivity.

Table (3.5) Effect of reflux condensate percentage on supply water **at steam 6 tons.**

Number of concentration	Steam (t/hr)	feed water (t/hr)	Make up t\d CR (55%)	Make up t\d CR (70%)	Make up t\d CR (85%)	Make up t\d CR (95%)
5	6	7.5000	100.8	79.200	57.600	43.200
10	6	6.6666	80.798	59.198	37.598	23.198
15	6	6.4285	75.084	53.484	31.884	17.484
20	6	6.3157	72.376	50.776	29.176	14.776
25	6	6.2500	70.800	49.200	27.600	13.200
30	6	6.2068	69.763	48.163	26.563	12.163
35	6	6.1764	69.033	47.424	25.824	11.424
40	6	6.1538	68.472	46.872	25.272	10.872
45	6	6.1363	68.071	46.471	24.871	10.471
50	6	6.1224	67.738	46.137	24.537	10.138

Table (3.8) Effect of reflux condensate percentage on supply water **at steam 12 tons.**

Number of concentration	**Steam (t/hr)**	**feed water (t/hr)**	**Make up t\d CR (55%)**	**Make up t\d CR (70%)**	**Make up t\d CR (85%)**	**Make up t\d CR (95%)**
5	12	15.0000	201.6000	158.4000	115.2000	86.4000
10	12	13.3333	161.5992	118.3992	75.1992	46.3992
15	12	12.8571	150.1704	106.9704	63.7704	34.9704
20	12	12.6315	144.7560	101.5560	58.3560	29.5560
25	12	12.5000	141.6000	98.4000	55.2000	26.4000
30	12	12.4137	139.5288	96.3288	53.1288	24.3288
35	12	12.3529	138.0696	94.8696	51.6696	22.8696
40	12	12.3076	136.9824	93.7824	50.5824	21.7824
45	12	12.2727	136.1448	92.9448	49.7448	20.9448
50	12	12.2448	135.4773	92.2752	49.7736	20.2773

3.4.3- Effect of draining time (blow dawn) on conductivity.

These tables show the effect of the drain water in relation to the conductivity. This basically depends on the time the water stays inside the boiler before draining. Therefore, the concentration number has an important role in raising and lowering the TDS value, in other meaning the conductivity.

Table (3.9) Effect of draining time (blow dawn) on conductivity **at steam 6 tons.**

NC	TIME	PPM	µs/cm	BD %Fw
5	1	500	780	1.5000
10	2	1000	1248	0.6666
15	3	1500	1560	0.4285
20	4	2000	2340	0.3157
25	5	2500	3120	0.2500
30	6	3000	3900	0.2068

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35	7	3500	4680	0.1764
40	8	4000	6240	0,1538
45	9	4500	7020	0.1363
50	10	5000	7800	0.1244

Table (3.12) Effect of draining time (blow dawn) on conductivity **at steam 12 tons.**

NC	TIME	PPM	µs/cm	BD %Fw
5	1	500	780	3.0000
10	2	1000	1248	1.3333
15	3	1500	1560	0.8571
20	4	2000	2340	0.6315
25	5	2500	3120	0.5000
30	6	3000	3900	0.4137
35	7	3500	4680	0.3529
40	8	4000	6240	0.3076
45	9	4500	7020	0.2727
50	10	5000	7800	0.2448

In these relationships, we notice how the concentration number affects each of the supply water, the feed water for the boiler, and finally the drain water. All these data are considered a closed circuit and any impact or defect will appear in the production process of the boiler.

We review and explain the effect of the numbers in the figure (3.3) that shows the relationship between the concentration number with the water flow, which is the supply water, feed water, and the drain water. The feed water at a steam productivity of 6 tons per hour was 7.5 tons, while the concentration number was 5 cycles. By increasing the concentration number, we note that the demand for feed water decreases to 6.1 tons. As for the drain water, the percentage was 20% of the feed water in the end reaching 2% at the concentration of 50 cycles, while the supply water went from 79 tons per day to 46 tons per day at the same number of cycles.

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We compare the results when there is a change in the boiler productivity value. Watch the figure (3.4) and (3.5) Note that the increase in the boiler productivity increases the demand for processing water from 79 tons per day to 105 tons per day, but we will need to know the best value for the concentration number, which gives the value of TDS in the Steam Zero. In the case of steam 6 tons per hour the best value for the concentration number is 8 cycles, while in the case of 10 tons per hour the best value is 10 cycles.

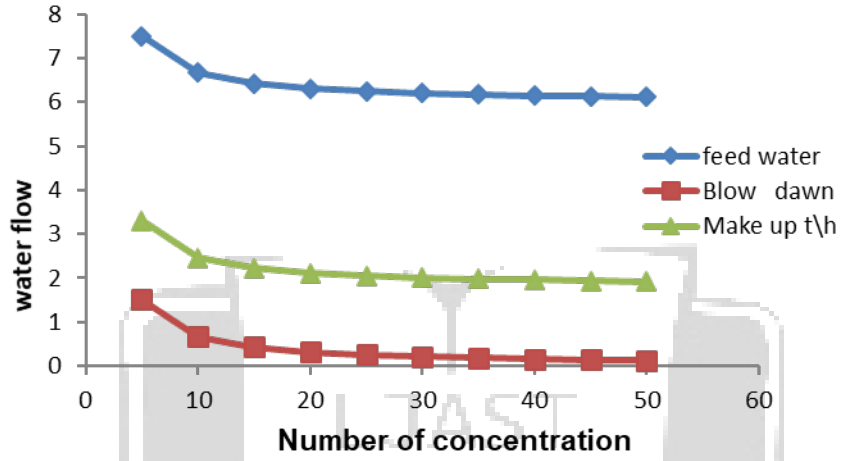

Figure (3.3) Effect of concentration number on boiler water balance **at steam 6 ton**

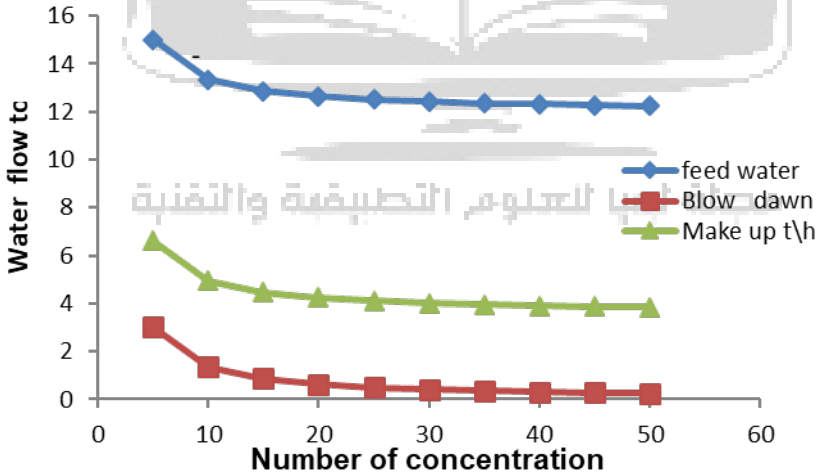

Figure (3.6) Effect of concentration number on boiler water balance **at steam 12 ton**

The following relationships will show figures (3.6), (3.7) effect of the change in the condensate reflux ratio on the supply water with other variables, for example the concentration number and boiler productivity. These relationships will give us the best percentage of reflux condensate in the presence

of a change in the productivity of the boiler and choose the best value for the concentration number that determines the TDS value in the steam.

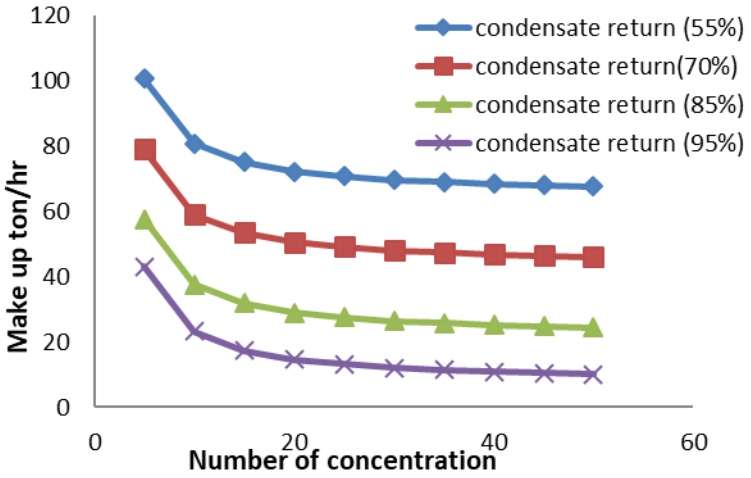

Figure (3.7) Effect of reflux condensate percentage on makeup water **at steam 6 ton**

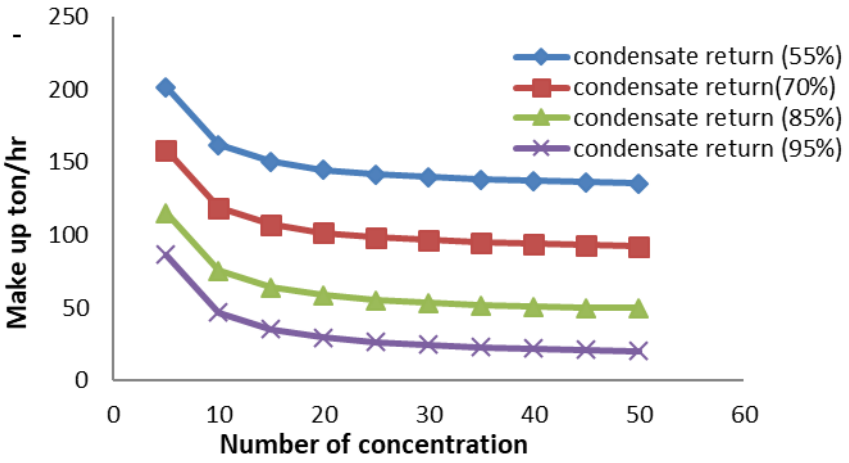

Figure (3.10) Effect of reflux condensate percentage on makeup water **at steam 12 ton**

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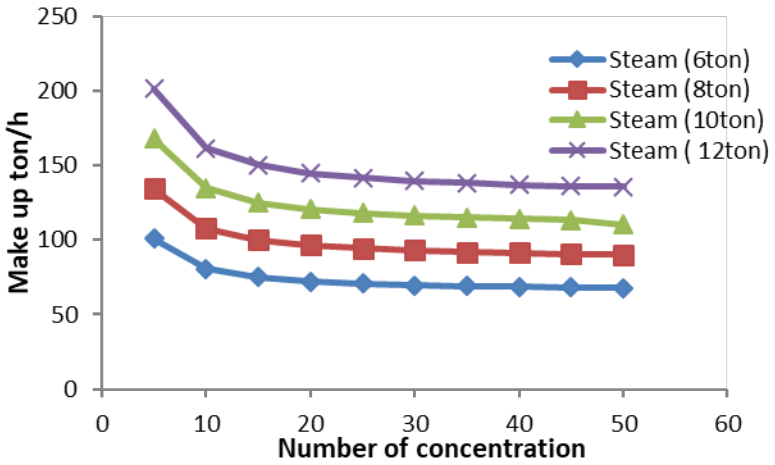

Figure (3.11) Effect of reflux condensate percentage on makeup water **at condensate percentage 55%**

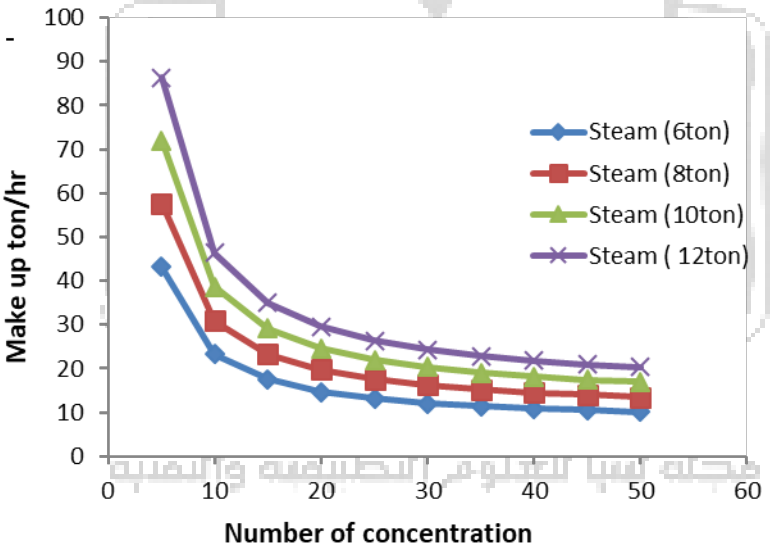

Figure (3.14) Effect of reflux condensate percentage on makeup water **at condensate percentage 95%**

These relationships determine, see the figure (3.19) required conductivity value inside the boiler, which is a clear indication of the amount of TDS. The conductivity has an inverse relationship with the drain water and time.

In the figure (3.9) note effect of the time on the conductivity and we will notice the correlation of the drain water with time

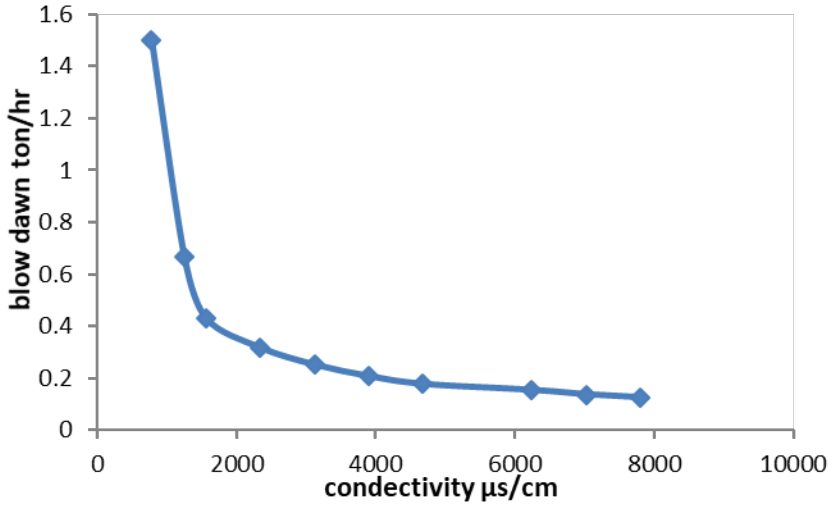

Figure (3.15) Effect of draining time (blow dawn) on conductivity **at steam 6 ton condensate percentage 70%**

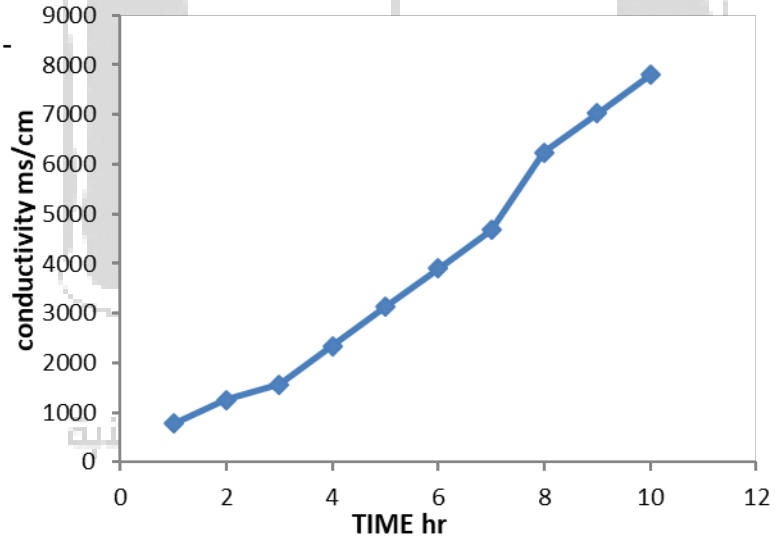

Figure (3.19) Effect of time on conductivity at **condensate percentage 70%**

4- Discussion and recommendations.

We review and explain the effect of the numbers in the figure (3.3) to (3.6) that shows the relationship between the concentration number with the water flow, which is the supply water, feed water, and the drain water.

The feed water at a steam productivity of 6 tons per hour was 7.5 tons per hour, while the concentration number was 5 cycles. By increasing the concentration number, we note that the demand for feed water decreases to 6.1 tons per hour. As for the drain water the percentage was 20% of the feed water in the end reaching 2% at the concentration of 50 cycles, while the supply water went from

3.30 tons per hour (79 tons per day) to 1.92 tons per hour (46 tons per day) at the same number of cycles.

We compare the results when there is a change in the boiler productivity value. Watch the figure (3.3) and (3.4) Note that the increase in the boiler productivity increases the demand for processing water from 3.30 tons per hour (79 tons per day) to 4.40 tons per hour (105 tons per day), but we will need to know the best value for the concentration number, which gives value of TDS in the Steam Zero. In the case of steam 6 tons per hour the best value for the concentration number is 7 cycles, while in the case of 10 tons per hour the best value is 11 cycles.

Number of concentration	TDS Feed water (100ppm)	Steam (t)	feed water	Blow dawn	Blow dawn %Fw	Make up t\h	Make up t\d	CR (70%)
7	700	6	7	1	14.28%	2.8	67.2	4.2
9	900	8	9	1	11.11%	3.4	81.6	5.6
11	1100	10	11	1	9.09%	4.0	96.0	7.0
13	1300	12	13	1	7.69%	4.6	110.4	8.4

4.1 Recommendations:

1- At the end of the study, we recommend studying the effect of oxygen in the water on the boiler.
2- Not using a device softener before inlet, the water to the boiler.

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