中正锅炉
ZOZEN BOILER

冷凝水回收系統

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飽和蒸汽表

TABLE OF SATUR-STED STEAM

蒸汽壓力 Steam Pressure (kg/cm² G)	飽和溫度 Saturated tem-Perature (℃)	比容積 Specific Volum (m³/kg)	顯熱量 Sensible Heat (Kcal/kg)	潛熱量 Latent Heat (Kcal/kg)	全熱 Overall Heat (Kcal/kg)
0.0	100.00	1.67300	100.092	539.06	639.15
0.2	105.03	1.41782	105.165	535.84	641.01
0.4	109.43	1.23208	109.605	532.99	642.60
0.6	113.35	1.09031	113.570	530.43	644.00
0.8	116.89	0.978472	117.160	528.07	645.23
1.0	120.13	0.888089	120.445	525.90	646.35
1.2	123.12	0.813309	123.480	523.89	647.37
1.4	125.90	0.750532	126.309	521.99	648.30
1.6	128.50	0.697014	128.953	520.20	649.15
1.8	130.94	0.650754	131.445	518.49	649.94
2.0	133.25	0.610505	133.796	516.88	650.68
2.2	135.43	0.575018	136.031	515.34	651.37
2.4	137.52	0.543509	138.159	513.86	652.02
2.6	139.50	0.515363	140.191	512.44	652.63
2.8	141.40	0.497985	142.136	511.06	653.20
3.0	143.22	0.467181	144.005	509.74	653.75
3.2	144.97	0.446364	145.804	508.47	654.27
3.4	146.65	0.427441	147.534	507.23	654.76
3.6	148.27	0.410054	149.205	506.02	655.23
3.8	149.74	0.395008	150.721	504.93	655.65
4.0	151.36	0.381516	152.386	503.71	656.10
4.2	152.83	0.371376	153.268	503.07	656.34
4.4	154.25	0.352924	155.377	501.52	656.90
4.6	155.64	0.341075	156.810	500.47	657.28
4.8	156.78	0.330014	158.203	499.44	657.64
5.0	158.29	0.319704	159.559	498.43	657.99
5.2	159.57	0.309995	160.882	497.44	658.32
5.4	160.81	0.300870	162.174	496.47	658.64
5.6	162.02	0.292292	163.433	495.52	658.95
5.8	163.03	0.285364	164.483	494.72	659.20
6.0	164.19	0.277617	165.696	493.80	659.50
6.2	165.32	0.269296	166.873	492.90	659.77
6.4	166.43	0.262423	168.031	492.02	660.05
6.6	167.52	0.256847	169.165	491.14	660.31
6.8	168.79	0.249380	170.497	490.12	660.62
6.0	169.78	0.243796	171.526	489.32	660.85
7.2	170.80	0.238170	172.592	488.50	661.09
7.4	171.80	0.232802	173.639	487.68	661.32
7.6	172.79	0.227622	174.678	486.86	661.54
7.8	173.74	0.222773	175.677	486.07	661.75
8.0	174.69	0.218080	176.671	485.29	661.96
8.2	175.61	0.213588	177.647	484.52	662.17
8.4	176.53	0.209278	178.607	483.76	662.37
8.6	177.43	0.205135	179.554	483.01	662.56
8.8	178.31	0.201158	180.485	482.26	662.75
9.0	179.18	0.197334	181.401	481.77	662.93
9.2	180.04	0.193740	182.307	480.80	663.11
9.4	180.88	0.190104	183.196	480.08	663.28
9.6	181.71	0.187791	184.074	479.38	663.45
9.8	182.53	0.183393	184.940	478.67	663.61
10.0	183.33	0.180218	185.793	477.98	663.77
10.2	184.13	0.177150	186.635	477.28	663.92
10.4	184.92	0.174177	187.467	476.60	664.07
10.6	185.69	0.171598	188.288	475.93	664.22
10.8	186.45	0.168537	189.098	475.26	664.36
11.0	187.20	0.165853	189.897	474.60	664.50
11.2	187.95	0.153146	190.688	473.95	664.64
11.4	188.68	0.160731	191.467	473.30	664.77
11.6	189.41	0.158290	192.239	472.66	664.90
11.8	190.12	0.155919	193.002	472.03	665.03
12.0	191.00	0.153618	193.755	471.39	665.15
12.2	191.52	0.151387	194.500	470.77	665.27
12.4	192.21	0.149219	195.238	470.15	665.39
12.6	192.90	0.147107	195.968	469.54	665.51
12.8	193.57	0.145063	196.688	468.93	665.62
13.0	194.24	0.143073	197.402	468.33	665.73

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凝結水回收立即採用「密閉化」

能源是國家的命脈經濟發展的動力，如何妥善規劃節約能源方案，爲業界當前第一要務。

凝結水（Condensate）回收再使用，乃今日能源節約呼聲中，最有效的途徑。一般工廠回收凝結水再利用，所使用的方法很多，回收之績效，雖已有相當成就，但只能算是少數中之少數，其餘大多數仍效果不彰，都僅限於「開放式」簡易回收之達成，且高壓凝結水所生成的再生蒸汽未能善加利用，任其散至大氣，這些能源的浪費都是顯而易見的，因此，原有設計有重新檢討的必要。一般工廠熱能回收系統，祛水器的變換、保溫材料與厚度熱機效率，均需有所改進，如欲求更有效的凝結水回收方法，回收系統就必須密閉化，使高壓凝結水所生成的再生蒸汽，均共同回收，泵入鍋爐，此一方法回收效益極高，可使整廠達到節約最適化之設計與操作。

Condensate Recovery in Closed Process

As we know, energy is of foremost importance to a nation's economic development. For the industry in general, the most urgent thing must be working out a project to cope with the problem of energy reservation.

Among the various energy reservation projects now available condensate recovery seems to be most effective, but only few of them are outstanding in performance. Most others, having used open process for their condensate recovery operation, fail to make use of the flash steam produced in the process, making it simply a waste. Though the condensate recovery system now used by the factories may work better by having its thermal engine, trap, insulation materials and thickness therminal engine replaced or improved the better way is still so make a closed process of it in order that the steam produced may be recovered and pumped into the boiler.

凝結水回收之意義：

1. 凝結水回收經有效利用，可大幅減少鍋爐燃料費，降低生產成本。
2. 凝結水爲最純的蒸餾水，不含鍋垢之固體成份，若加以回收利用可節省大量清鍋費、水費及電費。
3. 提高鍋爐給水的水質，使蒸汽品質提高，同時減少鍋爐之排放（Blow Down），節省能源的流失。
4. 凝結水回收，可減少補給水量，使爐內及爐外水處理費用大量減少。
5. 給水溫度提高，水中含氧量減少，可避免鍋爐、熱機、及蒸汽管路的銹蝕，同時空氣減少，增加熱傳速度，提高機器效率。
6. 給水溫度提高，減少鍋爐氣鼓的溫度差，避免鋼板熱脹冷縮，應力的不平衡，延長鍋爐的壽命。
7. 給水與爐內水溫差小，鍋爐給水時，蒸汽壓力穩定。
8. 給水溫度昇高，增加鍋爐蒸發量，較能應付鍋爐負荷的改變，及減少備用鍋爐使用機會。
9. 凝結水回收經利用，無蒸汽污染現象及祛水器排水之噪音，提高工作環境。
10. 給水溫度昇高，減少單位蒸汽生產熱能的需要量，直接節省燃料消耗，提高鍋爐效率。

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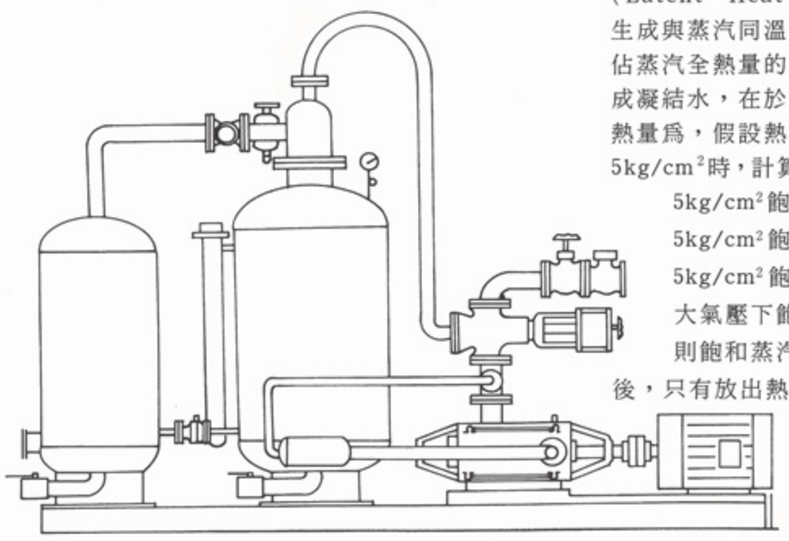
Advantages of Condensate Recovered

1. Condensate recovered can reduce greatly the cost of boiler fuels.
2. Condensate, being the most pure distilled water, can save the industry from expenses of boiler cleaning.
3. Condensate can hmprove the quality of the water fed to the boiler and reduce the "blow down" of the boiler.
4. Condensate recovered can reduce the amount of water feed and save the cost of water purgation both inside and outside the boiler.
5. Condensate, being able to raise the temperature of water feed and reduce its oxygen content, can protect boiler, thermal engine and steam pipings from corrosion and enhance heat transmission rate.
6. Condensate makes for less temperature difference in boiler steam cell, thus preventing unbalanced stress on boiler steel plate for long life.
7. Condensate produces less temperature difference between water feed and the water inside the boiler, making steam pressure stable.
8. Condensate provides water feed in higher temperature, enhancing steam evaporation of the boiler and coping better with its changing load to make standby boiler less necessary.
9. Condensate produces no steam pollution and water draining noise.
10. Condensate, by raising the temperature of water feed, can reduce the heat required for steam production, saving boiler fuel.



新型專利雙槽自吸密閉式回收系統之回收效益分析報告：

蒸汽媒體中含有兩種不同的能量，這種能量稱爲顯熱（Sensible Heat）及潛熱（Latent Heat）二種，顯熱即是將水提升至沸點所需要的熱能。潛熱爲將在沸點的水轉變爲蒸汽所需的能量，而潛熱通常是顯熱的二倍至四倍。因此在物理特性相互變化，由液態變爲氣態，生成蒸汽蒸汽經使用放出潛熱後，立刻冷凝生成凝結水，由氣態變爲液態，反之加熱於凝結水，可使凝結水重新蒸發產生蒸汽，又從液態回到汽態。一般使用能源的工廠，且大多數利用蒸汽作爲熱媒體，來間接對製程物料加熱，主要是利用蒸汽所含的全部熱量中，約佔百分之七十至八十左右的潛熱（Latent Heat）。因此使用過的蒸汽立刻冷凝生成與蒸汽同溫壓之凝結水，其顯熱含熱量，約佔蒸汽全熱量的百分之二十至三十左右，這些生成凝結水，在於不同的回收系統，可供再利用之熱量爲，假設熱機（設備）使用蒸汽飽和壓力爲5kg/cm²時，計算資料(請參圖表㈠蒸汽飽和表)。

5kg/cm²飽和蒸汽全熱爲：657.99Kcal/kg

5kg/cm²飽和蒸汽潛熱爲：498.43Kcal/kg

5kg/cm²飽和水溫度爲：159.559Kcak/kg

大氣壓下飽和水溫度爲：100Kcal/kg

則飽和蒸汽全熱當中，經熱機(設備）使用後，只有放出熱能（潛熱）爲498.43 Kcal/kg = (659.99-159.559) Kcal/kg，其佔蒸汽全熱量爲76%，蒸汽經使用放出熱能（潛熱）後，所冷凝生成的凝結水，可供「雙槽自吸密閉式」回收，最高溫爲159.559Kcal/kg=657.99-498.43) Kcal/kg，其佔蒸汽全熱量的24%。如果該熱機（設備）之凝結水未回收再利用時，其被捨棄熱量爲159.559 Kcal/kg，同樣的佔蒸汽全熱量爲24%，如果使用「開放式」回收，其被散至大氣之熱量爲 59.559 Kcal/kg=(159.559-100) Kcal/kg 佔蒸汽全量百分比爲 9%。故凡在大氣壓力下的凝結水回收，均稱爲「開放式」回收法，其能供給有效的熱能，最高只限於攝氏100 °C (100kcal/kg)，因在大氣壓力下，水的溫度於 100 °C 時，不可能永遠保持液體狀態，任何多於 100 °C 的熱能將立刻使部份水沸騰，轉變爲蒸汽，蒸汽的特性是蒸汽在熱機中，以相同壓力放出熱能(潛能熱)，後立刻凝結成蒸汽壓力、溫度相同的凝結水，如上述以5kg/cm² 飽和蒸汽壓力時，凝結水溫度爲 159.559 °C (159.559kcal/kg)，由溜水器排出並經回收管路流到聚水槽，此時聚水槽如在大氣壓力下，則每公斤凝結水的溫度最高只有攝氏100°C (100 kcal/kg)，由不同的壓力，造成不同溫度的變化，使每公斤凝結水熱含量從158.29°C (158kcal/kg)迅速降到100 °C (100kcal/kg) 其間的能量差，因能量不滅原理，立即放出熱量爲 59.559 °C (59.559kcal/kg)=(159.559-100) kcal/kg，並使大約百分之十一的凝結水，因爲吸收這種能量差，重新再蒸發生成蒸汽，這類蒸汽，一般稱爲再生汽(Flash Steam)，再生蒸汽和一般鍋爐所生產的蒸汽是完全一樣的，所以，高壓的凝結水，所生成的再生蒸汽若未能善加利用於低壓蒸汽的熱機，因此在「開放式」的凝結水回收中，必然造成大量再生蒸汽散失至大氣，損失能源，如爲達到再生蒸汽再利用的需求，唯一有效的方法。就應採用雙槽自吸密閉式回收系統。將所有來自不同壓力之凝結水及再生蒸汽，全部回收泵入鍋爐，提高鍋爐原有效率，節省更多的燃料支出。

多年來本公司秉持追求完美之經營理念，不惜投入大量資金與人力致力於凝結水回收系統之改良研發，而開發出突破傳統自然返回之回收系統，採自吸式強制回收系統，完全克服了以往一般密閉式回收系統之種種缺失，將凝結水回收之技術領域往前邁出關鍵性的一步。

雙槽自吸密閉式回收系統較一般密閉式回收系統之優點如下：

1. 強制將凝結水吸回泵進鍋爐熱機（設備）完全沒有凝結水積存，故升溫效率大幅提升。
2. 凝結水不會積存在熱機（設備），沒有水錘現象(Water Hammer)可延長熱機（設備）之使用年限。

Two-tank Auto-inflow Closed Recovery System

There are two different kinds of energy in steam media: Sensible heat and laten heat. The foremer refers to the energy required for raising the temperature of water to boiling point. The latter refers to the energy required for turning boiling water into steam. In general, latent heat contains energy three or four times that of sensible heat. When steam is used, it will release latent heat and become condensate. On the other hand, when condensate is heated, it will evaporate and become steam. In energy-consuming factories, most use steam as heat media to heat indirectly the materials under production process, because, among the heats contained by steam, some 70%-80% is latent heat. The used steam will instantly become condensate of the same pressure and temperature as that of the steam, which contains sensible heat some 20%-30% of the overall heat of the steam. The energy of the condensate recovered by various recovery systems is as follows:

(Under the circumstance when the saturated pressure of Tharmal Engine is 5kg/cm²)

5kg/cm² Saturated Steam Overall Heat:657.99Kcal/Kg

5kg/cm² Saturated Steam Latent Heat:498.43Kcal/Kg

5kg/cm² Saturated water Temperature:159.599Kcal/Kg

Saturated water Temperature at Atomospheric Pressure:100Kcal/Kg

There are about 498.43Kcal/Kg=(657.99-159.559) Kcal/kg of energy (Latent Heat) which will be exhausted from the Overall heat of Saturated Steam by using the Thermal Engine. That is 76% of

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the Overall Heat of Steam. The Steam will condense to Condensate and be recovered by Closed Process after the Latent Heat is exhausted. The highest energy of Latent Heat is 159.559Kcal/kg=(657.99-498.43) Kcal/Kg. That is 24% in Overall Heat of Steam. If the condensate was not recovered and reused in the Termal Engine, the Latent Heat=159.559Kcal/kg will be wasted. If recovered with open process, the energy of 59.559 Kcal/Kg=(159.559 100) Kcal/kg will be dissipated into Atomosphere. It is about 9% in Overall Heat of Steam. Therefore, the Condensate Recovery at Atomospheric Pressure is called "Open Recovery System". The open process will supply effective energy at 100°C (100Kcal /Kg) maximal. For the water will not keep in liquid forever neither at the temperature of 100°C nor at the Atomospheric Pressure. Then if the energy has more than 100°C, the water will boil immediately and change into steam. The condensate will has same presure and temperature as steam after the Latent Heat is exhausted. This is the property of steam. The temperature of condensate will be 159.559 Kcal/Kg when the Saturated Steam Pressure is 5kg/cm^2. If the Condensate drain from Water Purification Tank pass Recovery Piping to Water Storage, the Water Storage will be at Atomospheric Pressure and the highest temperature of Cndensate is only 100°C (100Kcal/Kg.)

The different pressure will cause changes in temperature, making energy of condensate from 158.29°C (158.29Kcal/kg) to 100°C (100Kcal/kg) immediately. According to the Law of Cnservation of Energy, the difference of energy is 59.559°C (59.559Kcal/kg)=(159.559-100) Kcal/kg, which will be absorbed by 11% condensate. We call the evaporating condensate as Flash Steam, which is the same as the steam produced from boiler. Therefore, if the steam is not reused in Low-pressure-steam Thermal Engine, it will make a lot of Flash Steam dissipated into Atomosphere. The only way to reuse Flash Steam and Condensate effectually is to adopt Two-tank Auto-inflow Closed Recovery System It can save fuel and reduce expenses.

On the basis of an idea of perfect management, we have invested a great deal of money and manpower to improve and develop the Condensate Recovery System. It has brought us a successful development of the Auto-suction Forcible Recovery System wich can overcome various defects of the ordinary closed recovery system as to make an important improvement in the techniques of condensate recovery.

In comparison with the common closed recovery system, Two-tank Auto-inflow Closed Recovery System has its advantages as follows:

(1) It can forcibly suck condensate to be pumped into boiler to make no condesate deposited in thermal engine (equipment), and the efficiency of raising temperature is greaty raised.

(2) As there is no Water Hummer due to no condensate deposited in thermal engine (equipment), it can lengthen the life of thermal engine (equipment).

「密閉式」統一回收系統的經濟利益：

凝結水回收系統一般可分爲開放式和密閉式兩種，由下表可以看出，密閉式回收系統的投資較符合經濟利益。但無論是那一種系統，由極高的投報酬率可得到一項結論，本公司藉以節約能源耕耘者之立場，在此謹誠懇的盼望，凡任何使用蒸汽鍋爐的工廠，即日建立完成凝結水回收之規劃，以促進極力應付能源不斷上漲所造成生產成本上昇的壓力，增強產品在國際市場的競爭能力，使石油價格，一再上漲的衝擊減至最少。

Utilities of Closed Recovery System

There are two kinds of condensate recovery system: Open Process and closed process. You can see from the Table lised below that it is worthwhile to make investment in closed recovery system. In order to cope with the rising pressure of cost increase and enhance the competing ability of local product in international markets, we suggest you to work out your project for condensate recovery early.

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使用「密閉式」統一回收系統，回收高壓凝結水5kg/cm^2，假設每小時回收二公噸（每分鐘回收33.3公斤），其回收經濟利益每年超過一百萬台幣以上，詳細計算如下：

Given a saturated pressure of 5kg/cm^2, the Closed Recovery System will recover two ton of condensate per hour, which in turn produces economic utility of more than NT$1 million per year. (See Table below)

	每小時回收量 Item	開放式 Open Process	密閉式 Closed Process	單位 Unit
	每小時回收量（註一） Condensate recovered per hour[1]	2,000	2,000	公斤/小時 Kcal/hr
×	散失至大氣之再生蒸汽量（註二） Flash steam dissipated to atmosphere[2]	89%	100%	%
=	每小時實際回收量 Autual recovery per hour	1,780	2,000	公斤 Kg
×	每年操作小時數（註三） Operation hours per year[3]	8,400	8,400	小時 hr
=	每年回收量 Recovery per year	14,952,000	16,800,000	公斤 Kg
×	每公斤回收熱量（註四） Heat recovered per Kg[4]	(100-20)	(158-20)	仟卡/公斤 Kcal/kg
=	每年所回收熱量 Heat recovered per year	1,196,160,000	2,318,400,000	仟卡 Kcal
×	鍋爐效率80% Boiler efficiency (80%)	1.25 (1/0.8)	1.25 (1/0.8)	常數 Constant
=	每年節省熱能量 Energy saved per year	1,495,200,000	2,898,000,000	仟卡 Kcal
÷	中油公司燃油發熱量 Heatproduced by CPC fuel	10,360	10,360	仟卡/公升 Kcal/liter
=	每年節省燃油量 Fuel saved per year	144,324	279,730	公升 liter
=	每年節省燃油量 Fuel saved per year	144.32	279.7	公秉 Kilo liter
×	中油公司燃油價格（註五） Price of CPC fuel[5]	16,000	16,000	台幣 NT
=	每小時回收一噸飽和凝結水每年節省燃油開支 Fuel expense saved per year	2,309,189.2	4,475,676	台幣 NT
+	每小時回收一噸飽和凝結水每年節省水費開支（註六） Water expense saved per year[6]	164,472	184,800	台幣 NT
+	每小時回收一噸飽和凝結水每年節省軟水處理費開支（註七） Water softening expense saved per year[7]	134,568	151,200	台幣 NT
=	貴廠每年節約（淨賺） Total expenses saved a year	2,608,229	4,811,676	台幣 NT

（註一）假設回收從祛水器排出的高壓飽和凝結水為（5kg/cm^2）。

（註二）在（5kg/cm^2）高壓飽和凝結水使用開放式回收會造成 11% 冷凝水損失，使用密閉式回收 0%。

（註三）假設每年操作時數為：一天 24 小時，一月 29 天，一年 12 月，共計約 8400 小時。

（註四）假設常溫水的溫度為 20°C，故含 20Kcal/kg 熱量。

（註五）中油公司燃油定價每公秉 16,000 元台幣，運費不考慮。

（註六）水每一公噸價值 11 元台幣，每年回收節省水費，不包括電費。

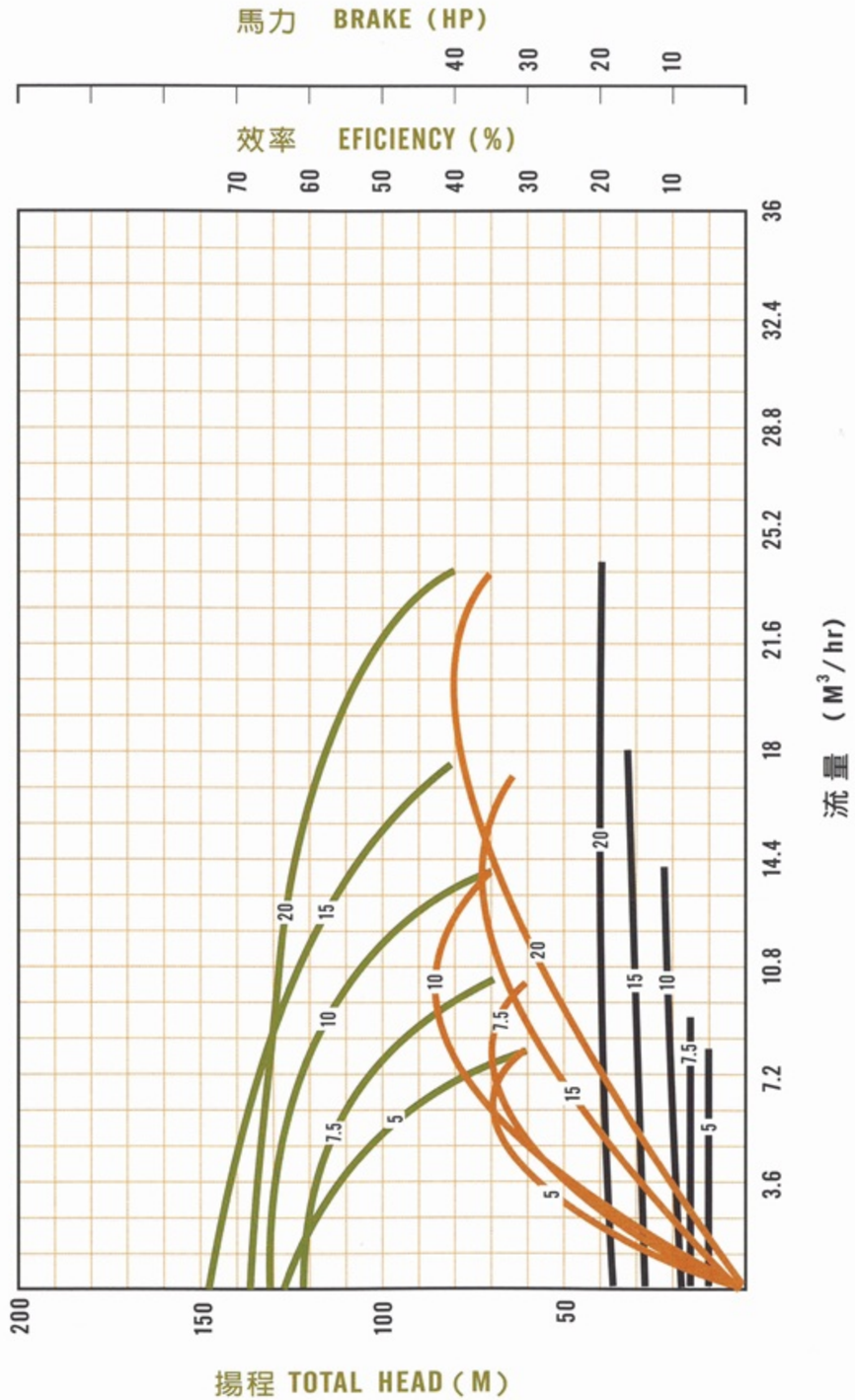
（註七）軟水處理費每一公噸為 9 元台幣，每年節省處理費，不包括人工費。

Notes:

1. Assuming high pressure saturated condensate water (5Kg/Cm^2) is discharged by the steam trap.
2. When using high pressure saturated condensate water (5Kg/Cm^2) in open type recovery system it will cause 11% of condensate loss, however when using in close type condensate recovery system the loss will be 0%.
3. Assuming 24 operation hours a day, 29 days a month, and 12 months a year, total hours about 8400.
4. Assuming the condensate contains 20 Kcal/kg heat at normal temperature of 20°C.
5. CPC fuel priced at NT$16,000 per kilo liter, transportation excluded.
6. Water sold at NT$11 per ton, electricity fee excluded.

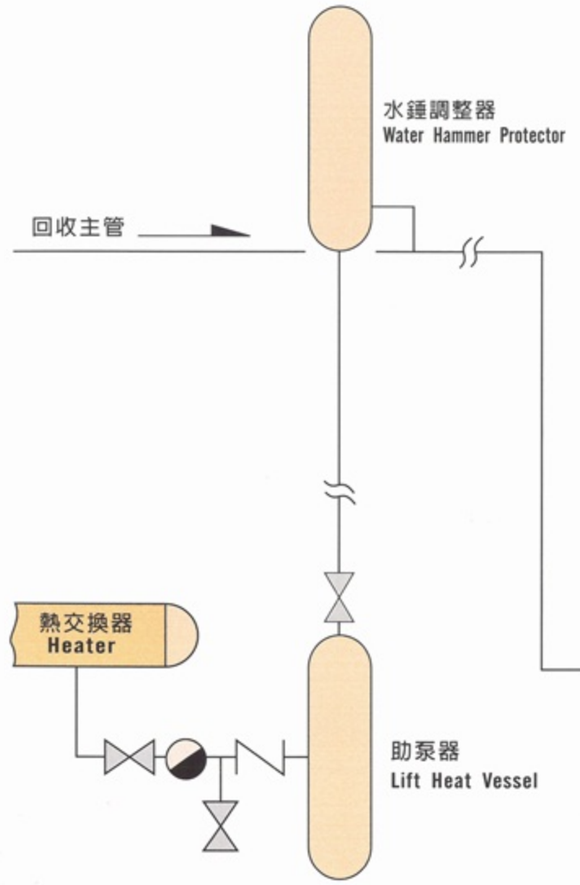
性能曲線圖

DRAWING OF CAPABILITY CURVE



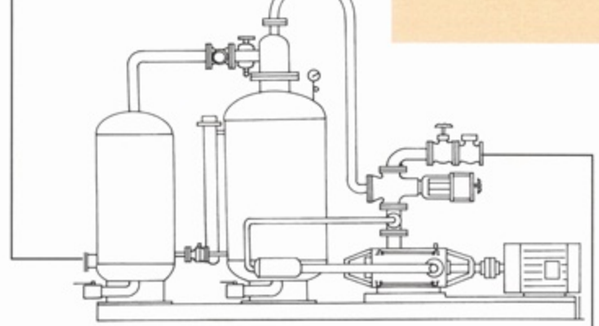
蒸汽冷凝水回收系統概略圖

DRAWING OF STEAM CONDENSATE RECOVERY SYSTEM



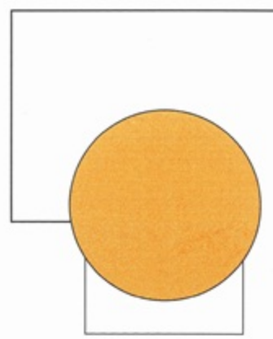
高架回收用揚昇助泵器
Over-head water raiser

水錤消除用調節器
Steam puff regulator



雙槽自吸密閉式蒸汽回收泵浦
Two-tank Auto-inflow Closed Steam Recovery Pump

鍋爐用高溫加壓泵浦
High Temperature Pressure Pump



鍋爐 Boiler

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