Outline explanation of Enepro21 World Edition

U.S. Patent No. US 8,396,605 B2

Overseas version simulation software that contributes to the prevention of global warming.



1. Overview of Enepro21WE

Distributed power generation facility and centralized thermoelectric facility

- New design
- Analysis of existing facility
- Energy saving analysis
- Equipment renewal



[Basic development philosophy]

- 1 Enepro21WE can flexibly respond to high-efficiency system design that matches the energy load characteristics of the region.
- ② The annual operation of existing facility can be accurately reproduced, and this is used as the base case. Being able to make accurate energy-saving diagnoses and propose renewals.
- ③ It should be "general-purpose technology software" that is easy for anyone involved in energy to use.
- ④ Enrich Online-Help, publish formulas, and eliminate black boxes.

[Basic structure]



Setting main requirements

- ① Thermoelectric load, outside air temp., outside air wet bulb temp., chilled / hot water supply temperature and return temperature.
- ② Setting of equipment configuration of thermoelectric facility
- ③ Setting of equipment performance data, environmental load evaluation data, charge data, weather data
- ④ Setting the operation pattern (operation priority) of the equipment

Based on these settings, you can run the simulation accurately on any system built with a typical system flow.

2. Features of Enepro21WE

Features 1. Accurately reproduce existing facility

The annual operation record of existing facility can be reproduced with high accuracy, and the difference between the energy consumption by simulation and the energy consumption of actual facility can be within an error range of 1 to 2%. This can be achieved because the balance calculation of power, heat and flow rate can accurately reproduce the operating state.

In the balance calculation, each energy balance influences each other's equipment, so the balance point is found by the iterative calculation of each balance and the whole iterative calculation through all the balances at the same time.

Balance calculation is calculated in the following order

- 1) Chilled water balance
- ③ Low chilled water balance
- ⑤ High pressure steam balance ⑥ Warm water balance
- \bigcirc Power balance

8 Exhaust heat balance _{CW}

2 Hot water balance

(4) Low Pressure balance

Regarding the balance of chilled water and hot water, not only the heat balance but also the balance of the "flow rate" of chilled water and hot water required for the secondary air conditioner on the building side is calculated to determine the number of chillers required and the load factor.



Features 2. Easily build the optimal thermoelectric system

By incorporating equipment into the general-purpose system flow, you can easily build an optimal system for thermoelectric loads.



In addition, the following items can be freely incorporated into the thermoelectric system to accurately calculate the energy balance.

- 1 Incorporate primary pump system, secondary pump system, free cooling system
- 2 Use seawater, river water, sewage, and groundwater as heat source water or cooling water
- ③ Accepts and balances electricity, chilled water, hot water, steam and hot water from other facilities
- ④ Calculation by incorporating photovoltaic power generation and solar heat utilization into thermoelectric facility
- 5 Flexible operating that combines GE cogeneration and GT cogeneration
 - Power purchase control that does not cause reverse power flow
 - Maximum power operation for the purpose of selling power
 - Thermal main operation according to steam load
- 6 Arbitrarily set the priority of equipment that uses the exhaust hot water discharged from GE You can freely set the heat utilization priority according to the load of Genelink, waste hot water recovery HE, and hot water supply unit.
- \bigcirc Flexible operation of heat storage system
 - Can handle heat storage and heat dissipation at the same time
 - Heat storage operation during nighttime and daytime hours
 - Set the operation of the heat storage unit to 6 patterns of time zones
 - In principle, heat dissipation is the highest priority.
 - You can also perform heat dissipation operation according to the setting of operation priority.

Features 3. Since the operating conditions can be set flexibly, the operation of existing facilities can be accurately reproduced.

- ① Set the operation priority of the equipment for each time zone according to the load pattern.
- 2 The generated power can be set to the following supply destinations.
 - Supply only to the power load of thermoelectric facility
 - · Supply only to the consumer's power load
 - Supply both the consumer's power load in addition to thermoelectric facility
- ③ Automatic COP correction when the chilled water outlet temperature is changed for each refrigerator
- ④ Reflection of capacity decline and COP deterioration due to aging of chiller
- 5 Set the cooling water outlet temp. of the cooling tower monthly
- 6 Set monthly load factor for heat storage of heat storage inverter turbo chiller
- \bigcirc Set the heat storage efficiency of the heat storage tank monthly
- ⑧ Cooling tower fan control settings: constant speed, pole conversion (4P⇔6P, 4P⇔8P), inverter control
- 9 Pump control method settings: constant flow rate control, constant pressure control, control valve control and inverter control
- ① Combined operation of constant flow pump and inverter control pump

Features 4. General-purpose technology software that can be easily used by anyone involved in energy

① System flow diagram enables visual system construction



2 Automatic connection of device data related to the main equipment

The related equipment within the dotted line are automatically connected.chilled water pump, cooling water pump, and attached cooling tower



Automatic pump setting, automatic setting function of attached cooling tower \rightarrow Further reduce user's trouble

Automatic pump setting: Automatic calculation of pump capacity and data input assist function for pump efficiency based on JIS.
 JIS=Japanese Industrial Standards



• Automatic settings for the included cooling tower: Can be set automatically based on equipment download data from the Enepro21 database.

Perform detailed calculation for the cooling tower
_Temp. condition• flow rate of the CCW
The number of CT required 3 unit Number specified
CCW inlet temp. of the CT37 ℃ (37℃~50℃)
CCW Outlet temp. of the CT32 °C (temp. difference between input and output:2.5°C or higher)
CCW flow rate 300 m3/h·台
Outside air wet-bulb temp. 27 °C
Cooling capacity 6279.1 MJ/h• unit
Coolins capacity correction 1
Outside air wet-bulb temp. (°C) 10 20 27 30
Cooling capacity(%) 100 100 100
Coolins capacity correction 2
Inlet temp. of CCW of the CT(°C) 15 25 35 40
Cooling capacity(%) 100 100 100 100
Coolins fan
Power consumption per one fan of the CT(kW) 7.5 kW/unit
Flow rate control
Constant Speed Motor
O Pole change motor
O Inverter mortor Lower limit of rotation speed(commercial) 5 %

- ③ Other auxiliary functions are also enriched
 - Automatic input function of enthalpy from steam pressure



- Output the calculation result in Excel format → Create a report together with the output
 of the graph
- There are many other useful features. For details, see "Enepro 21 operation explanation video".

④ Enepro21 database

It is prepared so that the equipment performance data required for simulation can be easily set.

A huge amount of performance data of more than 8,000 units has been collected from various equipment manufacturers.

5 Detailed online help function

Detailed online help is displayed for each window screen, and input methods and calculation methods are also disclosed.

Gas engine help screen: Display flow model and calculation formula

Content	4.3.6 Calculation expression	
4.3 Gas Engine cogenerator	1) Fuel consumption	
4.3.1 Model System diagram	From Expression 4. 3. 2	
4.3.2 Related devices		
4.3.3 Data input-"Performance · Capacity · number · Fuel etc."	Fuel consumption [Nm 3/h]	
4.3.4 Data input-" Auxiliary power consumption"	$= \frac{\text{KW}[\text{KW}] \times 3.6 [\text{M}]/\text{KW}\text{I}]}{\text{Logarithmatical matrix}} \times 100$	
4.3.5 Data input- "Cooling tower, etc."	Lower fuel nearing value [rif] value] × kwi [roj]	
4.3.6 Calculation expression	F	Expressio
	2) Actual vaporization amount of waste heat boiler	
	Combining Expression 4.3.2, Expression 4.3.3, and Expression 4.3.6, the rated actual vaporization amount of the waste heat boiler can be obtained as follows:	
	Actual vaporization amount [kg/h]	
	kW [kW] × 3600 [k]/kWh]	
4.3 Gas Engine cogenerator	$\Delta H_{S} [k]/kg] + \Delta H_{B} [k]/kg] \times Blow rate [%]/100$	
4.3.1 Model System diagram	× Steam heat recovery rate [%] kW [%]	
	Ey	xpression
Eideust gas	where	A SPACE ANAL
Ethnust Gas Bipass	$\Delta H_{S}[k]/kg] = Steam enthalpy [k]/kg] - water supply enthalpy [k]/kg]$	
Wate Heat Hate Scole Fac	$\Delta H_{B}[k]/kg] = Blowdown water enthalpy [k]/kg] - water supply enthalpy [k]/kg]$	
Boller Supply Water Blue dom Ethout Wear	At a certain electricity generation output (kW), the power generation efficiency and the waste hot water heat recovery ratio can be determined from the load factor and the performance data.	
Exhault Het Water Pure	3) First, the fuel consumption (Nm3/h) is determined by Expression 4.3.9, and the amount of heat recovery from waste hot water is calculated by the following expression.	
Gas Chiled water ouro	Amount of heat recovery from waste hot water First, the fuel consumption (Nm3/h) is determined by Expression 4.3.9, and the amount of heat recovery from waste hot water is calculated by the following exp	pression.
Oil Cooler Hest Exchanger Hot water recovery		
Gas Attached Cooling + Hast sucharger		
Ol Fune		
Supply Water	/n) is determined by Expression 4.5.9, and the amount of near recovery from waste not water is calculated by the following expression. [M]/n]	
00W pume	= Lower ruer nearing value [vi]/vin.j × ruer consumption [vin.j/n]	
	× waste riv neat recovery ratio [%]	
FIG. 4.3.1		

3. Introducing the Enepro21 database

Enepro21 utilization data collection Equipment performance data



Energy Integration Engineering

Epropping WE Equipment utilization data collection

When you download the necessary data from "Enepro21 Utilization Data Collection" and import it into Enepro21WE, various equipment data are automatically set.

When adopting Japanese equipment, it can be used as it is.

When using U.S. equipment, you can download similar equipment, build a system, and use it for prior consideration of what kind of system is good before obtaining accurate equipment performance data from the manufacturer. Once the user obtains the performance data from the equipment manufacturer, the performance data can be overwritten and corrected for simulation to obtain accurate simulation results. In addition, since the required performance data is overwritten, input errors are eliminated. **It radically solves the difficulty for users to obtain data and the time involved in entering data.**

Logout

[Equipment performance screen of inverter turbo chiller data imported to Enepro21WE]

Chilled water supply temperature 7 °C

Chilled water 5 °C heat storage mode performance data

No investor autor refragmente 12		0 8 8
Performance Capacity, Number of Unit, attached, GT [Pure] Cooling method Graph of Orienteriatics of partial load Performance	sense of the attached OT System diarram Performance Case in, Number of unit, attached, OT Furse Cookie, method Graph of Characteristics of partia	al lost Performance of the attached OT System diagram
CW mode (M1) CW storage (M0)	Contraction of the second	
Performance data (Relationship between load factor, CCW temp, and COP)	ection (CW mode)	-COP correction (CW storage mode)
Load factor 10 30 40 50 70 100 % OOP corresponding to 000 for the field of	action based on the CW outlet temp. Image: Common acting active model factor. CCW temp. and CCP no acting CCW temp. COP comesponding to CCW temp. and load factor action based on the CCW flow rate COP comesponding to CCW temp. and load factor no acting CCW temp. COP comesponding to CCW temp. and load factor action based on the CCW flow rate COP comesponding to CCW temp. and load factor in the acting active ratio CCW temp. COP comesponding to CCW temp. and load factor in the acting CCW temp. COP comesponding to CCW temp. and load factor in the acting acting active ratio CCW temp. COP comesponding to CCW temp. and load factor in the acting acting acting active ratio CCW temp. CCW temp. CCW temp. in the acting acting active ratio CCW temp. CCW temp. CCW temp. in the acting acting active ratio CCW temp. CCW temp. CCW temp. in the acting act	COP correction to a storage mode/ COP correction based on the COW flow rate no setting COP correction by arbitrary ratio no setting Detail setup
Design base temp. of OOW is 2210	Design base temp, of COW is 30 10	
Design temperature difference CW HW OCW HW OCW Stop of CCW temp. (%) Temp. of CCW charges according with (a) the temp. data + STO OCW STO Indirect take-out of CW To For the calculation of a rated capacity of pump.	Image: state temp 12 °C Design temperature difference CW CW 7 °C HW 0 °C HW 0 °C COW 5 °C COW 5 °C COW 5 °C OCW 5 °C OCW 7 °C Hereo: take-out of CW 7 °C Indirect take-out of CW 7 °C Por the calculation of a rated capacity of pump. The lower limit temp, of O	the lower limit temp. 12% Data) sp. + a) (seawater temp. + a) COW is applied for from \oplus to \oplus .
OK Cancel Cor	OK Cancel	Comment

Download data flow chart



Capacity / number / attached cooling tower

sumpler of unit and		are a series of the series of										
Number of unit	1											
	Design(kW)				Actual(kW)							
CW mode (M1)	1758				1758 kW	The actual ca	specity is up	ed to calc	ulate num	ber of un	it to be operate	sd.
CW storage (M4)	1758 O Se	t the same ac	tual ability to	or one year	1758 kW							
	(® Se	actual ability	monthly(%)									
		Feb.	Mar.	Acr. May	Jun	Jul. Aue.	Sep.	Oct.	Nov.	Dec. S	MR DD WTR D	D
	100	0 100.0	100.0 1	00.0 100.0	70.0	75.0 100.0	0 70.0	100.0	100.0	100.0	100.0 100.	0
	100	0 100.0	100.0 [1	00.0] [100.0	70.0	75.0 100.0	70.0	100.0	100.0	100.0	100.0] 100.	0
Cepecity and power	consumption per o	o too.o	attached C1	00.0] [100.0	0 70.0	75.0 100.0	0 70.0	100.0	Detailer	100.0 d Settings	[100.0] [100.	o]
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Capacity and power Capacity (MJ/h +u 4131	consumption per o nit) Power cons	ne tan of the mption (kW/ 5 The	attached C1 one fan) required num	ber of operat	ine units is c	75.0 100.0	0] [.70.0]	100.0	Detaile	d Settings no se	100.0 100.	o] ed C1
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Capacity and power Capacity (MJ/h - u 4131) Base wet-bub t Relation between ox Outside ait wet-b	consumption per o nit) Power bons (°C) 2 stake air wet-bub ub temp (°C) [0 100.0 ne tan of the amption (kW/ 5 The 7 1 temp. of atta 10	too.o [1 attached G1 one fan) required num ched CT an 20]	ber of operat d cooling capit 27	0 70.0	75.0 100.0	9 70.0	100.0	Detaile	100.0 d Settings no se	[100.0] [100 s of the attach atting il setup	o] ed C1

[Inverter turbo chiller load factor and COP graph]

Partial load COP characteristics of chilled water 7 °C supply mode and chilled water 5 °C heat storage mode



Cooling water set to 15°C (Chilled water 7 °C mode, heat storage 5 °C mode)

Cooling water set to 20 °C (Chilled water 7 °C mode, heat storage 5 °C mode)

1 COP characteristics of inverter turbo chiller

- Load factor vs. cooling water temp. of 4 points or more Set 6 sets of COP data (1) \sim (6) and set COP characteristics
- Cooling water temperature is constant for each load factor
- As a general rule, the minimum load factor (6) is the lower limit load factor for operation. Normally 20%
- The minimum cooling water temp. is the lower limit temp. for cooling water operation.
- In the case of an inverter turbo, the shape of the COP changes greatly depending on the temperature of the cooling water.

Each load factor vs. COP is regressed with a fourth-order polynomial for each of the six load factors.



[Creating a COP graph for an inverter turbo chiller]

The minimum operating load factor of a chiller is usually 20%. When the load factor is 20% or less, it enters the ON-OFF operation range in actual operation.

On the other hand, in power consumption calculation, it is necessary to calculate even with a load factor of 20% or less, so the ON-OFF operation state is simulated by continuous operation.

If the COP is extrapolated to a load factor of 10% or less, the COP becomes very small and the power consumption calculation may include a large error. Therefore, the COP is assumed to be constant when the load factor is 10% or less.

In the power consumption calculation, select two regression equations that sandwich the temperature of the refrigerator cooling water at the time of calculation. The COP of the cooling water temperature is calculated by interpolation from the two COP values at the load factor during that period.



[Inverter turbo chiller COP graph]

⁽²⁾COP characteristics of turbo chillers, absorption chillers, etc.



COP at reference temperature

COP and cooling water

- Since the minimum operating load factor of a chiller is usually 20%, an ON-OFF operation is entered in actual operation at a load factor of 20% or less. On the other hand, when calculating power and gas consumption, it is necessary to calculate even with a load factor of 20% or less. The ON-OFF operation state is simulated by continuous operation, and the COP at that time is extrapolated to 20% or less of the regression equation.
- However, extrapolating the COP to a load factor of 10% or less results in a very small COP and a large error in calculating power and gas consumption. A COP is considered constant if the load factor is 10% or less, as it may contain errors.
- The COP-cooling water temperature characteristic approximation method is created based on four points using a regression equation of a quadratic polynomial.
- From these two formulas, the operating COP of the unit is determined from the cooling water temp, and the load factor of the unit.

[Environmental load data loaded into Enepro21]

Primary energy •Environmental load coefficient	
Electricity reserved Daytime Nighttime Converted HHV of primary energy(kJ/kWh) 9760 9760 CO2 emission intensity (kg-CO2/kWh) 0.505 0.505 SOx emission intensity (g-SO2/kWh) 0 0 NOx emission intensity (g-NO2/kWh) 0 0 Equivalent value to Orude Oil (I/kWh) 0 0	
Gas CO2 emission intensity (kg-CO2/Nm3) SOx emission intensity (g-SO2/Nm3) 0 NOx equivalent to fuel(g-NO2/Nm3/ppm) 0 Equivalent value to Crude Oil (I/Nm3)	Heavy oil \bigcirc kg-CO2/kg Input unit of CO2 emission intensity \bigcirc kg-CO2/kg CO2 emission intensity(kg-CO2/l) 0 SOx emission intensity (g-SO2/kg) 0 NOx equivalent to fuel (g-NO2/kg/ppm) 0 Equivalent value to Crude Oil (I/l) 0
Kerosene O kg-CO2/kg Input unit of CO2 emission intensity Input unit of CO2 emission intensity CO2 emission intensity(kg-CO2/l) 0 SOx emission intensity (g-SO2/kg) 0 NOx equivalent to fuel(g-NO2/kg/ppm) 0 Equivalent value to Crude Oil (I/l) 0 Make-up water/Waste water 0	Other oil Input unit of CO2 emission intensity \bigcirc kg-CO2/kg Input unit of CO2 emission intensity \bigcirc kg-CO2/l CO2 emission intensity(kg-CO2/l) 0 SOx emission intensity (g-SO2/kg) 0 NOx equivalentto fuel (g-NO2/kg/ppm) 0 Equivalent value to Crude Oil (l/l) 0
CO2 discharge coefficient of Make-up water (t-CO2/m3) 0.000000 CO2 discharge coefficient of Waste water (t-CO2/m3) 0.000000	Equivalent value to the generated electricity (daytime)(MJ/MWh) 9760 Equivalent value to the generated electricity (nighttime)(MJ/MWh) 9760 (Note) For the calculation of the COP of system.

③Electricity charge data ④Gus charge data

[Electricity / gas charge form on Enepro21WE]

Note) Japanese rate form

😨 Utility cost - [Thermoelectric facility]		Utility cost - [Thermoelectric facility]
Electricity rates-1 Electricity rates-3 Electricity rates-4 Fuel rates Water Heatl rates		Electricity rates=1 Electricity rates=3 Electricity rates=4 Fuel rates Water+HeatI rates
Contract of high and extra-high voltage electricity Unit price of basic charge 1782 Yen/kW·month Contracted electricity 1350 kW (1) \sim	Comment Power company 東京電力 Type of contract 高庄季節別時間帯別電力(6kV)	Gas rates Definition of summer period 4~11 month **Summer period is normally from April to November. Fixed basic charge for summer period 0 Yen/Month Fixed basic charge for summer period 0 Yen/Month
Power factor 980 % Jan ~ Mar Apr ~ Jun Enersy charse 18.98 18.98 20.12 18.98 Yen/kWh	Remark ・電気需給約款・料金表[特定規模需要(特別高圧、高圧)] 平成28年4月1日実施から抜粋 ・再生可能エネルギー発電促進観課全単価は平成30年5	Basic flow rate energy charge for summer period 0 Yen/Nm3/h*month Basic flow rate energy charge for winter period 0 Yen/Nm3/h*month Mafximum usage amount by contract 0 Nm3/h
Contract of electricity by season and by time zone Unit price of basic charge 1782 Ven/kW: month Contracted electricity 1350 kW (1 ~ 12 month) 0 kW (0 ~ 0 month)	月~平成31年4月に適用 ・ENEPROの従量料金は上記の単価初順して取り込まれ る Type of electricity contract	Period (month) 1~12 0~0 0~0 0~0 Energy charge for summer period 85 0 0 0 Ven/Nm3 Energy charge for winter period 85 0 0 0 Ven/Nm3
Power factor 98 % ☑ Setup of peak-be 13 ~ 16 o'clock Iar Apr ~ Jun Jul ~ Sept Oct ~ Dec 5 19.65 21.1 19.65 Yen/kWh 4 15.44 15.44 Yen/kWh	 High · Ultra-high voltage electricity Electricity by seasonal hour Hour electricity Calculates the utility cost for the selected Type of electricity contract. 	Fuel oil rate Period (month) 1 - 12 0 - 0 0 - 0 0 - 0 Heavy oil 0 0 0 0 0 Ven/I Kerosene 0 0 0 0 0 Ven/I Others oil 0 0 0 0 Ven/I
peak-hour 21.75 W Energy charge on Sunday and holiday is calculated by using the nighttime energy charge of the month. Energy charge is fixed in summer (July~September) **Summer design date are the same as August, winter design date are the same as January	Addition of optional clause Contract of peak-hour adjustment Contract of reserve electricity Contract of heat storage adjustment/Thermal storage tank capacity discount Supplied power by independent electricity plant Ancillary service	type ner design date are the same as August, winter design date are the same as January
OK Cancel Save to file Read fr	om file	OK Cancel Save to file

[Outside air temperature / outside air wet-bulb temperature data read into Enepro21WE]

🚻 Temperat	ure data													
Hour	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	SMR DD	WTR DD
Average	5.8	6.1	9.7	14.3	19.4	22.8	27.1	28.6	25.0	19.4	13.8	7.9	29.5	2.9
0-1	4.1	4.8	7.9	12.1	17.2	20.8	25.2	26.7	23.3	18.0	12.3	6.3	27.1	1.3
1-2	3.7	4.3	7.3	11.6	16.9	20.5	25.0	26.5	23.0	17.6	11.9	6.0	27.0	1.5
2-3	3.3	3.7	6.8	11.2	16.6	20.3	24.8	26.2	22.7	17.3	11.5	5.6	26.8	1.2
3-4	3.0	3.4	6.4	10.9	16.3	20.2	24.6	26.1	22.5	17.1	11.2	5.4	26.5	1.4
4-5	2.8	3.1	6.2	10.7	16.1	20.1	24.4	25.9	22.3	16.8	11.0	5.2	26.3	1.5
5-6	2.6	2.9	6.0	10.6	16.5	20.4	24.7	26.1	22.2	16.6	10.9	5.0	26.5	1.3
6-7	2.8	2.9	6.5	11.5	17.5	21.1	25.5	26.8	22.9	17.0	11.0	4.9	27.3	1.6
7-8	3.2	3.5	7.5	12.7	18.7	22.0	26.5	27.8	23.9	17.8	11.7	5.6	28.2	1.9
8-9	4.2	4.6	8.8	14.1	19.9	23.0	27.5	28.9	25.1	18.8	12.7	6.9	29.3	2.5
9-10	5.4	5.5	10.1	15.4	21.0	23.9	28.7	30.0	26.0	20.0	13.8	8.2	30.1	2.9
10-11	7.0	7.0	11.4	16.5	21.9	24.7	29.4	30.8	26.8	21.0	15.3	9.6	31.5	4.5
11-12	8.3	8.0	12.3	17.4	22.5	25.3	30.0	31.4	27.7	21.8	16.3	10.8	32.5	5.1
12-13	9.1	9.0	13.2	18.0	23.0	25.7	30.3	31.8	28.2	22.3	16.9	11.4	32.8	5.9
13-14	9.5	9.5	13.2	18.1	23.0	25.8	30.3	31.8	28.0	22.3	17.1	11.6	33.0	6.3
14-15	9.3	9.4	13.2	17.8	22.5	25.6	29.9	31.4	27.8	22.1	16.9	11.2	33.1	5.8
15-16	9.0	9.4	13.0	17.5	22.0	25.2	29.5	30.9	27.5	21.9	16.5	10.7	32.6	5.1
16-17	8.4	8.9	12.4	16.9	21.5	24.8	28.9	30.4	26.8	21.3	15.8	9.9	32.1	4.2
17-18	7.8	8.2	11.7	16.1	20.7	24.2	28.2	29.7	26.0	20.6	15.3	9.3	31.1	3.4
18-19	7.1	7.5	11.1	15.3	19.9	23.4	27.4	28.9	25.4	20.0	14.8	8.9	29.9	2.7
19-20	6.6	7.0	10.6	14.7	19.4	22.8	26.8	28.4	24.9	19.5	14.4	8.5	29.1	2.2
20-21	5.9	6.5	10.0	14.2	18.9	22.3	26.4	28.0	24.5	19.1	13.9	7.9	28.8	2.0
21-22	5.4	6.1	9.5	13.7	18.5	22.0	26.1	27.7	24.2	18.8	13.4	7.5	28.7	1.5
22-23	5.0	5.7	9.0	13.3	18.1	21.6	25.9	27.3	23.8	18.5	12.9	7.0	28.5	1.5
23-24	4.5	5.3	8.5	12.9	17.7	21.3	25.6	27.0	23.5	18.2	12.6	6.5	28.4	1.4
Outside air	temperature	e Outside	air wet-bu	lb temperat	ure 河川;	水 tempera	ture 海水	temperatu	ure					
ОК		Calcel	Ca	alc WBT fro	m relative	humidity					s	Save to file	Read	d from file

4 Calculation execution and output

[Sample model system configuration (Complex building with a total floor area of 100,000 square meters)]



5. Countermeasures for improper settings

[View warning messages]

If the settings are incorrect or missing, a warning message will be displayed. The warn function prevents you from doing the wrong simulation.

Case Study 1. Entered equipment priority and forgot to set outlet temperature



Case Study 2. If the same equipment is set to equipment priority

Power generation Boiler daytime(1) Power generation Boiler daytime(2) Power generation Boiler daytime(3) Power generation Boiler nighttime(1) Power generation Boiler nighttime(2) Power generation Boiler nighttime(2)	
CW HW for daytime CW HW for nighttime CW heat storage HW heat storage LCW heat storage Receiving thermal brine and electricity Supply thermal brine and electricity Pump operation	
Determine the order of priority of operation for daytime.	
Daytime(1) 8 Hour~ 22 Hour 1 2 3 4 5 Warning	×
CW unit priority Heat storage take-out Inv. TR1-M1 Inv. TR2-M1 HP1-M1 Inv. TR1-M1 A	
Control temp. of CW outlet 7 7 7 7	
HW unit priority Daytime The priority order for CW : IVR1_M	l overlaps
Control temp of HW outlet	•
LCW unit priority	
Control temp. of LCW outlet	
OK	

Case 3. When there is an abnormality in the set temp. difference of the unit

Show warn for anomaly settings at the start of output calculation

				S Inverter turbo refrigerator (1)		
				Performance Capacity, Number of unit, attac	hed CT Pump Cooling method Graph of Characteristics o	of partial load Performance of the attached CT System diagram
Output menu				CW mode (M1) CW storage (M4)	d factory COW towns and COD)	
				Performance data (Relationship between loa		COP correction based on the CW outlet temp.
Calculation menu by hour Annual calculation menu				Load factor 10 30	40 50 70 100 %	no setting
All check is off	All check is off	August	All check is off	CCW temp. COP corresponding to CCW	temp. and load factor	no setting
Elec. balance	January	✓ Pattern1 - numbe	r of day(23 days)	15 m 8.76 16.93	17.88 17.57 15.01 10.69	COP correction by arbitrary ratio
Sale of all solar generated power	February	🗌 Pattern2 – numbe	of day(8 days)	20 m 4.53 10.11	11.33 11.79 11.17 8.92	
HP steam balance	☐ March			25 °C 2.88 6.93	8.03 8.63 8.7 7.54	
LP steam balance	🗖 April			29 °C 2.17 5.43	6.42 7.01 7.32 6.66	
Fuel consumption	I May			32 °C 1.81 4.64	5.54 6.12 6.52 6.1	
Make-up water amount/waste water amount	🗖 June					
CW balance	🗖 July			When the COW temp, is below zero 'C, it is % Set up the COW temp, order of lower to high	understood that data is not input. ier from the top column.	
HW balance	AugustPattern(1)					
Warm water supply balance	Septen			Design base temp. of CCW is 32 °C		
LCW balance	C Octobe		^			
Number of unit in operation	Novem ⁶ The design t	emperature difference of IVP1 M1	is incorrect. The calculation was interrupted	ow Algo	Setup of CCW temp. ("C) Temp. of CCW changes according with	
Power consumption	Decem 🔀 me design te	superature unerence of twist_with	is inconect. The calculation was interrupted	HW Ol %	(α)	above the lower limit temp
Details of power consumption	🗆 SMR dé					
Utility cost	🗁 WTR de	OK		CW storage 0 °C		
		UK		Indirect take-out of CW 0 °C		
				For the calculation of a rated capacit	The design te	mperature
					difference of chi	llad water is O
					unreferice of chi	neu water IS U

Case 4. When the capacity and number of units are insufficient for the load

Without stopping the annual calculation, the unit set at the end of the priority is automatically started and balance calculation continues.

The time zone when it starts automatically is described as a warn on the right side.

After completing the annual calculation, it is possible to modify such as adding unit according to this warn or changing the capability of the unit.

LP steam balance Mar. Pattern1 days 20: calculating Fuel consumption Mar. Pattern2 days 11: calculating Make-up water amount/waste water amount Apr. Pattern2 days 10: calculating	
CW balance May Pattern1 days 21: calculating May Pattern2 days 10: calculating	
HW balance	
Warm water supply balance Jun. Pattern2 days 9: calculating	
LOW balance	
Power consumption Aug. Pattern1 days 23: calculating	
Details of power consumption 17o'clock: the number of Air-cooled heat pump (3) automatically increas	ed.
Utility cost	8 0 .
Primary energy/Environmental load summary Sep. Pattern1 days 18: calculating	
System COP/CO2 emission intensity	
Maximum values table	
The second data was a second and the second data was a concerning was a co	

6. How to use Enepro21WE

Familiarize yourself with Enepro21WE and think about various ways to prevent global warming. (1) Analysis of existing thermoelectric facility

Create an annual load pattern based on one-year operation data

Analyze the performance of the equipment, enter the current performance, and enter the information of the actual equipment operation pattern in the created annual load.

Simulate annual energy consumption

• The difference between the simulation result and the actual energy consumption can be reproduced within an error range of 1 to 2%.

• Equipment performance and operation patterns accurately reflect the actual operation of thermoelectric facility

• This case file that reproduces the current situation will be the base case for energy conservation measures and system improvement studies.

2 Re examination of equipment operation method

- ① By comparing the result of the base case reproduced in (1) with the simulation result with various settings changed, the following examination can be performed.
 - Is the equipment properly allocated to the load?
 - Are equipment with different capacities operated in the proper sequence of operations?
 - Is the operation considering the relationship between the cooling water temp. and the unit efficiency and the relationship between the outlet temp. of the unit and the load factor?

3 Consideration of facility renewal



Simulation results by exchanging with equipment scheduled to be renewed

> The performance comparison of the equipment alone cannot accurately reflect the operating conditions of the entire thermoelectric facility, and the partial load characteristics, cooling water temperature dependence of performance, internal power, etc. cannot be evaluated correctly. Therefore, there is a big difference between the energy consumption calculated by the equipment alone and the actual consumption.

4 Verification after equipment renewal

Simulation of operation for one year after equipment renewal Replace only the renewed equipment with the old one Simulate operating for one year

You can quantitatively calculate the difference in energy consumption

<u>(5)</u> Examination of optimum operating and utilization for training of operators

You can consider the optimum operation of thermoelectric facility by following the steps below. It can also be used to improve the skills of operators and to train them in operation.

- 1) Create the actual thermoelectric load for the week. Since the thermoelectric load program can set 8 patterns of load per month, input the load for 1 week in order from pattern 1 to pattern 7 on the set date.
- 2) Connect the thermoelectric load program created in 1) to the case file created in advance in the base case.
- 3) Set the actual equipment operation pattern and operation parameters for each pattern (setting date).
- 4) Perform a simulation for each pattern (set date) and compare the energy consumption on the set date with the simulation results to confirm that they almost match. If there is a large difference, check that there is no difference in the operation pattern and parameter settings of the equipment, and correct it if necessary.
- 5) It is possible to find improvement measures for operation by changing the operation pattern and parameters of the equipment for each pattern (setting date), performing a simulation, and comparing and examining the actual operation results.

7. Enepro 21 License Achievements and Patents

① Approved by the Ministry of Land, Infrastructure, Transport and Tourism

Enepro21" is recognized as accurate simulation software by "Guidelines for calculating primary energy" when planning new construction and large-scale renewal of thermoelectric facility.

2 License record

Enepro21 has been used by major Japanese companies such as major design companies, energy companies, heat supply companies, equipment manufacturers, universities since 2008, and these companies will greatly benefit from the design and analysis results by Enepro21.

- Nihon Sekkei.INC. Nikken Sekkei Ltd Kanden Energy Solution Co., Inc.
- International Petroleum Development Co., Ltd. Tokyo Gas Co., Ltd.
- Tokyo Gas Engineering Solutions Co., Ltd., Kyudenko Toho Gas Co., Ltd.
- Daigas energy Co., Ltd. Tokyo Heat Supply Co., Ltd. Shinjuku Minami Energy Service)
- OSAKA GAS CO.,LTD Takenaka Co., Ltd.
- Mitsubishi Electric Co., Ltd(Advanced Technology R&D Center)
- Shibaura Institute of Technology Yokohama National University Kogakuin University

3 Patent

Obtained domestic patent and US patent

Name "Simulation system for thermoelectric facility"

U.S. patent : US 8,396,605 B2

Award history

- 22nd SME Excellent New Technology / New Product Award Software department Received "Excellence Award" and "Environmental Contribution Special Award"
- 7th Air Conditioning and Sanitary Engineering Society Promotion Award "Technology Promotion Award"

Engineering for Tomorrow

with Enepro21World Edition

