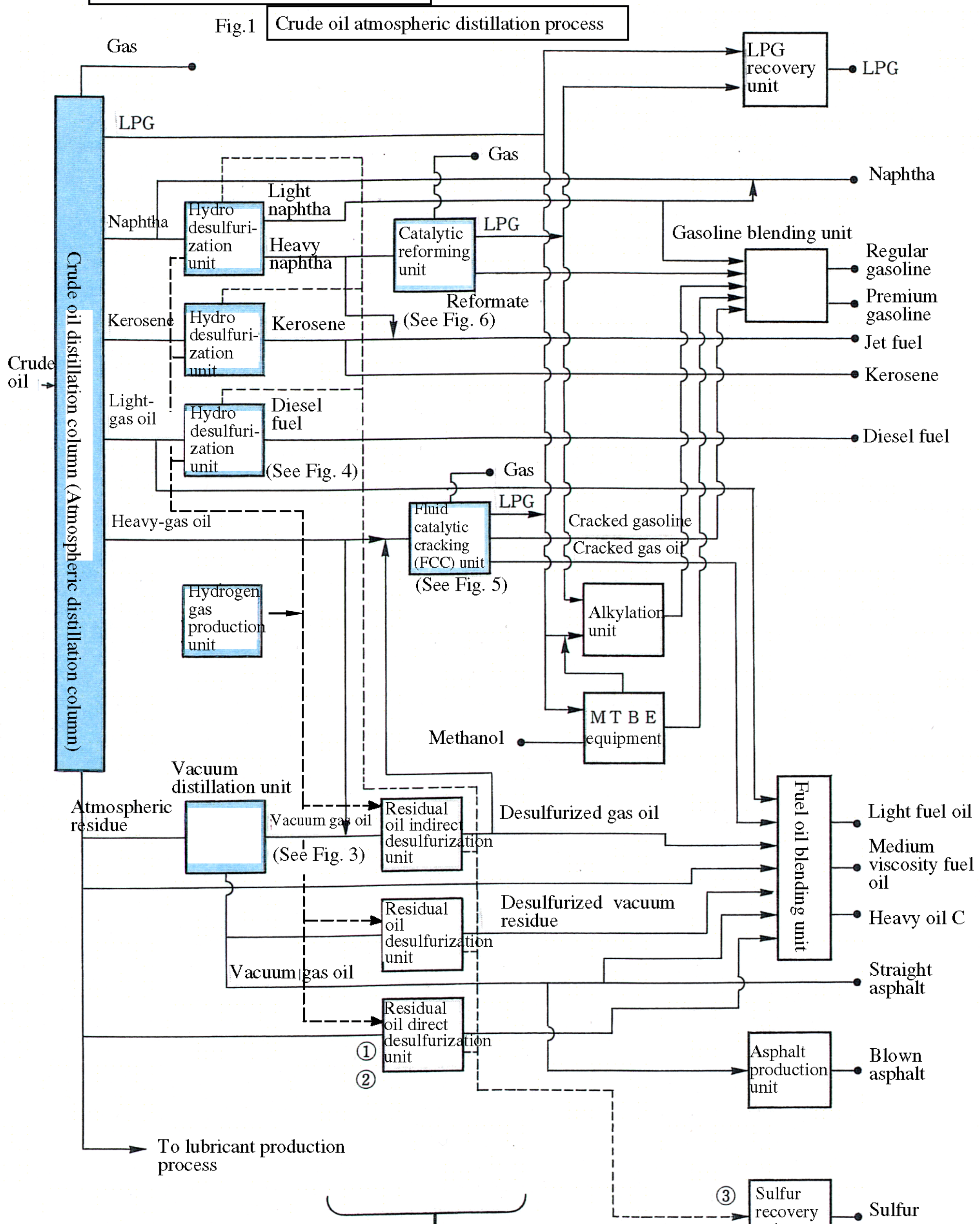
Section 4 :
Oil Refining Industry

Process Flow
Data Sheets

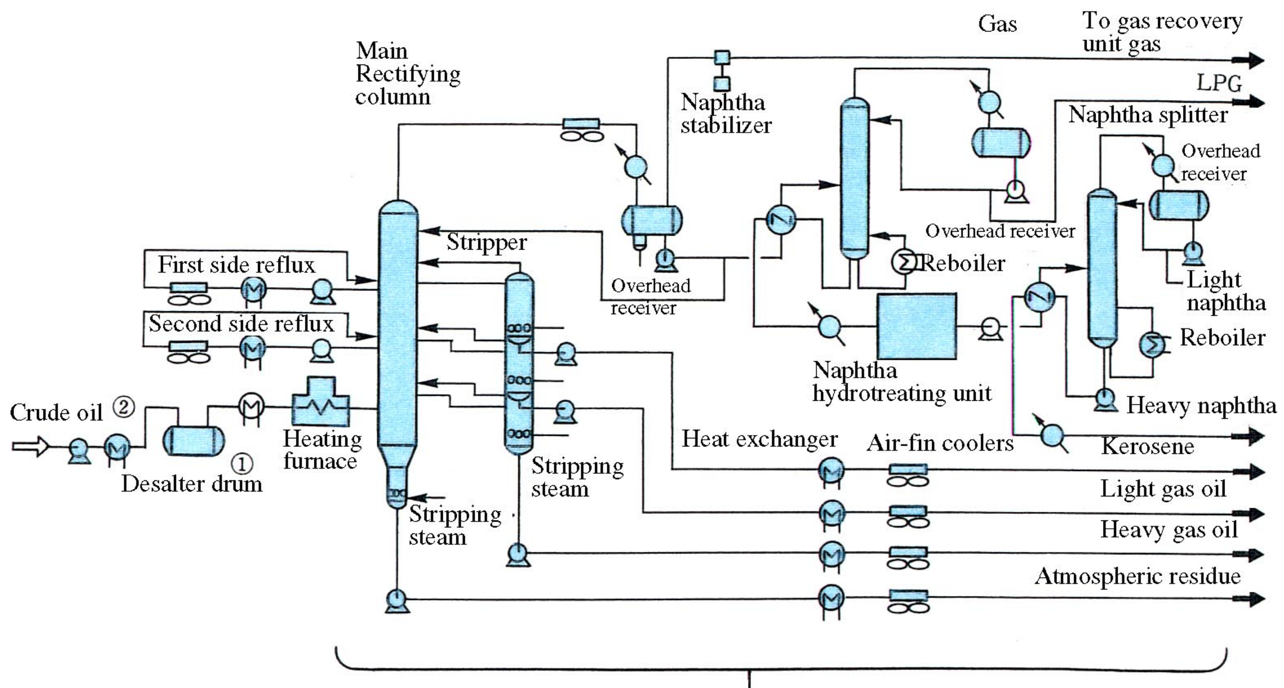
Oil Refining : Production Process and Energy Saving Technology (No.1)

Fig. 1 Entire oil refining process



Item No.	Technology Item/Title
OR-ME-5	Oil refining unit: Installation of a side reboiler on a distillation column in the petroleum refining process
OR-ME-6	Petroleum refining unit: Installation of a membrane separator for hydrogen

Fig. 2 Crude oil atmospheric distillation process



Item No.	Technology Item/Title
OR-OM-2	Atmospheric crude oil distillation column: Recovery of waste heat of heavy gas oil
OR-OM-11	Petroleum refining process: Rearrangement of heat exchangers of a distillation plant

Facilities common to all manufacturing industries

Item No.	Technology Item/Title
OR-ME-5	Oil refining unit: Installation of a side reboiler on a distillation column in the petroleum refining process

Oil refning facilities

Item No.	Technology Item/Title
OR-OM-4	Vacuum gas oil desulfurization unit: Improvement of heat recovery system

Hydrogen generation unit

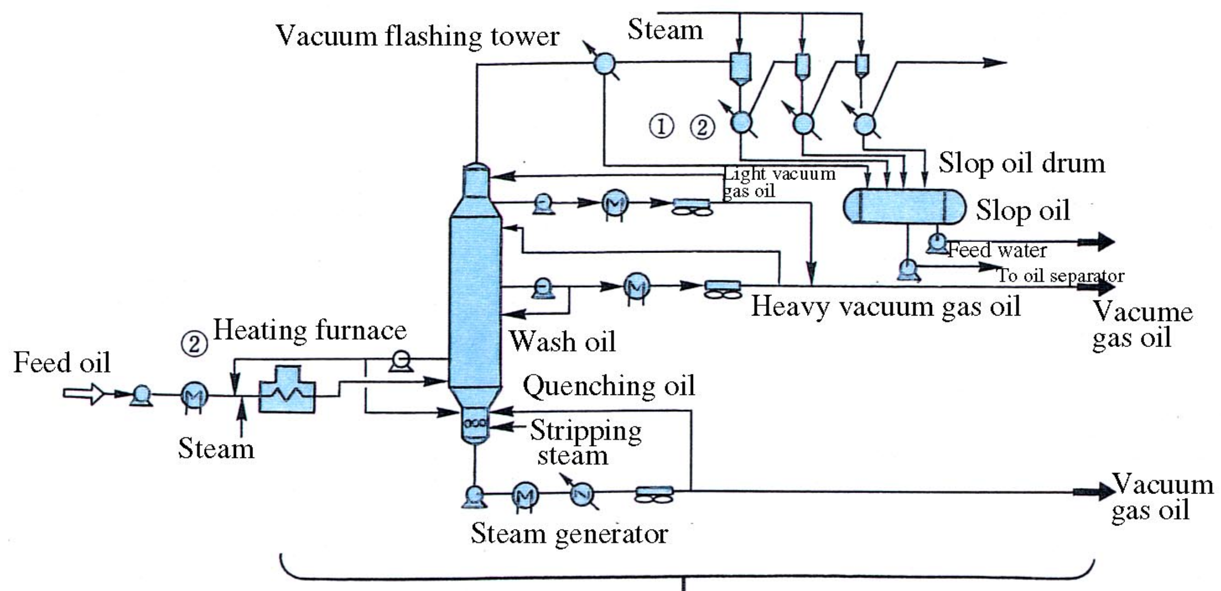
Item No.	Technology Item/Title
OR-ME-6	Petroleum refining unit: Installation of a membrane separator for hydrogen
OR-OM-14	Hydrogen production unit: Computer-controlled reduction of surplus hydrogen
OR-OM-12	Hydrogen production unit:Reduction of steam/carbon ratio

Fuel gas system

Item No.	Technology Item/Title
OR-OM-15	Petroleum Refining Process: Flare Gas Recovery System
OR-OM-16	Increased concentration of amine solution in the off-gas desulfurizing process

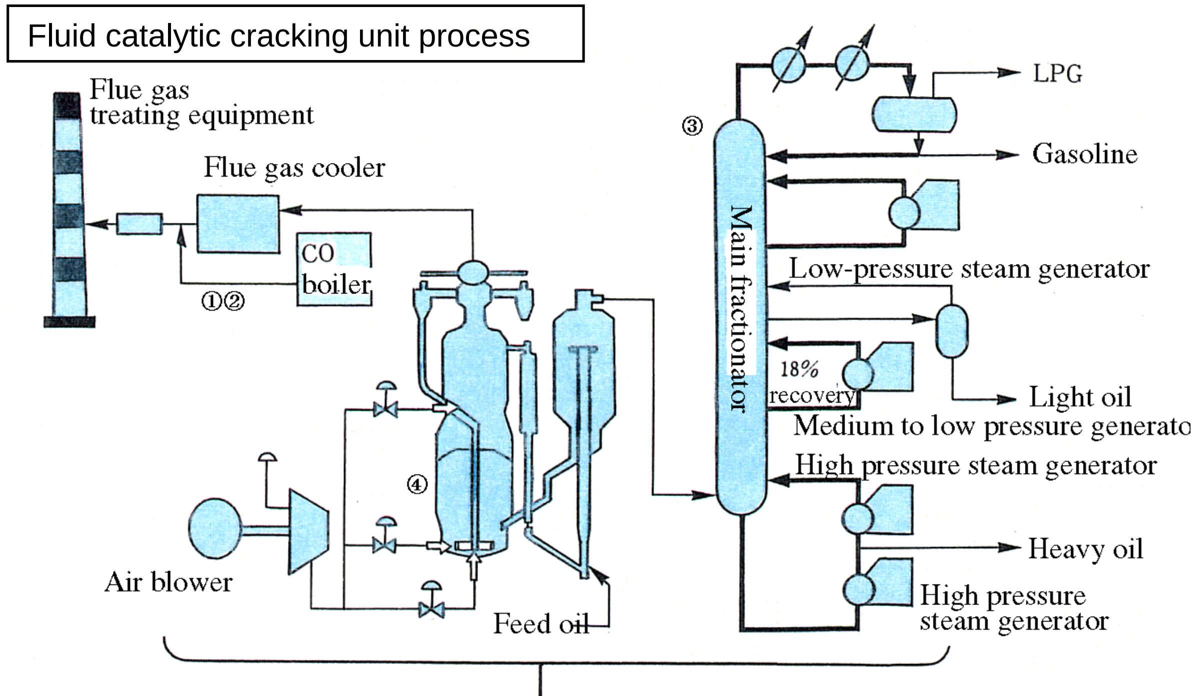
Oil Refining : Production Process and Energy Saving Technology (No.2)

Fig. 3 Vacuum distillation unit process



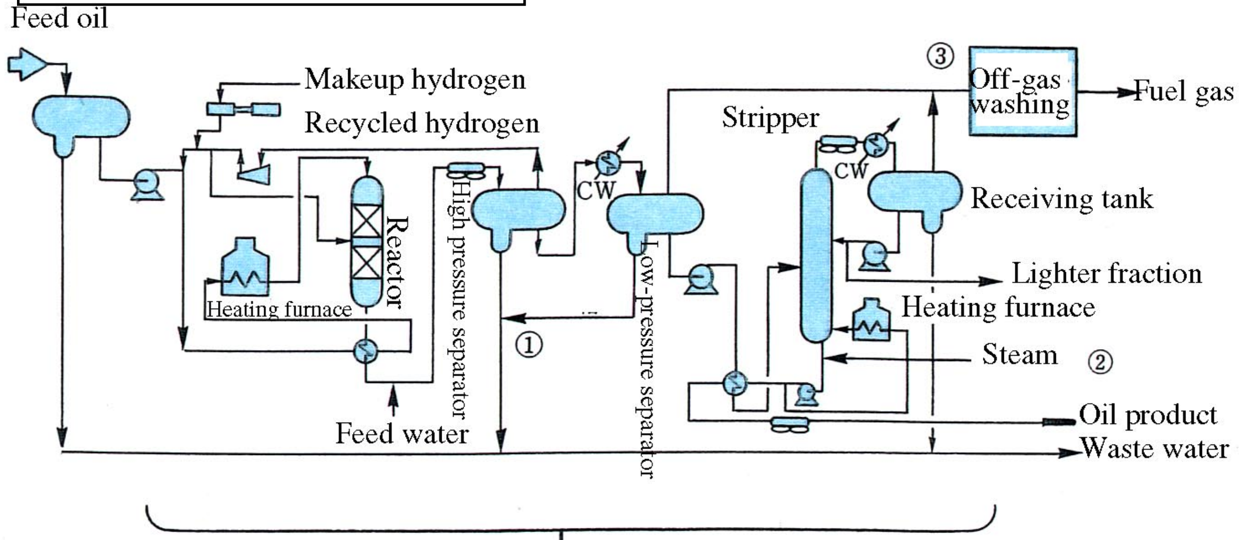
Item No.	Technology Item/Title
OR-ME-1	Vacuum distillation unit: Reduction of injection steam by recycling overhead steam
OR-OM-1	Vacuum distillation unit: Hot charge to the vacuum distillation unit
OR-OM-3	Vacuum distillation unit: Recovery of waste heat of the overhead vapor

Fig. 5 Fluid catalytic cracking unit process



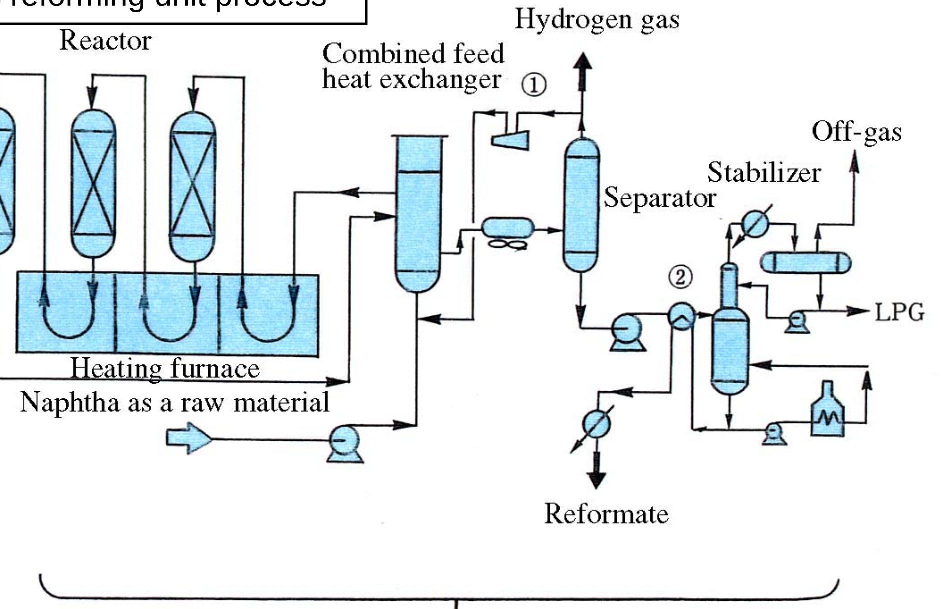
Item No.	Technology Item/Title
OR-ME-2	Fluid catalytic cracking (FCC) unit: Power recovery system (1)
OR-ME-3	Fluid catalytic cracking (FCC) unit: Power recovery system with humid steam condensing turbine (2)
OR-OM-7	Fluid catalytic cracking (FCC) unit: Improvement of heat recovery by modification of operating conditions of the main fractionator.
OR-OM-8	Fluid catalytic cracking (FCC) unit : Energy saving by reducing the pressure inside the regeneration column

Fig. 4 Hydro-desulfurization unit process



Item No.	Technology Item/Title
OR-OM-4	Vacuum gas oil desulfurization unit: Improvement of heat recovery system
OR-OM-13	Hydrodesulfurization process: Effective utilization of steam
OR-OM-17	Vacuum gas oil desulfurization unit: Reduction of steam supply to the reboiler for the amine regenerator

Fig. 6 Catalytic reforming unit process



Item No.	Technology Item/Title
OR-OM-9	Oil refining process: Reduction of the quantity of the recycled gas in the reforming unit
OR-OM-10	Catalytic Reforming Unit: Energy Saving by Low-pressure Operation of Distillation Columns

OR-ME-1

Energy Conservation Directory

[Industry Classification] Oil Refining	Vacuum distillation unit	[Energy Source] Fuel (Steam)
[Technology Classification] Machinery & Equipment	Reduction of injection steam by recycling overhead steam	[Practical Use] 1979

Outline

Steam is injected into the atmospheric distillation column to reduce the partial pressure of lighter fractions. The injected steam goes to the overhead condenser as overhead steam to be condensed to waste water. This modification recycled the injected steam back to the distillation column by means of an injector, thereby achieving energy saving.

Principle & Mechanism

[Function of steam ejector (thermo-compressor)] (Refer to Fig. 1.)

The steam ejector generates vacuum inside the body by injecting high-pressure steam (driving steam) at a high velocity from nozzles and induces the low-pressure steam (supply steam) which is used as recycled steam in this case.
This enables the hitherto unused and discharged low-pressure steam to be pressurized and reused.

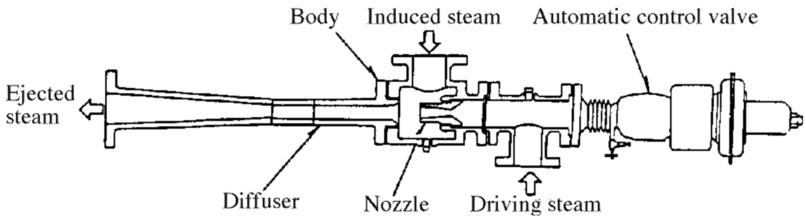


Fig. 1 Structure of the ejector (Thermo-compressor)

[Description] Structure explanation, Shape, and/or System diagram

1) Generally, less than 30 percent of the steam used is injected into the furnace heater coils and more than 70 percent is injected into the tower bottom.
2) By recycling the overhead steam by means of an ejector, steam injection is reduced by 15 tons per hour at 100,000 BPD throughput.

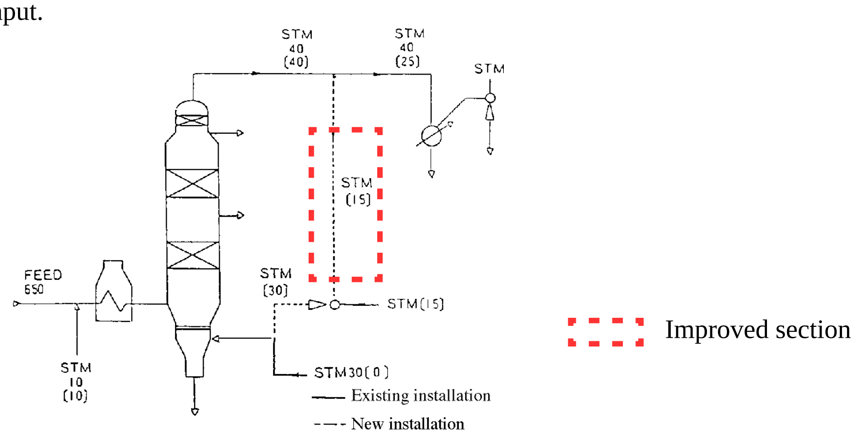


Fig. 2 Flow scheme of steam recycling system of the vacuum distillation column

Energy saving effects

Table 1 Energy saving effects (100,000 BPD throughput base)

	After improvement	Note
Steam consumption	Reduction of 105,000 t/y (15 tons/hour)	(Operating hours: 7,000 h/y)
Crude oil equivalent	Reduction of 8,562 kL/year	

[Economics] Equipment cost

Investment amount (A): 100 to 150 million yen
Improvement effect (B): 170 million yen/year
Investment payback (A/B): 1 year

Remarks

[Example sites]	[References]	[Inquiry]
Employed at many sites	Energy Saving Journal, (Vol. 32 No. 7, 1980), p85	ECCJ(JIEC) / Petroleum Association of Japan

OR-ME-2

Energy Conservation Directory

[Industry Classification] Oil Refining	Fluid catalytic cracking (FCC) unit	[Energy Source] Steam
[Technology Classification] Machinery & Equipment	Power recovery system (1)	[Practical Use] 1995

Outline

The flue gas, or coke combustion gas (containing CO at a high content), generated from the regenerator of a fluid catalytic cracking (FCC) unit of petroleum refining process, is normally sent to a CO boiler after pressure reduction using a pressure-reducing valve and pressure-reducing orifice. The present technology recovers a portion of the pressure energy of this gas in the form of power by installing an expander turbine for pressure reduction. The flue gas, after being de-pressured by the expander turbine, is sent to the CO boiler for combustion.

Before Improvement

The coke (CO gas) required for 10,000 BPD production is from 3 to 6 tons. From 11 to 14 kilograms of air is required for combustion of one kilogram of coke. The power required for feeding this combustion air accounts for more than 50 percent of the entire power requirement of the FCC unit.

[Description of Improvement]

Structure explanation, Shape, and/or System diagram

[The gas expander installed in the FCC unit]

1) As is shown in Fig. 1 below, the gas expander turbine is connected with the air blower and a steam turbine on the same axis.
2) The coke combustion gas discharged from the regenerator has a pressure from 1.5 to 3.0 Kg/cm^2 g and temperature from 620 to 730˚C. This flue gas is sent to a CO boiler where its CO content is burned to recover heat energy in the form of steam.

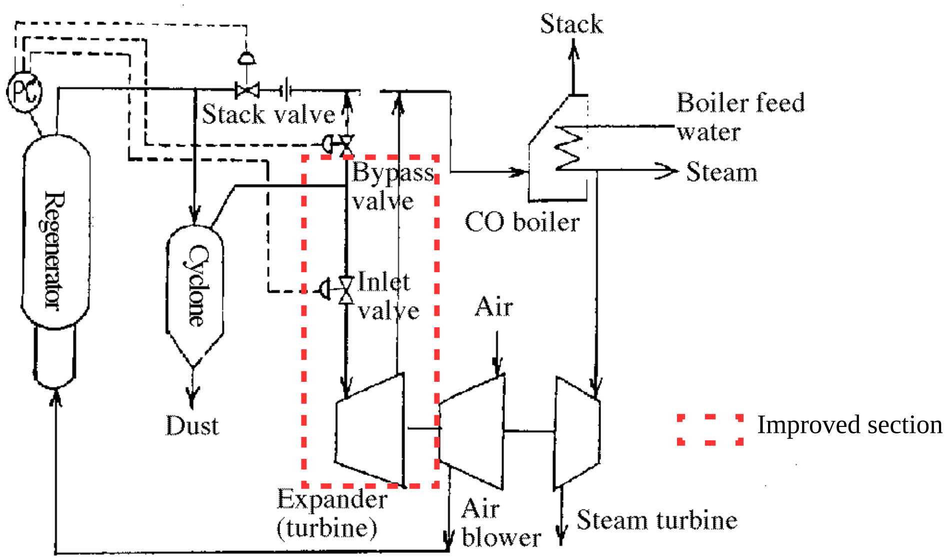


Fig. 1 Flow scheme of FCC gas expander system

Energy saving effects

Table 1 Energy saving effects of the FCC gas expander turbine

	Before installation	After installation
Generation capacity (35,000 BPD)	-	7,000 kW
Annual generation capacity (8,000 hour/year)	-	56,000 MWh
Crude oil equivalent	-	Reduction of 13,600 kiloliters/year

[Economics] Equipment cost

Investment amount (A): 1,800 to 2,300 million yen,
Improvement effect (B): 840 million yen/year
Investment payback (A/B): 2.5 years

Remarks

This technology was trial-tested on a commercial plant in December 1995 at Shengli State Refinery, Shantung Province of China, by the New Energy and Industrial Technology Development Organization as a Model Project for Power Recovery and proved to be effective.

[Example sites] Installed at many sites	[References] PETROTECH (1980) Vol 3, No. 10, P913	[Inquiry] ECCJ (JIEC) / Petroleum Association of Japan

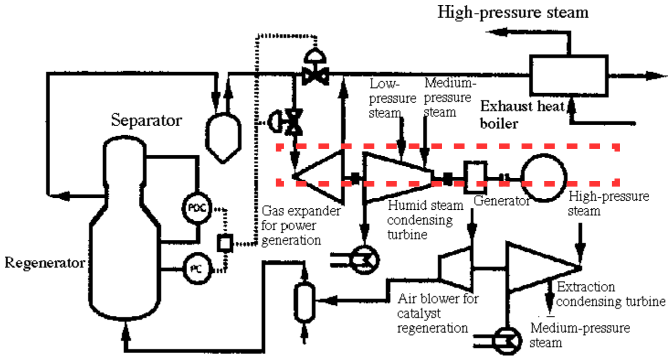
OR-ME-3

Energy Conservation Directory

[Industry Classification] Oil Refining	Fluid catalytic cracking (FCC) unit	[Energy Source] Electricity, Steam
[Technology Classification] Machinery & Equipment	Power recovery system with humid steam condensing turbine (2)	[Practical Use] 1992

Outline

The fluid catalytic cracking unit used in the petroleum refining industry to crack heavy oil produces a flue gas with a high temperature and high pressure from its regenerator. To recover the pressure energy and heat energy of the flue gas, a flue gas expander and a humid steam condensing turbine were installed, the latter of which effectively utilizes the excess low-pressure steam generated in the unit. These are a typical example of power recovery practiced in the petrochemical industry.

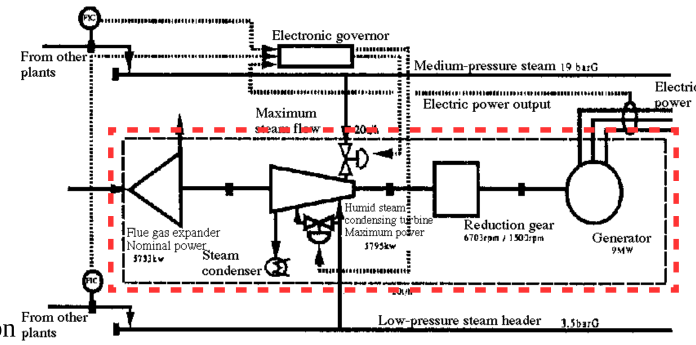


Improved section

Fig. 1 Flow scheme of fluid catalytic cracking

[Description] Structure explanation, Shape, and/or System diagram

[Configuration of power recovery system]
This system consists of a flue gas expander to recover pressure energy and heat energy of the flue gas from the regenerator, and a humid steam condensing turbine to effectively utilize excess low-pressure steam generated in the unit, a reduction gear and a power generator.



Improved section

Fig. 2 Power recovery system with humid steam condensing turbine

[Features of the facilities]

1) The power recovery system combines the fluid catalytic cracking unit with a steam turbine in a tandem arrangement.
2) Power is recovered from excess low-pressure steam by a steam turbine.
3) An electronic governor for the humid steam condensing turbine selects the appropriate operation mode so that the electric power and steam balances of the entire plant may be automatically optimized.
4) The fluid catalytic cracking unit and the power recovery system are independently configurated in a tandem arrangement. The operation of power recovery system may be suspended for maintenance and inspection, independently from the operation of the plant.

[Example specifications of gas expander and steam turbine]

- Gas expander: Single stage axial flow 2.5 Kg/cm^{2}abs., 711˚C, 5,733kW
  Steam turbine: 19 Kg/cm^{2}g, 20 tons/hour max. down to 3.5 Kg/cm^{2}g, 20 tons/hour max. at rated rpm

Energy saving effects

Table 1 Energy saving effects by power recovery

	After improvement	Recovered power
Power recovered by gas expander	5,200 kW	5,625 kW in total
Power recovered from 3.5 tons/hour low-pressure steam	425 kW	
Total power generation (8,000 h/y operation)		45,000,000 kWh/y
Crude oil equivalent		10,935 kL/y

[Economics] Equipment cost

Investment amount (A): about 1250 million yen
Improvement effect (B): about 540 million yen/year
Investment payback (A/B): 2.3 years

Remarks

[Example sites]	[References]	[Inquiry]
Sendai oil refining plant of Tohoku sekiyu Co. Ltd.	Collection of Energy Conservation cases (1995), Vol. 41, No. 9, P.92	ECCJ (JIEC) / Petroleum Association of Japan

OR-ME-4	Energy Conservation Directory	
[Industry Classification] Oil Refining [Technology Classification] Machinery & Equipment	Petroleum refining unit Installation of waste heat boiler to sulfur recovery unit	[Energy Source] Fuel , Steam [Practical Use] Prior to 1980

Outline	This modification installed a waste heat boiler to recover heat from combustion of hydrogen sulfide, H_2S, the feed to the sulfur recovery unit of a petroleum refining plant.
Principle & Mechanism	The process of sulfur recovery involves at first adjusting the composition ratio of combustion air in the main reaction furnace to make a stoichiometric ratio of H_2S and SO_2 in the Claus reaction, or 2 to 1. H_2S and SO_2 react to form elemental sulfur at high temperatures without catalyst according to the following chemical equations. [Combustion reaction of H2S with oxygen] 2H2S + 3O2 -> 2SO2 + 2H2O [Claus reaction] 4H2S + 2SO2 -> 3S2 + 4H2O [Thermal decomposition of H2S (side reaction)] 2H2S -> 3S2 + 2H2

[Description] Structure explanation, Shape, and/or System diagram

[Sulfur recovery process] (Refer to Fig. 1.)

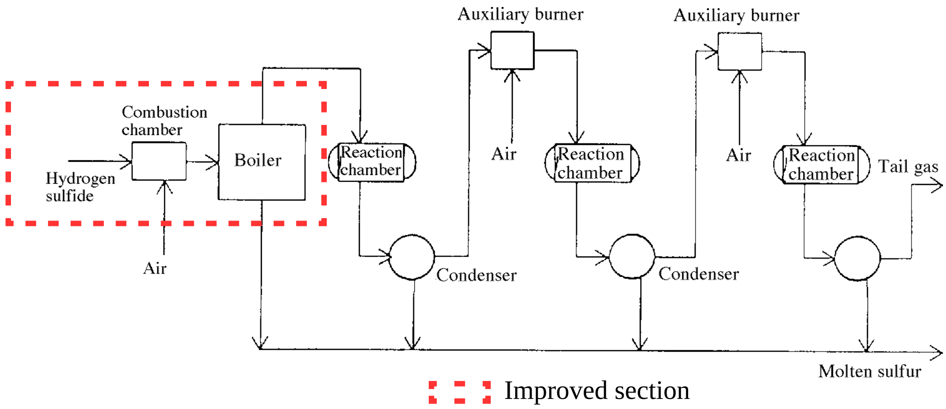


Fig. 1 Process of sulfur recovery and reaction chamber waste heat recovery boiler

[Sulfur recovery reaction waste heat recovery boiler] (Refer to Fig. 2.)

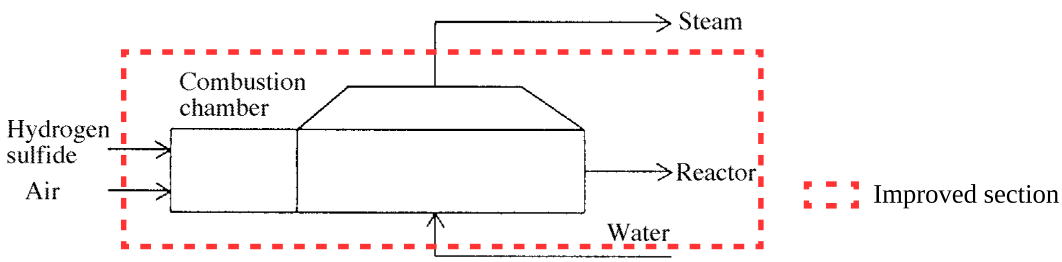


Fig. 2 Boiler for sulfur recovery unit (Steam generator)

Energy saving effects

Table 1 Energy saving effects of waste heat boiler to sulfur recovery unit

	Effect	Notes
Boiler steam generation	3.0 t/h ($13kg/cm^2g$)	Operating at 7,200 h/y
Crude oil equivalent	1,761kL/y	

[Economics] Equipment cost	Investment amount (A): 500 to 100 million yen, Improvement effect (B): 35 million yen/year Investment payback (A/B): 2.9 years
Remarks	

[Example sites]	[References]	[Inquiry]
Incorporated in the original design.	Industry-owned technical materials and data of oil companies	ECCJ (JIEC) / Petroleum Association of Japan

OR-ME-5 — Energy Conservation Directory

[Industry Classification] Oil Refining

[Technology Classification] Machinery & Equipment

Oil refining unit

Installation of a side reboiler on a distillation column in the petroleum refining process

[Energy Source] Fuel (Steam)

[Practical Use] 1970s -

Outline

This modification represents a typical energy saving measure adopted by petroleum refining industry. This modification installs a side reboiler around the central levels of a process distillation column in petroleum refining to reduce consumption of heating steam.

Principle & Mechanism

1) In operation of a distillation column, reducing the reflux ratio at the feed plate as close as possible to the minimum can reduce consumption of heating steam.
2) By installing the side reboiler the reflux ratio of the preceding stage can be reduced to the minimum.
3) Fig. 1 indicates the effect of the side reboiler on the distillation performance by means of a vapor-liquid fractional distillation calculation diagram (McCabe-Thiele diagram).
4) Installation of a side reboiler raises the intermediate plate temperature and thus promote distillation; this reduces the load on the bottom reboiler.

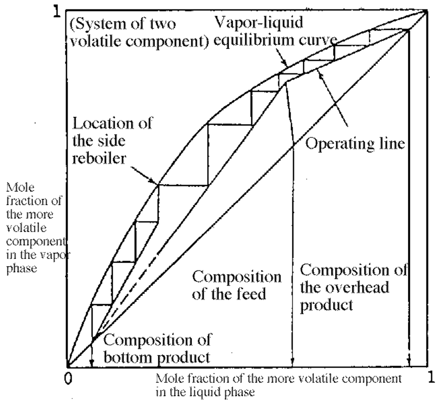


Fig. 1 Vapor-Liquid fractional distillation calculation diagram

[Description] Structure explanation, Shape, and/or System diagram

[Structure of distillation column with a side reboiler] (Refer to Fig. 2.)

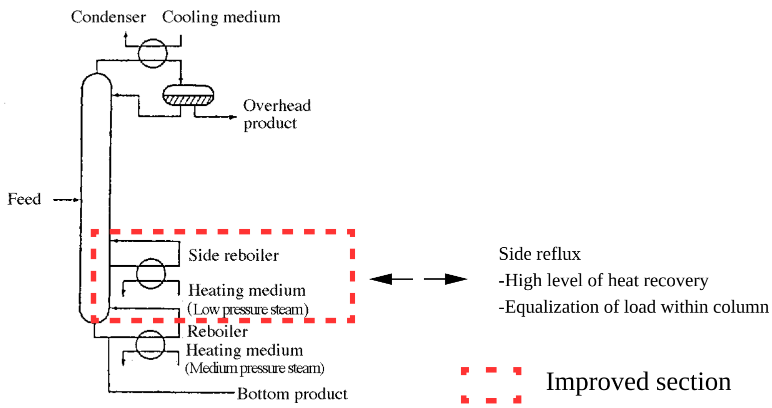


Fig. 2 Structure of distillation column with a side reboiler

Energy saving effects

Table 1 Energy saving effects of distillation with a side reboiler (7,400 T/y)

	Before installation of side reboiler	After installation of side reboiler	Effect
Consumption of medium pressure steam	1,600 kg/h	880 kg/h	
Consumption of low pressure steam	0	640 kg/h	Reduction of 80 kg/h
Crude oil equivalent			

[Economics] Equipment cost

Investment amount (A): 10 to 20 million yen Improvement effect (B): 1 million yen/year
Investment payback (A/B): 10 years
Improvement effect by modification only is limited. If the design can incorporate the distillation column with decreased diameter and a side reboiler of smaller size, improvement effect.can be multiplied.

Remarks

Refer to OR-OM-9.

[Example sites]
Most distillation columns emply side reboiler to recover heat.

[References]
"Practical Energy Conservation", Kagaku Kogakusha

[Inquiry]
ECCJ(JIEC) / Petroleum Association of Japan

OR-ME-6

Energy Conservation Directory

[Industry Classification] Oil Refining	Petroleum refining unit	[Energy Source] Fuel
[Technology Classification] Machinery & Equipment	Installation of a membrane separator for hydrogen	[Practical Use] 1991

Outline

The hydrogen production cost of the existing hydrogen production plant is high. Installation of a membrane separator for hydrogen realized energy saving and reduction of cost by recovering hydrogen from refinery byproduct gas streams and consequently by reducing the operation rate of the existing hydrogen production plant.

Principle & Mechanism

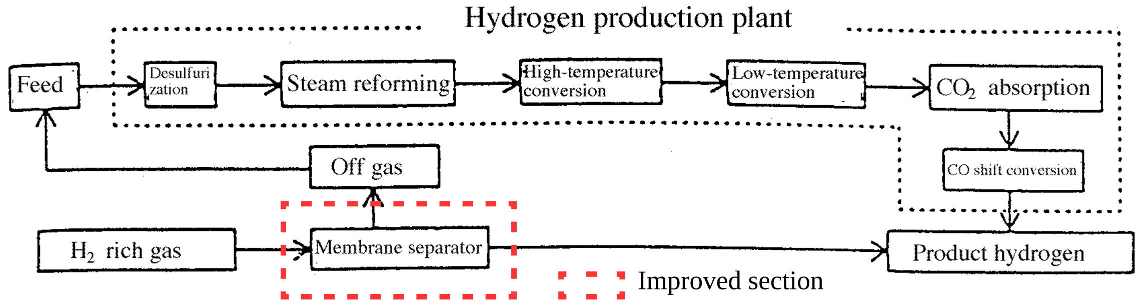


Fig. 1 Vapor-liquid fractional distillation galculation diagram

[Description]

Structure explanation, Shape, and/or System diagram

Summary of modification]
- Installation of a membrane separator for hydrogen
- Partial operation of the reformer furnace of the existing hydrogen production plant and r.p.m. control of the induced and forced-draft fans (IDF, FDF).

[Process design capacity]
- H_2 rich gas: 240 kNm^3/day
- Recovery rate of hydrogen: 75.5 vol. % minimum
- Hydrogen purity: 95.0 vol. % minimum

[Process design conditions]

Table 1 Process design conditions

	Feed gas (H_2 rich gas)	Produced hydrogen	Off gas
Flow, kNm^3/day	240	150	90
Pressure, Kg/cm^2	38.5	16.5	37.5
Temperature, ° C	40	40	40
Hydrogen content, vol. %	75.5	95.5	38.5

[Specifications of membrane separator for hydrogen]
- Material of the membrane: Aromatic polyimide
- Structure of the membrane: Hollow fibers
- Membrane module: 7

Energy saving effects

Table 2 Energy saving effects of the membrane separator for hydrogen

	Effect by introduction	Note
C-grade fuel oil equivalent of fuel consumption	Reduction of 6,100 kL/y	
Crude oil equivalent of fuel consumption	Rreduction of 6,466 kL/y	

[Economics] Equipment cost

Investment amount (A): 250 to 300 million yen Improvement effect (B): 130 million yen/year
Investment payback (A/B): 2.5 years

Remarks

[Example sites]	[References] Collection of Energy Conservation Cases 1992, p. 913	[Inquiry] ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-1

Energy Conservation Directory

[Industry Classification] Oil Refining	Vacuum distillation unit	[Energy Source] Fuel
[Technology Classification] Operation & Management	Hot charge to the vacuum distillation unit	[Practical Use] 1987

Outline

The present modification raises the temperature of the feed charged from the atmospheric distillation to the vacuum distillation unit in petroleum refining. In this way, the modified operation reduces the specific consumption of energy required for the vacuum distillation unit.

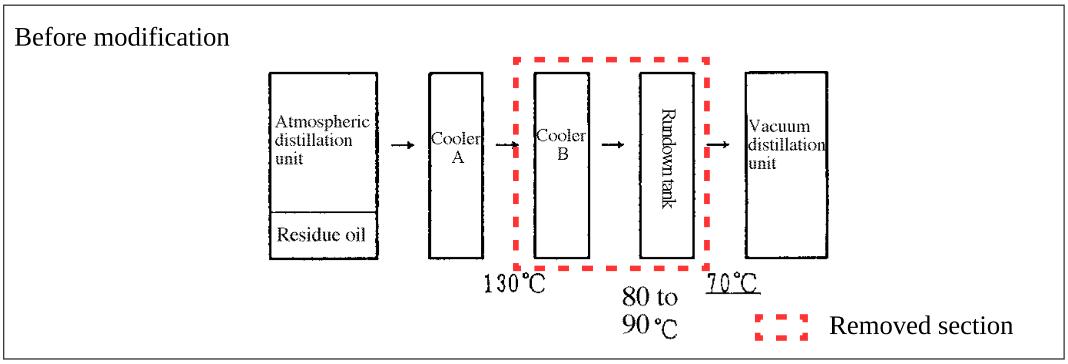
Principle & Mechanism

1) The traditional operation method ran down the atmospheric distillation residue through Cooler A and Cooler B to the rundown tank. The temperature at the outlets of Cooler A and Cooler B were 130˚C and 80 to 90˚C, respectively.
2) The atmospheric distillation residue stored in the rundown tank was fed to the atmospheric distillation unit at about 70˚C.

[Description]

Structure explanation, Shape, and/or System diagram

1) The atmospheric distillation residue is fed to the vacuum distillation unit directly from the outlet of the ooler A outlet where the fluid temperature is 130˚C. In this way, the temperature of the feed to the vacuum distillation unit is raised, which reduces the specific consumption of energy of the vacuum distillation unit and increases generation of steam.
2) Fig. 1 shows the process flow schemes before and after the modification.



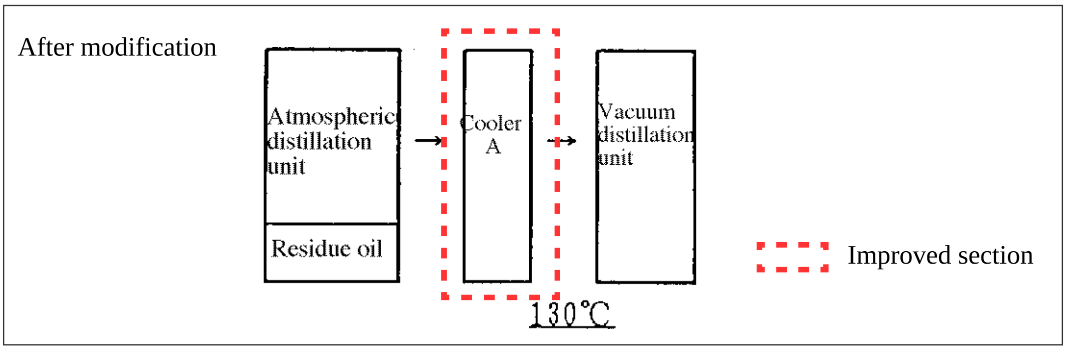


Fig. 1 System flow of power recovery system of the regenerator gas

Energy saving effects

Table 1 Energy saving effects (Basis: 80,000 BPD production)

	After modification	Note
Reduction of fuel	1,240 kL/y	(Heavy fuel oil equivalent)
Crude oil equivalent	1,314 kL/y	

[Economics] Equipment cost

Investment amount (A): yen, Improvement effect (B): 26 million yen/year
Investment payback (A/B): years
Piping and instrumentation required.

Remarks

This technology is a basic operation improvement technology extensively applicable not only to petroleum refinery but also to other industries as well in addition to petroleum refinery, chemical industry for example.

[Example sites]	[References]	[Inquiry]
Employed at many sites.	Industry-owned technical materials and data of oil companies	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-2	Energy Conservation Directory	
[Industry Classification] Oil Refining	Atmospheric crude oil distillation column	[Energy Source] Fuel, Steam
[Technology Classification] Operation & Management	Recovery of waste heat of heavy gas oil	[Practical Use] 1982

Outline

The treated water from the waste water treatment unit was utilized as feed water to the desalters. However, the reboiler of stripper in the waste water treatment unit used medium-pressure stream newly produced as a heat source for the reboiler. While on the other hand, waste heat of heavy gas oil from the atmospheric distillation column was not effectively utilized because of the waste heat being small.

Improvement Study

Checklist for utilizing heavy gas oil as a heat source:
- The existing reboiler should be usable without modification.
- In case of a tube leak, the leaked heavy gas oil goes into the desalters and therefore should not present problems.
- In the case of the atmospheric distillation column being out of service, low-pressure steam can be used as an alternative heat source to the reboiler.

[Description]

Structure explanation, Shape, and/or System diagram

[Flow scheme before improvement]

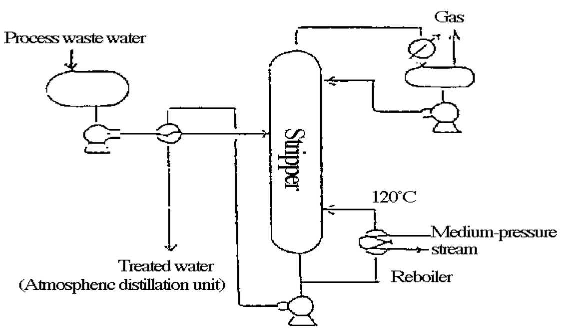


Fig. 1 Flow scheme of primary waste water treating unit

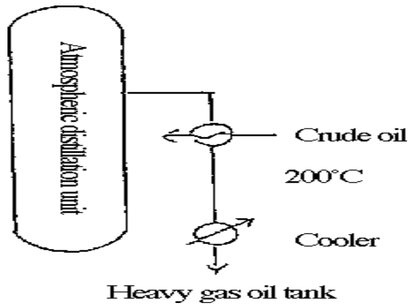


Fig. 2 Flow of heavy gas oil

[Flow scheme after improvement]

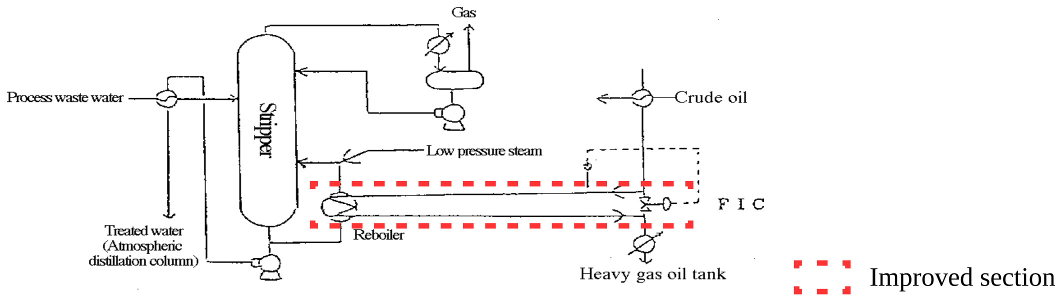


Fig. 3 Flow of the reboiler heating system after improvement

Energy saving effects

Table 1 Energy saving effects

	After modification	Effect
Steam consumption of the reboiler	1.6 t/y reduction	11,500 t/y reduction
Crude oil equivalent		938 k/y reduction

[Economics] Equipment cost

Investment amount (A): Low investment costs. Piping and instrumentation for heavy gas oil process flow required.
Improvement effect (B): 18 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]	[References]	[Inquiry]
	Collection of Energy Conservation Cases 1993, p. 1127	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-3

Energy Conservation Directory

[Industry Classification] Oil Refining	Vacuum distillation unit	[Energy Source] Fuel (Steam)
[Technology Classification] Operation & Management	Recovery of waste heat of the overhead vapor	[Practical Use] 1992

Outline

The waste heat from the cooler for the overhead vapor of a vacuum distillation unit was known to be very large. The waste heat, however, has not been effectively recovered because of its low temperature. This technology utilizes the waste heat from the cooler as a heat source for preheating the water of the boiler and reduces the steam required for heating the daerator.

Before Improvement

The reflux to the overhead of the vacuum distillation unit was cooled by two coolers, a water cooler and an air cooler, and the waste heat of the fluid, or heat from cooling, was not recovered for reuse.

[Description of Improvement]

Structure explanation, Shape, and/or System diagram

1) The waste heat from the air cooler is recovered to preheat the feed water to the deaerator.
2) The pressure of the deaerator is controlled by an ACS system between 1.5 and 2.0 Kg/cm^2g. As a result, the consumption of steam by the deaerator is reduced by 30 percent.

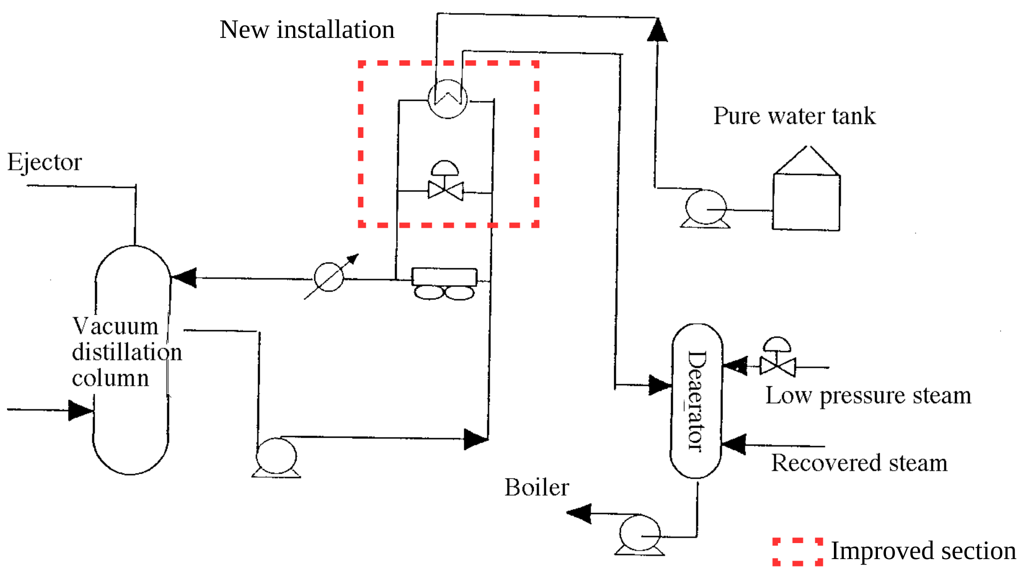


Fig. 1 Flow of waste heat recovery from the overhead vapor of the vacuum distillation unit to preheat feed water to deaerator

Energy saving effects

Table 1 Effects of the heat recovery from the overhead vapor to heat feed water to deaerator (34,000 BPD base)

	Before improvement	After improvement	Effect
Steam consumption - fuel oil equivalent	1,355 kL/y	927 kL/y	428 kL/y (or 32 percent) reduction
Steam consumption - crude oil equivalent			454 kL/y reduction

[Economics] Equipment cost

Investment amount (A): 20 to 30 million yen, Improvement effect (B): 10 million yen/year
Investment payback (A/B): 3 years

Remarks

[Example sites]	[References]	[Inquiry]
	Collection of Energy Conservation cases (1993), P.367	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-4	Energy Conservation Directory	
[Industry Classification] Oil Refining	Vacuum gas oil desulfurization unit	[Energy Source] Fuel
[Technology Classification] Operation & Management	Improvement of heat recovery system	[Practical Use] 1979

Outline

The existing vacuum gas oil desulfurization unit cools the reaction products to separate them into gas, including recycling gas, and oil, and then reheats the oil for fractionation. The amount of heat dissipated at this condensing cooler is great. To recover a portion of this heat loss on one hand, and to overcome the increasing fouling of the combined feed heat exchanger which increases restriction on throughput on the other, the heat recovery system of the entire plant was improved and a new hot separator was installed.

[Description]

Structure explanation, Shape, and/or System diagram

[Installation of a hot separator/heat exchanger]
1) A hot separator was installed to reduce the heat loss at the effluent cooling condenser.
2) The combined heat exchanger system was expanded to increase heat recovery from the reactor effluent.
3) A preheater was added to the charge oil system to increase heat recovery from the fractionator bottom.

[Improvement effects and system flow] (Refer to Fig. 1.)
1) The temperature at the inlet to the reactor charge heater has risen from 323˚C to 344˚C.
2) The temperature at the fractionator charge heater has risen from 230˚C to 261˚C.
3) The throughput has increased because of the reduced loads on the heaters.

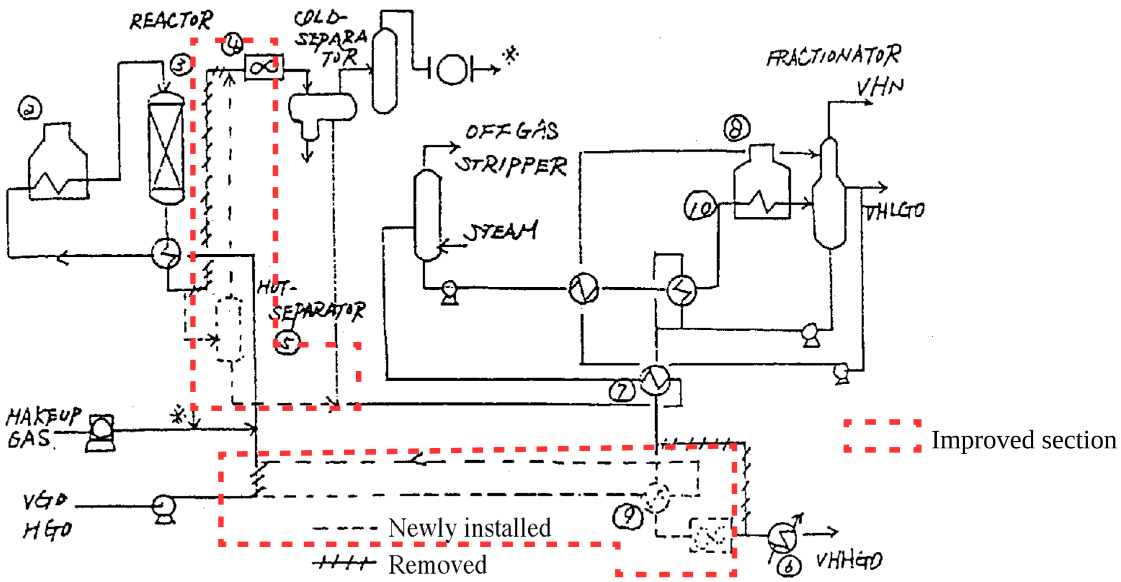


Fig. 1 System flow diagram of the vacuum gas oil desulfurization unit with hot separator/heat exchanger

Energy saving effects

Table 1 Energy saving effects

	After improvement	Note
Fuel consumption - heavy fuel oil equivalent	7,300 k/y reduction	
Fuel consumption - crude oil equivalent	7,738 k/y reduction	

[Economics] Equipment cost

Investment amount (A): 500 million yen
Improvement effect (B): 218 million yen/year
Investment payback (A/B): 2.3 years

Remarks

[Example sites]	[References]	[Inquiry]
	Collection of Energy Conservation cases (1980), Vol. 41, P.92	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-5	Energy Conservation Directory	
[Industry Classification] Oil Refining	Heavy oil direct desulfurization unit	[Energy Source] Fuel
[Technology Classification] Operation & Management	Reduction of oxygen content in the flue gas	[Practical Use] 1988

Outline

The heavy oil direct desulfurization unit changed its operation from desulfurization mode to hydrocracking mode to produce more higher value-added products in response to the changes in demand pattern. The change was accompanied by a severe overuse in operation of the reactor and therefore the unit was required to operate under a reduced throughput. As a result, the load on the feed furnace was reduced and the oxygen content in the furnace flue gas increased in percentage. Attempts to operate the furnace in a manner to reduce the oxygen content in the flue gas ended up in failure because localized excessive heating of the furnace tubes occurred. Modification was made of the burner arrangement and performance and of damper clearances to enable the furnace operation with reduced oxygen content in the flue gas.

Principle & Mechanism

[Subject facility]

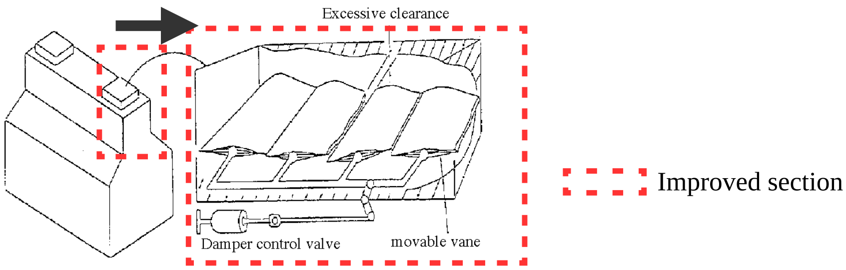


Fig. 1 Structure of the damper and feed furnace

[Description]

Structure explanation, Shape, and/or System diagram

[Modification to realize furnace operation with low oxygen content in the flue gas]

1. Modification of burner arrangement to improve combustion performance
   - Determination of optimum combustion flue gas amount
   - Reduction of the number of burners by half
   - Relocation of the burners at optimum locations
   - Implementation of countermeasures against localized heating
2. Modification of the flue gas damper configuration (Refer to Fig. 2.)
   - Of the four movable vanes of the flue gas damper on the furnace, three were fixed leaving only one vane movable. This modification made the area of clearances smaller.
   - The point of installation of the minimum stopper was calculated from the load data of the furnace. The damper control valve and the movable vane were adjusted to the newly calculated values.

[Resultant reduction of oxygen content]

The oxygen content in the flue gas was reduced from 5.2 to 2.5 percent.

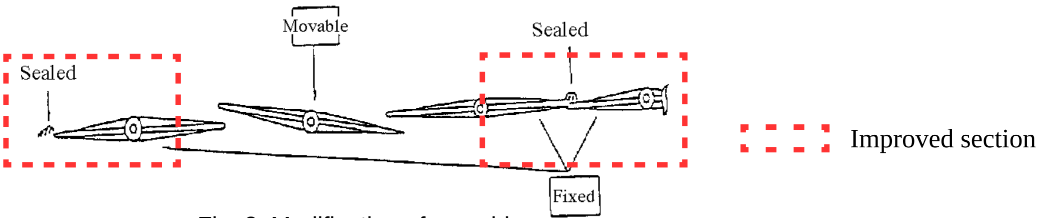


Fig. 2 Modification of movable vanes

Energy saving effects

Table 1 Energy saving effects of oxygen reduction in the flue gas

	Before modification	After modification	Effect
O_2 content in flue gas, %	5.2 %	2.5 %	
Fuel consumption - fuel oil equivalent			490 kL/y reduction
Fuel consumption - crude oil equivalent			519 kL/y reduction

[Economics] Equipment cost

Investment amount (A): yen, Improvement effect (B): 10 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]	[References]	[Inquiry]
		ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-6

Energy Conservation Directory

[Industry Classification] Oil Refining	Heavy oil direct desulfurization unit	[Energy Source] Steam
[Technology Classification] Operation & Management	Rotation control of the recycle gas compressor	[Practical Use] 1985

Outline

The recycle gas of this unit is pressurized by the recycle gas compressor and loses pressure as it passes through the reactor, heat exchangers and control valves. If it is possible to operate the unit with the control valves, the major contributor to the pressure drop, nearly fully open, the power consumption of the compressor could be reduced. The improvement herein explained realized energy saving by controlling r.p.m. of the compressor in operation to reduce pressure drops across control valves.

Principle & Mechanism

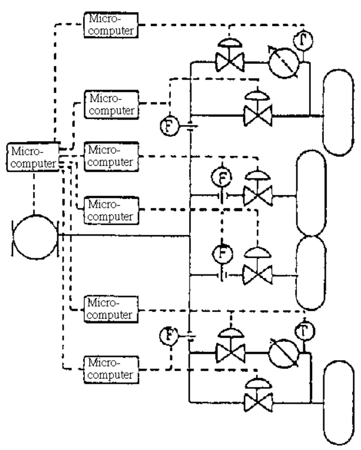
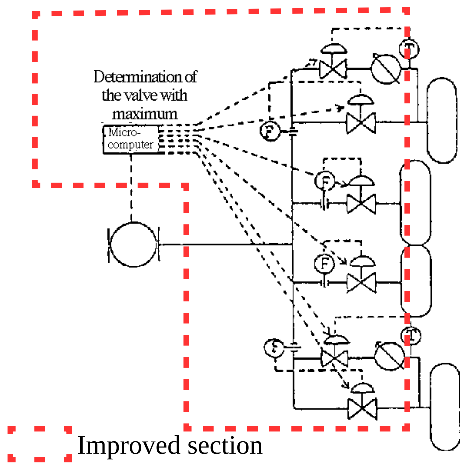
- The pressure loss at the control valves accounts for 17% of all losses in this system when the valves are 80% open.
  Control valves, if operated in full open, reduce most efficiently the power consumption required However, in actual operations, r.p.m. of the compressor need to be controlled so that control valves are 90 % open to accommodate the fluctuation of the process.

[Description]

Structure explanation, Shape, and/or System diagram

1. Comparison of control systems (Refer to Table 1)

Table 1 Comparison between flow rate control system and control valve opening control system

	Flow rate control system	Control valve opening control system
Flow control		
System	The microcomputers determine flow rates and control the rotation of the compressor so that all the six control valves are equally 90 percent open.	The microcomputer searches the six control valves to find the valve with maximum opening. The rotation of the compressor is adjusted to control the flow rate so that the valve of maximum opening is 90 percent ormoreopen.

2. Results of the modification
   Of the above two candidate systems, the control valve opening control system was adopted for its greater reliability, although this system is slightly inferior to the other system in energy saving effect.
   After employing the system, the opening of the control valves increases from 80 to 95 percent, and the pressure drop across the control valves decreases to 2.01 Kg/cm^2 from 4.28 Kg/cm^2.

Energy saving effects

Table 2 Energy saving effects by rotation control

	Before improvement	After improvement	Effect
Steam consumption (t/h)	32.8 t/h	30.6 t/h	2.2 t/h reduction
Stem consumption (t/y)			18,400 t/y reduction
Crude oil equivalent			1,582 kL/y reduction

[Economics] Equipment cost

Investment amount (A): a set of microcomputers: 12 million yen,
Improvement effect (B): 61 million yen/year
Investment payback (A/B): 0.2 year

Remarks

[Example sites]	[References]	[Inquiry]
	Collection of Energy Conservation cases (1986), P.167	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-7

Energy Conservation Directory

[Industry Classification]
Oil Refining

[Technology Classification]
Operation & Management

Fluid catalytic cracking unit

Improvement of heat recovery by modification of operating conditions of the main fractionator

[Energy Source]
Fuel (Steam)

[Practical Use]
1992

Outline

In the market environment where distillate products are increasingly demanded, yield patterns of fractions are changing. Accordingly, it became necessary to review the heat balance of the main fractionator to develop a scheme for optimum heat recovery. The modification aimed to develop an operating condition which optimize heat recovery from the overhead, middle and bottom refluxes, thereby improving the energy saving effects.

Principle & Mechanism

1) The overhead reflux to the main fractionator is cooled by cooling water.
2) The middle reflux and bottom reflux supply heat to the splitter and debutanizer columns, respectively. Thereafter they also heat the feed water preheater and steam generator, respectively.
3) In order to maximize heat recovery it was necessary to minimize the cooling duty of the overhead reflux and to review heat consumption of the reboilers for the splitter and debutanizer column.

[Description] Structure explanation, Shape, and/or System diagram

[Review of the operating conditions (Refer to Fig. 1 and Table 1.)
1) The relationship between the reflux ratios and properties of gasoline and LPG was established by test plant operations. From this, the minimum heat consumption required by the reboiler was determined.
2) The effects of the overhead reflux flow rate and middle reflux temperature on the properties of gasoline fraction and LCO fraction were determined by test plant operations. From this the operating conditions which maximized heat recovery was determined.
3) As a result of the modification of operating conditions, degree of preheating and steam generation were increased. Thus, energy recovery was increased.

Table 1 Heat recovery for each energy saving measure

Energy Saving Measure	Increased steam generation, t/h
Heat recovery by increased MPA reflux	1.94
Heat recovery by decreased splitter reflux	0.37
Heat recovery by decreased debutanizer reflux	0.99
Total	3.3

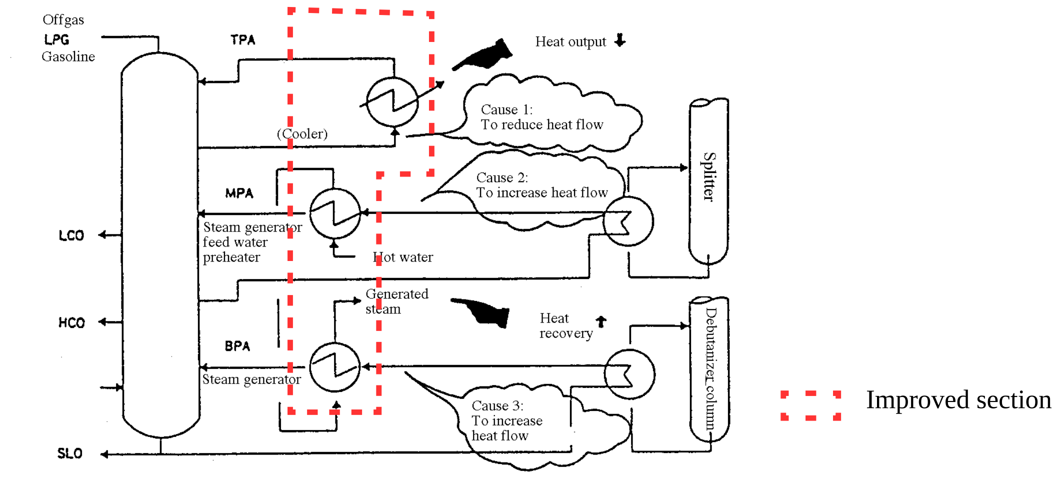


Fig. 2 Heat input and output at the fractionator section of the fluid catalytic cracking unit

Energy saving effects

Table 2 Energy saving effects by heat recovery

	Improvement effect	Note
Recovery of heat from cooler duty (steam generation)	3.3 t/h	At operation of 7,000 h/y
Crude oil equivalent	1,884 kL/y reduction	

[Economics] Equipment cost

Investment amount (A): Operational improvement without capital investment
Improvement effect (B): 38 million yen/year
Investment payback (A/B): years

Remarks

The technology of effective heat recovery by distillation column with side reflux is applicable to other processes.

[Example sites]

[References]
Collection of Energy Conservation cases (1990), Vol. 42, No. 3 P.53

[Inquiry]
ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-8

Energy Conservation Directory

[Industry Classification] Oil Refining	Fluid catalytic cracking (FCC) unit Energy saving by reducing the pressure inside the regeneration column	[Energy Source] Steam, Fuel
[Technology Classification] Operation & Management		[Practical Use] Prior to 1980

Outline

The pressure within the Fluid Catalytic Cracking (FCC) unit can be reduced by increasing the capacity of the cooler at the top of the FCC distillation column. This modification achieves energy saving by reducing the pressure inside the regeneration column and thereby reducing the consumption of steam for driving the air blower for the regeneration column.

Principle & Mechanism

The possibility of the following items were examined before modification.

1) To reduce the pressure inside the system by increasing the capacity of the air cooler at the top of the distillation column.
2) To reduce the air volume of the air blower for the regeneration column.

[Description] Structure explanation, Shape, and/or System diagram

1) The flow of the system including the FCC regeneration column is shown in Fig. 1.
- By reinforcing the cooling capacity of the air fin cooler, it becomes possible to reduce the air pressure within the system, and to reduce the air pressure of the air blower for the regeneration column.
- Along with reduction of the air pressure, it was confirmed that this measure reduces the air volume of the air blower, resulting in reduced specific consumption of the high pressure steam required for driving the air blower. (See Table 1).

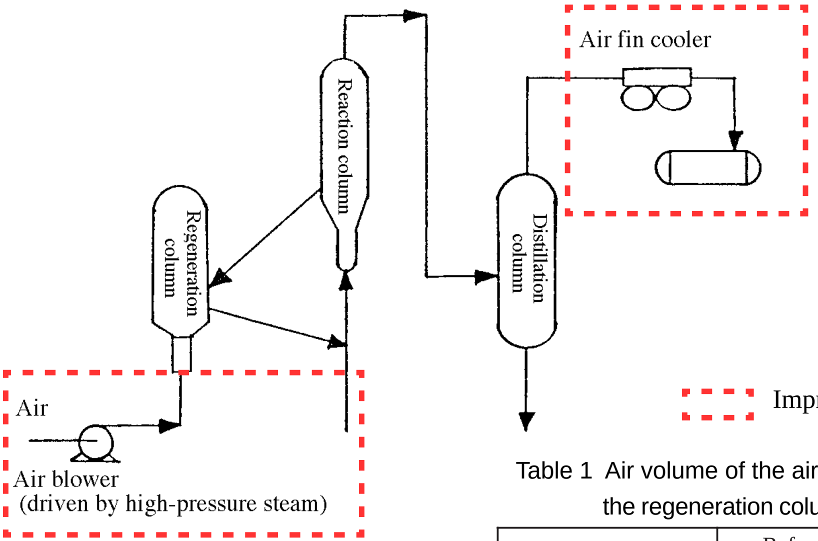


Fig. 1 System flow of the Fluid catalytic cracking unit (FCC)

Table 1 Air volume of the air blower and air pressure of the regeneration column before and after improvement

	Before improvement	After improvement	Effect
Regeneration column air pressure (kg/cm^2)	2.86	2.63	0.23 reduction
Air blower air volume (m^{3}N/h)	1,755	860	895 reduction

Energy saving effects

Table 2 Energy saving effects by reducing regeneration column air pressure

	After improvement	Note
FCC oil throughput	842,000 kL/y increase	
High pressure steam consumption	12,557 t/y reduction	
Crude oil equivalent	1,024kL/y reduction	

[Economics] Equipment cost

Investment amount (A): 20 to 100 million yen, Improvement effect (B): 20 million yen/year
Investment payback (A/B): 3 years

Remarks

[Example sites]	[References]	[Inquiry]
	"Collection of Energy Conservation cases (1979), Vol. 31, No. 8, by ECCJ"	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-9	Energy Conservation Directory	
[Industry Classification] Oil Refining [Technology Classification] Operation & Management	Oil refining process Reduction of the quantity of the recycled gas in the reforming unit	[Energy Source] Fuel, Steam [Practical Use] Prior to 1980

Outline	This method of operation reduces the gas quantity recycled in the reforming unit or the desulfurizing unit to the allowable limit, thereby saving the power for recycling the gas and the heat power required for the furnace.
Before Improvement	In the reforming unit or the desulfurizing unit, a gas which is rich in hydrogen is circulated for maintaining the hydrogen concentration necessary for the reaction and for preventing deterioration of the catalyst due to carbon deposition on the catalyst. The volume of the recycling gas often becomes more than necessary.
[Description of Improvement] Structure explanation, Shape, and/or System diagram	1) By reducing the volume of the recycled gas, it is possible to reduce the power for driving the compressor as well as the heat required for the furnace. However, as the decrease of the recycling gas may lead to the deterioration of the catalyst, the reduction of the recycle gas has to be controlled within the allowable limit.

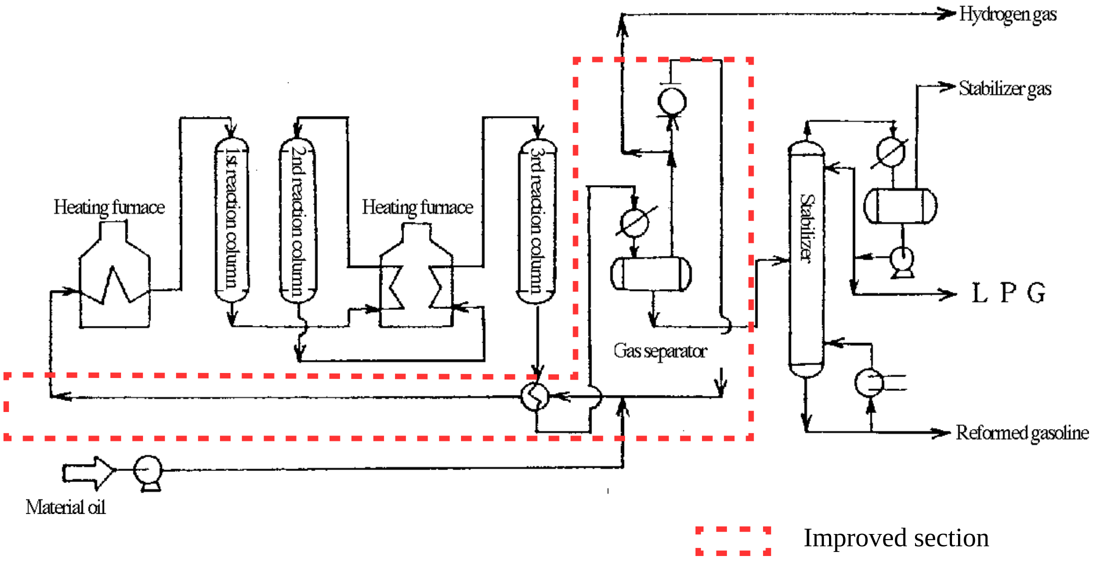


Fig. 1 Flow of the recycled gas in the reforming unit

Energy saving effects

Table 1 Energy saving effects (Reforming unit on the 10,000 BPD basis)

		Before	After	Effect
Molar ratio of hydrogen/hydrocarbon		6.4	5.1	
Energy consumption	Fuel			2.56 kL/d reduction
	Electric power			5,120 kWh/d reduction
Crude oil equivalent *				1,268 kL/y reduction

(Notes: at operation of 330 day/y)

[Economics] Equipment cost	Investment amount (A): Operational improvment without capital investment Improvement effect (B): 25 to 40 million yen/year The effect varies depending on power cost. Investment payback (A/B): years
Remarks	

[Example sites]	[References]	[Inquiry]
	Industry-owned technical materials and data of oil companies	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-10

Energy Conservation Directory

[Industry Classification] Oil Refining	Catalytic reforming Unit	[Energy Source] Fuel (Steam)
[Technology Classification] Operation & Management	Energy saving by low-pressure operation of distillation columns	[Practical Use] 1979

Outline

If operation pressure of a distillation column is lowered, the bottom temperature is lowered and the heat brought out with the bottom stream is reduced. Operation of a distillation column at a lower pressure, together with a lower throughput and relaxation of the product specifications, contributes to energy saving, as long as the concerned facilities tolerate such operations.

Principle & Mechanism

[Relationship between operation pressure of a distillation column and specific fuel consumption] (Refer to Fig. 1.)

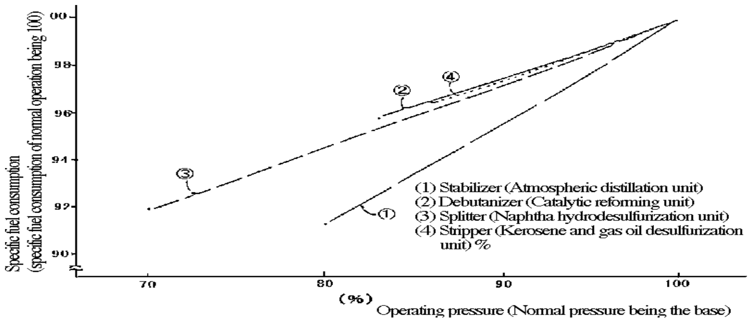


Fig. 1 Relationship between operating pressure and specific fuel consumption for individual units

[Description] Structure explanation, Shape, and/or System diagram

[Case of low pressure operation] (Refer to Fig. 2.)

1) In the case of the naphtha hydrodesulfurization unit, lowering the pressure of debutanizer lowers the temperature of the liquid sent to the splitter, which, in turn, increases specific fuel consumption of the splitter. This case lowered the operating pressure of the splitter while keeping the operation condition of the debutanizer unchanged.
2) The stabilizer of the atmospheric distillation unit and the splitter of the naphtha hydrodesulfurization unit both send the bottom hot oil to the subsequent processes. In both cases lowering the operating pressure lowers the bottom oil temperature and consequently increases the specific fuel consumption of the subsequent processes. Under such constraints, the operating pressures of the stabilizer and the splitter that could maximize the merits of the entire system were determined.

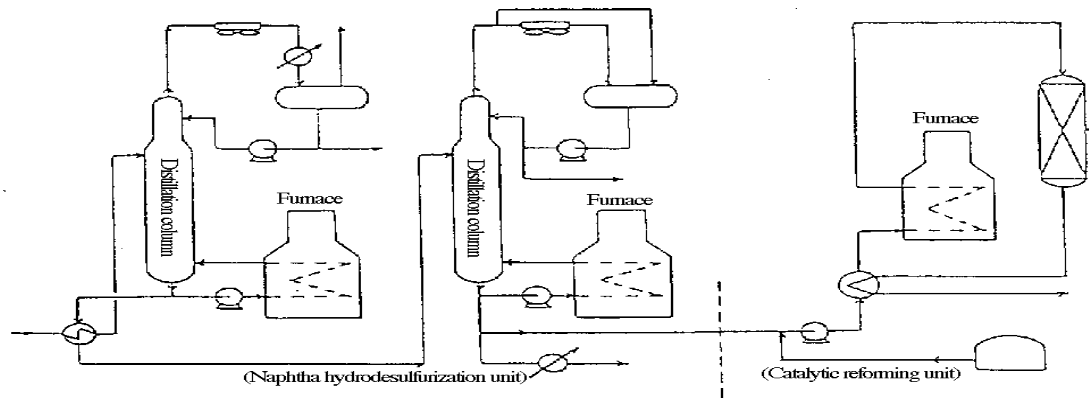


Fig. 2 Flow of related processes

Energy saving effects

Saving of fuel consumption : 1,100 kL/y (Heavy fuel oil equivalent)
Energy saving in crude oil equivalent : 1,166 kL/y

[Economics] Equipment cost

Investment amount (A): Operational improvment without capital investment
Improvement effect (B): 23 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]	[References]	[Inquiry]
	Collection of Energy Conservation Cases (1980), P.915	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-11

Energy Conservation Directory

[Industry Classification] Oil Refining	Petroleum refining process Rearrangement of heat exchangers of a distillation plant	[Energy Source] Fuel
[Technology Classification] Operation & Management		[Practical Use] 1989s

Outline	The modification expanded and rearranged heat exchangers of a residue vacuum distillation plant as part of the modification of the unit. The modification achieved energy saving by increasing heat recovery rate and reducing the load of the furnace.

[Description]

Structure explanation, Shape, and/or System diagram

[Before modification]

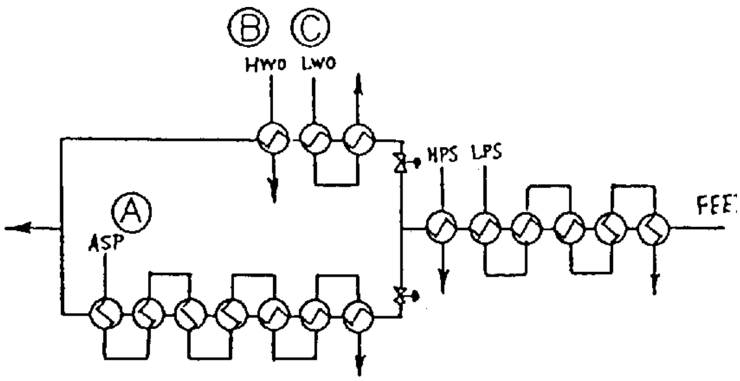


Fig. 1 Heat exchanger layout before rearrangement

[After modification]

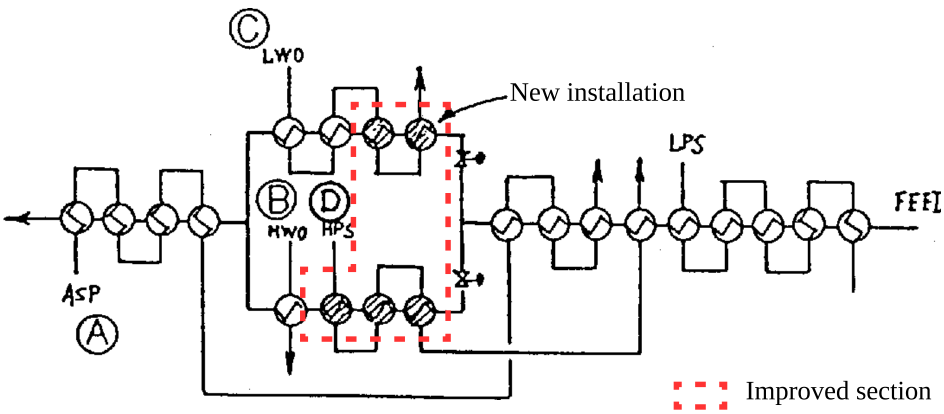


Fig. 2 Heat exchange layout after rearrangement and expansion

Energy saving effects	The modification has achieved energy saving of heavy fuel oil equivalent of 1,150 kiloliters a year, or crude oil equivalent of 1,219 kiloliters a year.
[Economics] Equipment cost	Investment amount (A): 50 to 100 million yen for a system with a heat transfer area of 700 m^2, including cost for piping and modification. mprovement effect (B): 25 million yen/year Investment payback (A/B): 3 years
Remarks	Software to develop an optimal design of the heat exchanger configuration is available.

[Example sites]	[References]	[Inquiry]
Extensively used in most petroleum companies.	Industry-owned technical materials and data of oil companies	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-12

Energy Conservation Directory

[Industry Classification] Oil Refining	Hydrogen production unit	[Energy Source] Fuel
[Technology Classification] Operation & Management	Reduction of steam/carbon ratio	[Practical Use] 1989

Outline

The steam to carbon ratio of this hydrogen production unit was 5.5 and higher than other refineries' values of 4.5 to 5.0. Because of the specific energy consumption is high, the refinery embarked on a modification to reduce the steam to carbon ratio and successfully reduced it to 4.7.

Principle & Mechanism

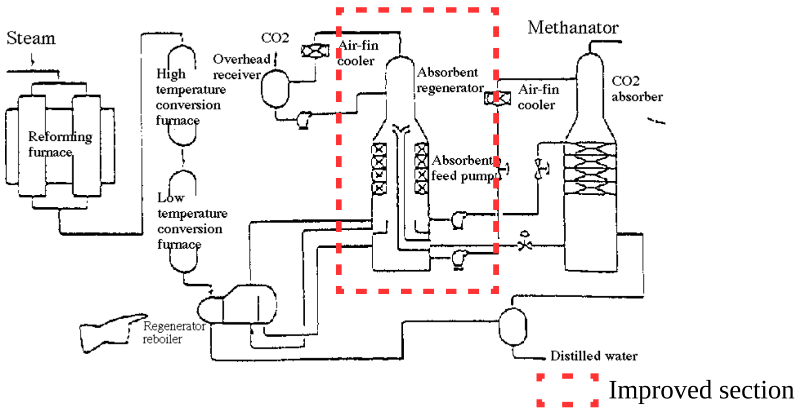


Fig. 1 Flow scheme of the regenerator

[Description] Structure explanation, Shape, and/or System diagram

[Anticipated Problems]
Problems that are anticipated when the steam to carbon ratio is reduced are as follows:
- Increased carbon deposits on the catalysts
- Rise of surface temperature of the reaction tubes of the reforming furnace
- Insufficient steam supply to the conversion reactors
- Insufficient heat supply to the absorption agent re-generating column
- Foaming in the absorption tower

[Results of the Study]
- At steam to carbon ratios of 4.7 or higher, none of the problems except foaming was encountered.

[Countermeasures to Foaming]
- The cause of foaming was identified: flow velocity of the absorbent became too fast because the ceramic packings in the absorption tower had been broken into small pieces.
- Replacement of the ceramic packings by more sturdy stainless steel packings solved the foaming problem. As a result, the stream to carbon ratio was reduced from 5.5 to 4.7.

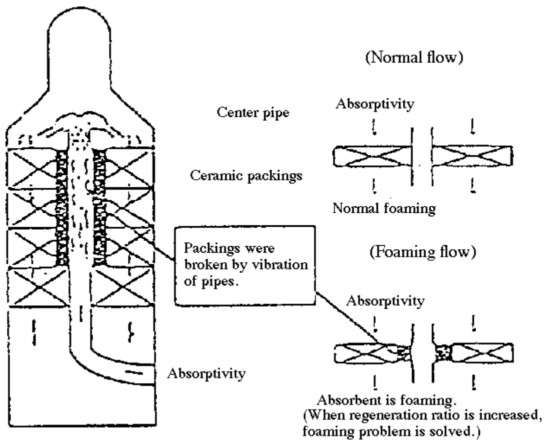


Fig. 2 Inside structure of the absorption tower

Energy saving effects

Table 1 Energy saving effects

	After modification	Note
Fuel consumption - fuel oil equivalent	3,630 kL/y reduction	
Fuel consumption - crude oil equivalent	3,848 kL/y reduction	

[Economics] Equipment cost

Investment amount (A): Operational improvement without capital investment
Improvement effect (B): 77 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]

[References]
The Energy Conservation Center, Japan, "Collection of Energy Conservation Cases 1990" p. 61

[Inquiry]
ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-13

Energy Conservation Directory

[Industry Classification] Oil Refining	Hydrodesulfurization process	[Energy Source] Fuel (Steam)
[Technology Classification] Operation & Management	Effective utilization of steam	[Practical Use] 1980

Outline

This modification represents an improved operation to effectively utilize steam from the waste heat boiler of the Claus furnace which recovers sulfur from the acid gas generated from the hydrodesulfurization unit.

Principle & Mechanism

1) The heat source of the Claus furnace is the heat of partial combustion of clean acid gas rich in H_2S and a mixture of ammonia and hydrogen sulfide, NH_3 and H_2S.
2) The boiler of the Claus furnace generates steam wiyth a pressure of 19 Kg/cm^{2}g at a rate of 5 tons per hour.
3) The steam is used for the following purposes:
- Supply to the furnace of the vacuum distillation unit: 3 tons/hour
- Injection to the low-pressure steam line after pressure reduction from 19 Kg/cm^{2}g to 5 Kg/cm^{2}g: 2 tons/hour

[Description] Structure explanation, Shape, and/or System diagram

1) The hydrogen sulfide stripper of the hydrodesulfurization unit has used steam with a pressure of 20 Kg/cm^{2}g. A study indicated that the steam pressure could be reduced to 15 Kg/cm^{2}g without any operation problem.
2) The flow of the steam line after modification is shown in Fig. 1.

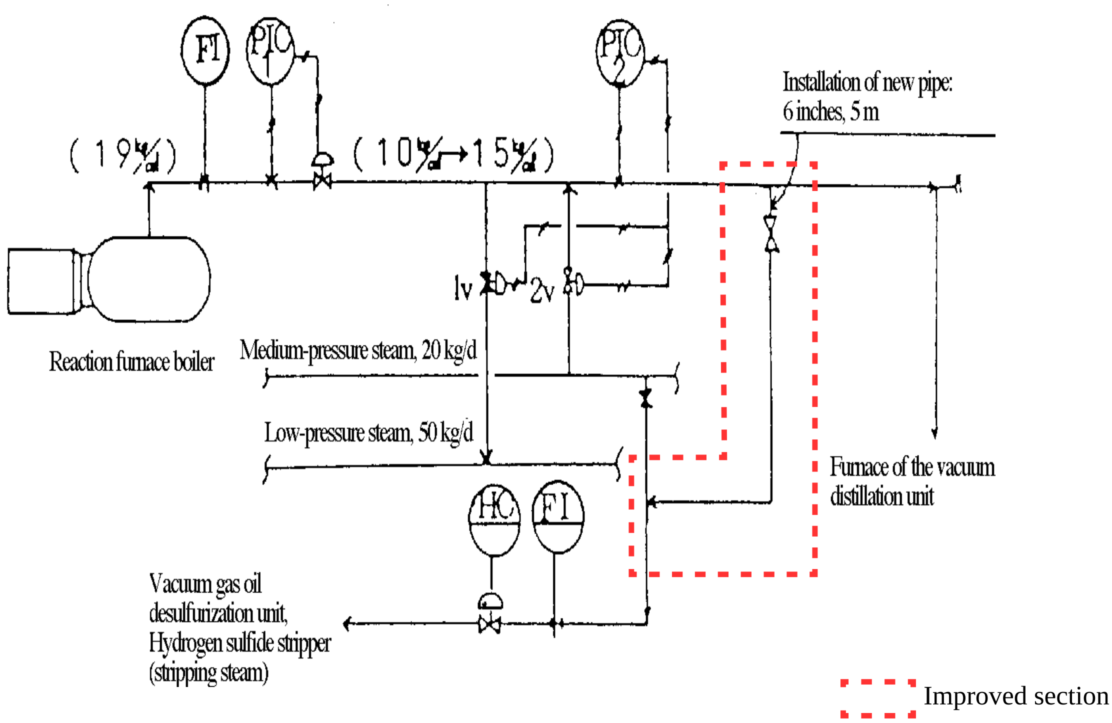


Fig. 1 Modified flow for effective utilization of Claus furnace boiler

Energy saving effects

Table 1 Energy saving effects of effective utilization of Claus furnace boiler steam

	Effect	Note
Steam generation of Claus furnace boiler	15,000 t/y	
Crude oil equivalent	1,223 kL/y reduction	

[Economics] Equipment cost

Investment amount (A): 1 million yen, Improvement effect (B): 25 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]	[References]	[Inquiry]
	The Energy Conservation Center, Japan, "Collection of Energy Conservation Cases 1981," p. 115	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-14

Energy Conservation Directory

[Industry Classification]
Oil Refining

[Technology Classification]
Operation & Management

Hydrogen production unit

Computer-controlled reduction of surplus hydrogen

[Energy Source]
Fuel

[Practical Use]
1990

Outline

The operation of the hydrogen production unit is required to ensure stable supply of hydrogen to the related units regardless of fluctuation of all operational variations. Because of this requirement, production quantity of purified hydrogen tends to be excessive, resulting in production loss. This method minimizes the surplus hydrogen production by computer control.

Before Improvement

Conventionally, the quantity of hydrogen production was manually controlled in response to the changes in demand for hydrogen as well as the changes in the amount of raw materials fed into the hydrogen production unit. However, the control was insufficient because of the manual operation, and the surplus hydrogen tends to be about 2.5% on an average. The surplus hydrogen had to be flare-combusted in the combustion tube.

[Description of Improvement]

Structure explanation, Shape, and/or System diagram

1) Production quantity of hydrogen was controlled by ACS computers in response to changes in hydrogen demand and in the amount of raw materials. (See Fig. 1.)
2) As a result, production loss of the hydrogen production unit became 0 %.

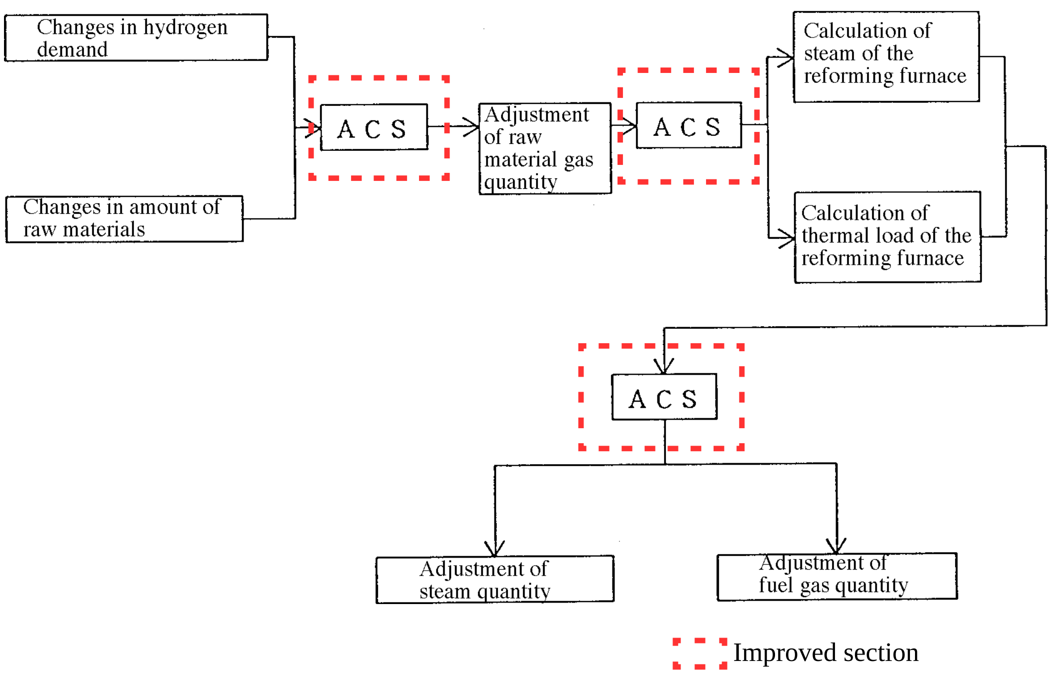


Fig. 1 Computer control of the hydrogen production unit in response to changes in hydrogen demand and raw material amount

Energy saving effects

Table 1 Energy saving effects by minimizing productioin loss of the hydrogen production unit

	After improvement	Note
Fuel consumption - C grade heavy oil equivalent	1,350 kL/y reduction	
Fuel consumption - Crude oil equivalent	1,431 kL/y reduction	

[Economics] Equipment cost

Investment amount (A): 10 million yen, Improvement effect (B): 29 million yen/year
Investment payback (A/B): 0.4 year

Remarks

Hardware technology for ACS control system exists. Manpower cost for developing technology for utilizing it in this process required.

[Example sites]

[References]
Industry-owned technical materials and data of oil companies

[Inquiry]
ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-15	Energy Conservation Directory	
[Industry Classification] Oil Refining	Petroleum refining process	[Energy Source] Fuel
[Technology Classification] Operation & Management	Flare gas recovery system	[Practical Use] 1989

Outline

The flare gas discharged from this refinery amounts to as much as 9 to 10 tons per day. This corresponds to 3,000 kiloliters of fuel oil. The refinery implemented a plan for recovery of this flare gas.

Principle & Mechanism

- An analysis of the flare gas showed that the hydrogen content in this gas was as high as 48 percent.
- Two methods, water sealing compressor method and ejector method, were studied and the water sealing compressor method was selected because of its lower operating cost.

[Description]

Structure explanation, Shape, and/or System diagram

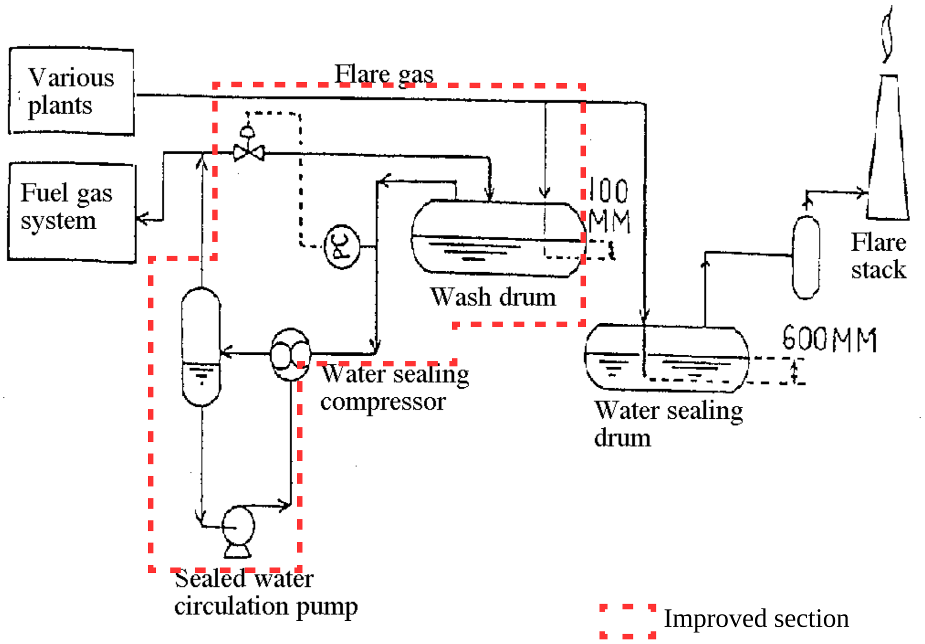


Fig. 1 Flow scheme of flare gas recovery system

Energy saving effects

Table 1 Energy saving effects of flare gas recovery

	After improvement	Note
Recovered flare gas	3,000 t/y	
Recovered flare gas - crude oil equivalent	900,000 kL/y	at 300 kL/ton of operation

Note: Yearly average flare gas volume: 10 tons/day, Operating days: 300/year

[Economics] Equipment cost

Investment amount (A): 100 to 150 million yen, Improvement effect (B): 70 million yen/year
Investment payback (A/B): 2.5 years

Remarks

[Example sites]	[References]	[Inquiry]
	The Energy Conservation Center, Japan, "Collection of Energy Conservation Cases 1990," p. 809	ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-16

Energy Conservation Directory

[Industry Classification] Oil Refining

[Technology Classification] Operation & Management

Increased concentration of amine solution in the off-gas desulfurizing process

[Energy Source] Fuel, Steam

[Practical Use] Prior to 1980

Outline

Concentration of amine used for desulfurizing the off-gas is increased, thereby decreasing the circulation quantity of amine solution and reducing the steam used for dissipating the absorbing gas (H_2S) in the regeneration tower.

Principle & Mechanism

1) H_2S is absorbed in amine solution (rich amine) in the absorption tower. The rich amine is heated in the regeneration tower to dissipate the absorbed H_2S, then the amine (lean amine) is recycled to the absorption tower.
2) The quantity of steam used for regenerating the amine solution is proportional to the circulation quantity of the solution.

[Description] Structure explanation, Shape, and/or System diagram

1) This method aims to save heat energy for the regeneration tower by increasing the concentration of amine solution and thus reducing the circulation quantity. However, care must be taken in reducing the circulation quantity: if the circulation quantity is merely reduced more than appropriate, H_2S load increases, and erosion of the equipment and the leak of H_2S into the gas result.
2) If the concentration is excessively increased, foaming may occur.
The Amine concentration generally adopted is as follows.

MEA	15 weight %
ADIP	25 weight %

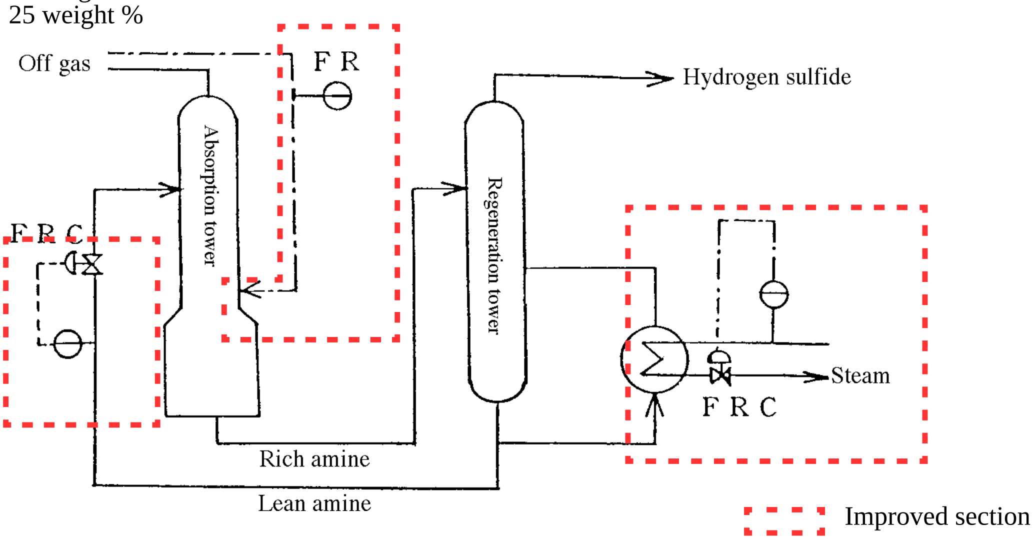


Fig. 1 Process flow for reducing the steam used for dissipating the absorbing gas in the regeneration tower

Energy saving effects

Table 1 Example of reduction in consumption of steam used for heating

		Before	After	Effect
Operation condition, APID concentration		2.5 mol/L	4.0 mol/L	1.6 times
Energy comsumption	Steam	28.3 t/h	17.7 t/h	10.6 t/h reduction
	Electrtic power	275 kWh/h	241 kWh/h	34 kWh/h reduction
Crude oil equivalent *				6,980kL/y reduction

(Note: Operating days: 8,000 h/year)

[Economics] Equipment cost

Investment amount (A): small (operational improvement without capital investment)
Improvement effect (B): 140 million yen/year
Investment payback (A/B): years

Remarks

[Example sites]

[References]
"Energy Saving Journal", ECC, (Vol. 31 No. 8, 1979)

[Inquiry]
ECCJ(JIEC) / Petroleum Association of Japan

OR-OM-17	Energy Conservation Directory	
[Industry Classification] Oil Refining	Vacuum gas oil desulfurization unit Reduction of steam supply to the reboiler for the amine regenerator	[Energy Source] Electricity, Steam
[Technology Classification] Operation & Management		[Practical Use] 1992

Outline

As the circulation rate of amine solution is increased in gas scrubbing, the hydrogen sulfide content in the washed gas is generally reduced. As the steam for amine regeneration is increased, the degree of amine regeneration is increased. The steam for amine regeneration accounts for more than 90 percent of the operating cost of the amine section. This case is an example of energy saving achieved in the steam for regeneration by realizing operation at fixed rate of throughput.

Principle & Mechanism

[Definition]

- Amine circulation ratio = Rate of amine circulation /Throughput rate of the vacuum gas oil desulfurization unit
- Steam ratio = Rate of regeneration steam/Rate of amine circulation

[Description]

Structure explanation, Shape, and/or System diagram

1) Minimum required rate of amine circulation and that of generation steam were studied based on test run data. As a result, the amine circulation ratio and steam ratio were determined to be 0.7 and 0.095, respectively. However, the minimum allowable throughput of the trays of the amine regeneration column limited the operation rate to 44 percent.
2) In addition, a microcomputer control system was introduced to control the steam rate in response to the fluctuation of the throughput of the vacuum gas oil desulfurization unit. At the steam ratio of 0.095 there was some allowance for further reduction. The overhead temperature of the regeneration column was controlled at a fixed temperature to further promote energy saving.

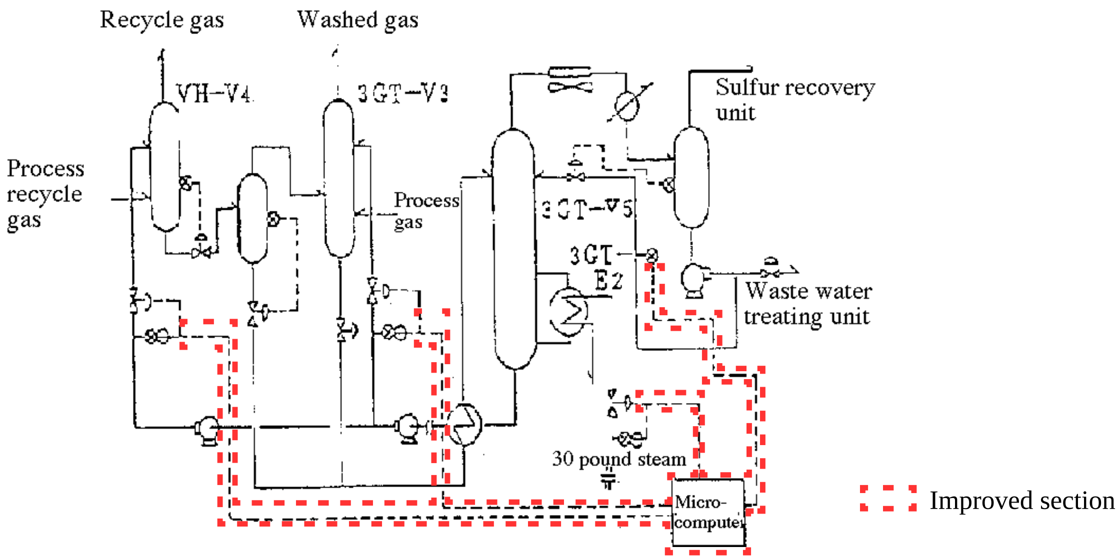


Fig. 1 Microcomputer control system for overhead reflux flow of regeneration column

Energy saving effects

Table 1 Energy saving effects (Throughput: 45,000 BPD base)

	Before improvement	After improvement	Note
Fuel consumption		5,600 kL/y reduction	Effects vary among individual refining plants.
Crude oil equivalent		5,936 kL/y reduction	

[Economics] Equipment cost

Investment amount (A): a set of microcomputers: 20 to 50 million yen,
Improvement effect (B): 120 million yen/year
Investment payback (A/B): 0.5 year

Remarks

[Example sites]	[References]	[Inquiry]
	The Energy Conservation Center, Japan, "Collection of Energy Conservation Cases 1984," p. 1261	ECCJ(JIEC) / Petroleum Association of Japan