Hitachi Group's Involvement in Oil and Gas Industry

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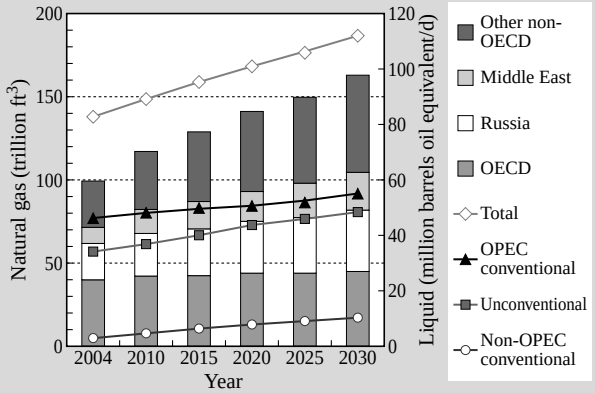
OVERVIEW: The persistent trend towards long-term growth in international energy consumption is exacerbating the problem of global warming caused by increasing CO_2 emissions. The oil and gas industry is working proactively in its role as a global citizen to deal with this problem within its own sector and elsewhere. Through a number of energy-saving technologies developed over the years, Hitachi Group has reduced CO_2 emissions and contributed to environmental conservation in the oil and gas sector. This article describes how Hitachi is applying its energy conservation technologies to tackle environmental challenges, particularly in oil and gas plants.

INTRODUCTION

AS typified by the drastically expanding energy consumption in emerging countries in recent years, global demand for oil and gas resources is expected to continue to grow significantly, requiring efficient use and sustained supply of limited resources (see Fig. 1). On the other hand, there is a pressing need to improve oil and gas plants and make their systems more environmentally friendly in order to deal with the problems of global warming and increased CO_2 emissions resulting from this growth in energy consumption. This is as true of existing plants as it is of new plants.



Source: Energy Information Administration (EIA) International Energy Outlook 2007

OECD: Organization for Economic Cooperation and Development
OPEC: Organization of the Petroleum Exporting Countries

Fig. 1—Worldwide Consumption of Marketed Energy, 2004–2030.
The long-term trend for growth in oil and gas energy consumption continues.

Hitachi Group has developed various technologies and offers solutions for oil and gas plants to meet these challenges.

REFERENCES OF HITACHI GROUP'S ACTIVITIES

Hitachi Group has delivered a wide variety of equipment, materials and systems for individual applications in oil and gas plants. Major items include centrifugal compressors, which are important items for production, pumps, HV (high voltage) motors, data control systems, and power supply equipment such as gas turbine generators and substations (see Fig.2).

Reducing life cycle costs is a key issue for centrifugal compressors which also need to maintain high efficiency and provide a wide operating range. As a manufacturer of centrifugal compressors, Hitachi Plant Technologies, Ltd. undertakes ongoing research into a wide range of technologies aimed at these objectives of high efficiency and wide operating range.

In the field of gas turbine generators, reliability, higher performance and efficiency, fuel flexibility, and the ability to comply with special specifications are important criteria and are key considerations in gas turbine development at Hitachi Group.

Details of this work are explained further in later sections.

Based on its considerable experience in supplying equipment, Hitachi has also been actively involved in recent years in supplying various solutions that combine the technologies and products described in the previous sections to deliver environmentally friendly equipment and energy saving measures for the reliable supply of resources to meet the ever-growing demand for energy.

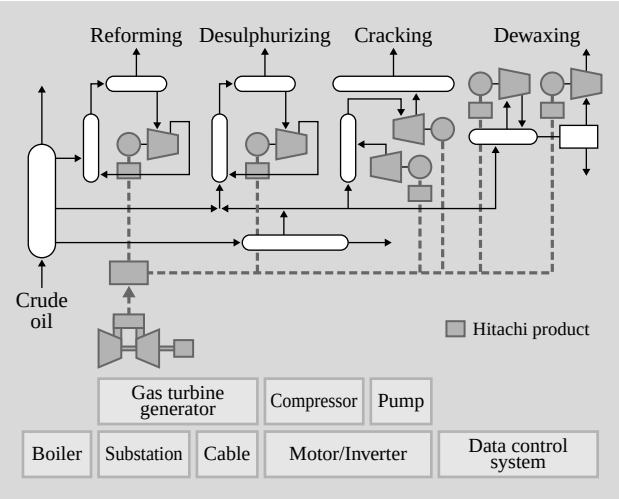


Fig. 2—Case Study of Hitachi Product Installation at Oil and Gas Plant.
Covers a wide range of areas from power generation to process machinery.

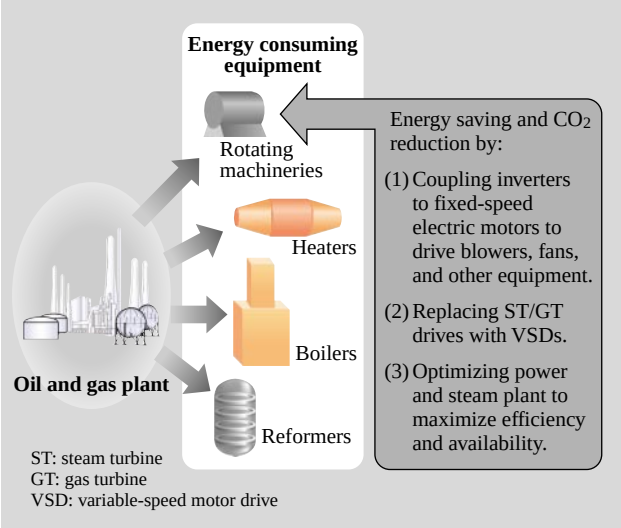


Fig. 3—Concept of Hitachi All-electric Drive Solutions. A range of solutions are offered with a focus on rotating machineries.

The following section introduces a number of these solutions.

ALL-ELECTRIC DRIVE SOLUTIONS FOR ENERGY SAVING AND CO_2 REDUCTION

Background

Primary energy consumption in the industrial sector accounts for 37% of global primary energy and is still growing at an average annual rate of 1.5%. The industrial sector is widely diverse and includes activities such as exploration and production of natural resources, converting these into raw materials, and manufacturing of final products. Plant owners, especially those who are involved in energy intensive activities, face strong incentives to improve efficiency and reduce energy consumption because of the pressures to minimize overall production costs against a background of volatile energy prices. Along with energy consumption, there is also a strong expectation on plant owners to reduce CO_2 emissions in response to environmental regulatory requirements and growing demand for more environmentally friendly products. Considering the potential for efficiency improvements, it is estimated that use of VSDs (variable-speed motor drives) can typically reduce energy use in motor drives by 30% and these savings translate directly into lower plant energy costs. Given that 20 million industrial motors make up 65% of worldwide industrial electricity consumption, this means that, in theory, savings of 360 million tons of CO_2 could be achieved by improving motor drive efficiency all over the world. That is, improving the efficiency of industrial motor drives also provides a significant contribution to reducing CO_2 emissions, making it an example of an extremely effective solution to the concerns of plant owners described above.

Features of Hitachi All-electric Drive Solutions

Given the above background, although one-third of energy consumed in industrial plants is in the form of heat, the "All-electric Drive Solution" is targeted primarily at rotating machineries in industrial plants for reasons associated with ability to retrofit, avoiding the need for process redesign, and minimizing CAPEX (capital expenditure) and shutdown times (see Fig. 3).

In the field of plant equipment, Hitachi's experience is particularly strong in the area of rotating machineries. Hitachi, Ltd. was founded in 1910 as a repair plant attached to Kuhara Mining Co.'s Hitachi Mine. The company's first products were motors. Since then, Hitachi has developed various rotating machineries and related technologies.

Hitachi has focused on solutions that utilize this machinery and technologies. The following section provides some references of typical three solutions.

REFERENCE OF ALL-ELECTRTIC DRIVE SOLUTIONS

Coupling Inverters with Fixed-speed Electric Motors

Plant facilities that are required to operate flexibly have an increasing need to use VSDs for rotational speed

TABLE 1. Comparison of Drive Types for Rotating Machineries
Comparisons of drive types are given.

Item \ Drive type	Steam Turbine	Gas Turbine	Electric Motor
Plant size	Up to medium size on track records	Up to large size (selection from limited GT models)	Up to 65 MW on track records
Hot weather impact	No impact	Needs helper turbine and/or motor	No impact with redundant power supply
Safety	Boiler outside train	GT inside train	Equipment for power supply outside train
Operability	Flexible but complicated start-up sequence for auxiliary systems	Narrow operation range	Flexible with inverter
Maintainability	Highly reliable but requires large number of spare parts	Requires periodic maintenance (20 to 40 d/year)	High availability and few spare parts
CAPEX	High because large volume of field work required	Low	Low with stable power supply
Life cycle cost	High due to loss of steam during start-up	Medium	Low
Vendor	Numerous	Limited	Numerous

control in order to save energy. VSDs offer significant energy-saving benefits for a range of different machinery that is currently operated using fixed-speed motors such as fans, pumps, and blowers. These benefits include control range, rate of change of speed, and maintainability [(1)].

Converting existing machinery and motors to use VSD control involves the following steps.
(1) Identify which machinery and motors to convert
(2) Accurately calculate the energy savings for each target motor
(3) Design the equipment and systems
(4) Deliver, install and commission
(5) Verify the energy savings

The important point for the customer in this process is whether the estimated and actual energy savings can be determined accurately and Hitachi has extensive experience in the technology for estimating, monitoring, and verifying these savings.

Torsional vibration due to higher harmonics has been identified as a potential problem when using VSDs but Hitachi has technology to suppress or eliminate torsional vibration to prevent damage to the equipment. Details of this technology are described in the "Examples of Electric Drive Solutions and Applied Technologies" report included in this issue.

Replacement of Steam and Gas Turbine Drive with VSD

At the facility level, it is said that more efficient rotating machinery systems can typically reduce energy consumption by 15 to 20% and that optimizing compressors can produce improvements of 20 to 50% [(2)].

There are several ways of driving compressors such as steam turbine drive, gas turbine direct drive, and motor drive. Each system has advantages and disadvantages as summarized in Table 1 and motor drive systems with the features listed below represent a good solution for energy saving and CO_2 reduction:
(1) Minimum investment in existing plant, shutdown time, and modifications to the operating process and utilities
(2) High availability, operability and maintainability with sustainable and redundant power supplies
(3) High efficiency by applying state-of-the-art CCGT (combined cycle gas turbine) and VSD
(4) Sustainable production that is not affected by hot weather and periodic overhauls
(5) Flexible design and short project lead times by using standard materials

Optimization of Existing Power Plant System

However, in addition to the demand-side efficiency improvements described above, where possible, improvements in the efficiency of supply-side systems (existing power plant systems) can also be an important factor in maximizing total plant efficiency and availability while minimizing CO_2 emissions.

The simplest way to reduce CO_2 emissions from industrial plants is to switch fuel source from coal to oil or from oil to gas because the ratio of CO_2 emissions from coal, oil, and gas is 10 : 8 : 6 respectively. The efficiency of electricity generation using a simple-cycle gas turbine fueled by gas is approximately 35%. Other methods for increasing energy efficiency include converting the generation system to use CCGT or steam injection and cogeneration (see Fig. 4).

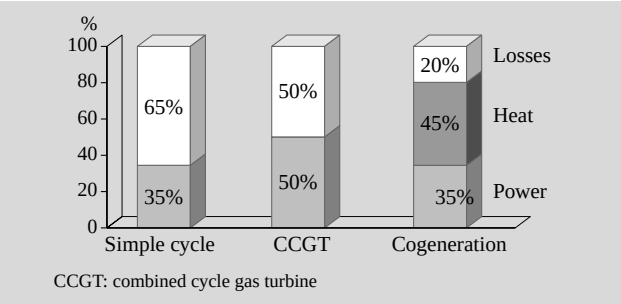


Fig. 4—Energy Efficiency Improvements.
The figure shows energy efficiency improvements in power and steam plants.

Energy efficiencies above 50% can be obtained from a CCGT fitted with a HRSG (heat recovery steam generator) and steam turbine. This works by using the 560°C exhaust gas from the gas turbine to generate super-heated steam at a temperature of 520°C and pressure of 5 MPa in the HRSG, and then feeding this into the steam turbine.

Adding a steam injection system can further improve efficiency by several percent. Steam injection system can be installed simply by extending a medium-pressure steam line rated at more than 2.5 MPa and spiking into the gas turbine combustor.

Furthermore, the basic advantage of cogeneration is that the conventional mechanical efficiency is increased to more than 80% by recovering and using the energy contained in flue gases.

CONCLUSIONS

These solutions not only supply the products needed for energy saving and CO_2 reduction, they are also available as a practical solution package to answer the questions that plant owners inevitably have about the actual improvement in the energy efficiency of their plants. For this reason, Hitachi offers a customized service to help clients identify potential efficiency improvements in electricity and other energy sources.

Hitachi will continue to use these methodologies to offer solutions to oil and gas plants proactively.

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