

B-16.6.11 Study on evaluation of effectiveness for CH₄ and N₂O emission control technology (Final Report)

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Abstract To fully evaluate the effectiveness of various measures for reducing emissions of CH₄ and N₂O, we have studied and analyzed the effectiveness and cost of various technologies used for controlling these gases. As a final evaluation, we did the research necessary to develop a cost-benefit ratio analysis. Since it can be assumed that employment of these technologies have a significant effect on the primary objectives of the facilities, besides just the control of CH₄ and N₂O emissions, these related effects were also studied. While doing this research, an effort was made to gather information on details on present emission control (EC) technology, objectives of present research, requirements, and progress of EC technologies development, as best possible for development of evaluation methods, taking into consideration past research and efficiency. By setting realistic assumptions, based on the above studies, analyses were made to estimate feasible reduction rates of individual EC technologies, and the potential overall impact of various technologies on reduction of GHG from various sources. For final evaluation of EC technologies, it is necessary to consider their impacts on the primary objectives of the facilities and other side effects, and it is also necessary to quantitatively consolidate mechanisms that can affect society and industries, and to study modeling such mechanisms. We are proposing here schemes for the future, based on these studies.

Keywords CH₄ and N₂O emission control technology, cost/benefit ratio, reducing effects, total evaluation, effects on primary objectives, spreading effects

1. Introduction

CH₄ and N₂O are major greenhouse gases (GHG), together with CO₂. The reduction target for these gases has been established at COP3, and its achievement is considered an important challenge. However, the potential greenhouse effects from emission sources of CH₄ and N₂O have not been fully determined at present. Therefore, it is necessary to locate highly potential sources of CH₄ and N₂O emissions that are not required to have controls, and to facilitate studies on emission control technology and to make up an action plan to achieve the reduction target. However, at present the accuracy of estimating CH₄ and N₂O emissions at sources is extremely low. Although there are potential high emission sources of gases, such as N₂O from domestic and industrial wastewater treatment systems, some

sources have not been properly estimated because of insufficient scientific knowledge.

Technology to control emissions from individual sources being developed in conjunction with this research project, basic and fundamental information is being gathered, and promotion of demonstration study in the future has become an important subject. For promotion of an efficient demonstration study, it is necessary to evaluate emission control technologies that have been developed and to place emphasis to the importance on them. A number of approaches can be considered as methods of evaluation but it is important to consider the method of evaluation as a final target, taking into account the cost-benefits and side effects, which are considered as matters of the highest priority for selection of emission control technology, as well as impacts on primary objectives, including productivity and treatment efficiency, and on the environment. It is also important, to accomplish GHG reduction at a worldwide level, to provide pollution control measures for developing countries in Asia, with its large population and rapidly growing economy.

This research project has been made taking the above points into consideration, and to establish baseline data to allow total evaluation of technical features and individual technologies related to emission control technologies being developed as a result of this project. Cost factors are analyzed to establish baselines affecting primary objectives, such as productivity and treatment efficiency, and cost benefit ratios.

2. Consolidation of Evaluation Methods

2.1 Study of CH₄ and N₂O Emission Control Technology

Technologies being developed by this project are at various levels including fundamental studies, bench scale studies, and pilot scale studies, but this research has been made mainly on technologies in the following listed fields, which are considered feasible for a future demonstration projects.

(1) The Field of Energy

- ① Partial heating method by blowing auxiliary fuel gas into combustion equipment and pretreatment of fuel and two-step combustion method (1A Fuel Combustion : 1A1 Energy industry : fixed combustion facilities) <N₂O>

(2) The Field of Agricultural

- ① Management of organic matter in paddy fields [removal of biomass] (4C Rice Cultivation) <CH₄>
- ② Selection of paddy-rice plant breeding (4C Rice Cultivation) <CH₄>
- ③ Changing procedures for applying manure from uniform fertilizing to channel fertilizing (4D Agriculture Soils) <N₂O>
- ④ Use of slow-acting nitrogenous fertilizers or fertilizers containing a nitrification control agent (4D Agriculture Soils) <N₂O>
- ⑤ Improve the productivity of milk cows (4A Enteric Fermentation) <CH₄>
- ⑥ Improve the productivity of cattle raising (4A Enteric Fermentation) <CH₄>
- ⑦ Improvement of feed-grain composition for ruminant livestock (4A Enteric Fermentation) <CH₄>

(3) The Field of Waste

- ① Changes to mechanical batch-type waste incineration process (6C Waste Incineration) <N₂O>

- ② Changes to domestic wastewater treatment process (6B Wastewater handling) <N₂O>
- ③ Changes to the combustion process for sludge incinerators (6C Waste Incineration) <N₂O>

2.2 Basic Factors for Technology Evaluation of CH₄ and N₂O Emission Controls

An evaluation of emission control technologies was made, placing importance to the following points:

(1) Evaluation based on Cost-Benefits

It was decided during the course of this project that evaluations would be based on that cost-benefits can be the most common axis for evaluation of individual technologies that priorities for employment of emission control technology is the most important factor from the view of administrative policy that there are many different emission control technologies. For these reasons it is necessary to use basic indexes, including costs, for full evaluation of technologies, and to evaluate the relationship with costs required for effects of emission control technology, and introduction and operation of emission control technology, that is, the analysis of cost-benefits.

(2) Consideration of Primary Objectives

Emission control technology accomplishes its purpose of reducing emissions of CH₄ and N₂O. However, negative impacts often appear in conjunction with these primary objectives, such as reduced crop yields in the agricultural field, or negative environmental impacts. Therefore, efforts were made to develop technologies to accomplish the primary objectives in a practical manner for individual situations.

(3) Consideration of Side Effects

Since emission control technology is aimed at reducing emission of CH₄ and N₂O, these can be reduced by implementation of such technology. However, indirect side effects often have an impact on the natural and social environments, including water resources and labor forces, when the control measures are implemented. Therefore, a strong effort was made to understand, as much as possible, the full extent of all impacts resulting from the individual emission control technologies.

(4) Generalization of Evaluation Methods

It is desirable that the evaluation methods discussed here be usable in various regions and under any environmental condition, both inside and outside of the country. For this purpose, the study was made in a manner to generalize such evaluation methods as much as possible.

2.3 Extraction of Items to be Examined, and Gathering and Filing Data

The emission control technology addressed in this project affects not only the control of CH₄ and N₂O emissions but other subjects as well. Since the range of such effects can vary dependent on different emission control technologies, a study of evaluation methods was made to clarify the objectives, the priorities, and progress of the study to understand the current status of individual emission control technologies.

2.4 Major Items Examined

- (1) Details of Emission Control Technologies
- (2) Final Objectives of Study (spreading of knowledge within the country and to developing countries) and Progress of Study
- (3) Profile of Study (prerequisites)
 - ① Change of work, management demands, and resources required (consumables and equipment) before and after introduction of emission control technology.
 - ② Effects and influences of introduction of emission control technology (effects of reduced greenhouse gases, effect on primary objectives and other related factors).
 - ③ All other items to be considered.

2.5 Examination of Cost/benefit Ratios and Identification of Problems for the Following Fiscal Years

Based on information obtained from the above, estimation accuracy was examined by making clear the prerequisites required for estimation of cost benefit ratios of individual emission control technologies and related assumptions that are necessary for quantifying factors affecting the computation of cost benefit ratio of the individual emission control technologies considered.

For evaluation of the primary objectives and side effects, quantitative and qualitative data were shown in a meaningful range. For effects on primary objectives and influences of side effects, examination of items to be evaluated and evaluation guidelines in order to incorporate these into overall evaluation. These items were examined in detail so that evaluation in accordance with evaluation guidelines, including the cost-benefit ratio, could be done.

3. Evaluation Method, Discussion

3.1 Data Necessary for Cost-Benefit Analysis and Analyzing Directions

It is necessary to consider the following.

(1) Consolidation of Items Necessary for Evaluation

It is necessary to consider all costs, including the costs related to side effects, and to establish base line costs in order to evaluate the various technologies.

I. Costs

- ① Material and property cost
 - Cost for procurement of durable properties (infrastructure, equipment etc.)
 - Cost for procurement of consumables (furnishings, maintenance, energy, water utilization, etc.)
- ② Labor cost
 - Labor cost relating to changed procedures
 - Labor cost related to addition work.

II. Effects

- ① Reduction of emission of GHG: change in emissions of CH₄, N₂O, and CO₂
- ② Impacts, or side effects: effect on the production (such as crop yields, or quantity of

waste disposed)

(2) Evaluation Procedures

In more refined analysis in the future, prerequisites for application of emission control technology as shown below are consolidated at first based on the analysis made this time to arrange and adjust necessary data. Where importance of analysis is placed on macro estimate, it is necessary to adjust the results of estimating individual cases to match the actual state of emission of gases of the entire country.

I. Basic Plan

① Determination of project design

- Judgment is required when considering if the plan requires changes in management of products, whether the project is inside or outside the country, and the overall impact of the project to see if it is a Win-Win situation

② Determination of information required.

③ Determination of baseline: establish standard procedures to be used as baseline.

II. Arrangement of Data

① Data verified by studies: identify the relationship between results of the study and emission control.

② Data estimated from available information: make assumptions through appropriate processing of existing statistics.

③ Dummy data: apply dummy data to unknown data.

(3) Themes and Emission Control Policy in the Future

Baselines were assumed for individual emission control technologies in this research project, but there is room for modification. Although individual studies have their unique conditions as baselines, these cannot be applied to analysis as they are, even if they are similar data. Therefore, modification of baselines related to individual emission control technologies and development of methods of effectively using existing data will become themes for future discussion.

Where the focus of emission control technology is placed on the transfer of technology, it becomes necessary to consider the costs shown below.

① Material and property cost: transportation cost, etc.

② Labor cost: cost required for upgrading and recruiting human resources

3.2 Incorporation of Benefits into Cost-Benefit Analysis

In order to evaluate emission control technologies in the practical form and to spread them as a core technology, it becomes necessary to incorporate benefits into cost-benefit analysis. The following is an outline of items to be discussed for the incorporation of benefits.

(1) Consolidation of Items to be subjected to Benefit-cost Evaluation

Application of emission control technology means that a current working system is changed to a new working system, and that change in addition to the discharge of GHG will occur. In order to take this into consideration, it is necessary to perform a cost-benefit

evaluation on the effect of individual items shown below.

- ① Influence on primary objectives of system: qualitative influence (such as the quality of crops)
- ② Other side effects:
 - Influence on the society, other than industries (social benefits, infrastructure, etc)
 - Influence on industries (on products and labor markets)
 - Influence on the environment, other than global warming (on atmospheric air, water quality, soil contamination, natural resources, etc)

(2) Information Required

Upon development of methods to perform the above cost-benefit evaluation, the following arrangement can become necessary.

① Consider impacts on society

Consider how individual technologies may impact society and develop procedure to quantify this impact. It is desirable this be considered together with examining the practicability of a design. It is important to make clear how influences on the environment (other than global warming) is fed back in various forms, including side effects or impacts on society.

② Quantifying individual items

Influences on the society and on industries can be evaluated by their economic impact, but influences on the environment (except for global warming) must be divided into those that can be evaluated by economics and those that cannot be so evaluated, as shown with the feedback model in above.

The above describes analyses to be made in the future. The target should be to quantify these effects, taking into account the impacts on society and industries.

4. Conclusion

Fundamental studies and analyses were made during this research project on the cost-benefit analysis of measures to control emissions of CH_4 and N_2O from various sources where artificial occurrence of these gases can be assumed. It is understood that it is necessary to establish baseline data for the various emission control technologies to develop methods for the practical use of existing data, and that arrangement of mechanisms, modeling, and quantifying of individual items are important because of their impacts on society. All these factors must be considered in making the cost-benefit analysis.

Based on the above, it will be necessary in the future to: (1) develop methods of effectively gathering and using existing research data and filing of data for this purpose (including linking with IPCC Inventory Task Force), and, (2) develop methods for evaluating benefits society receives from emission control technology (accomplishments and side effects). However, the greatest factor influencing the evaluation of emission control technologies is the accuracy of estimating the CH_4 and N_2O at various emission sources. It is necessary to establish methods for evaluating the accuracy these estimates, not only by promoting research, but also by obtaining additional data.