Study on the effect of the progress of materials technology on the reduction of CO2

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1.Introduction

Industries associated with materials generate CO2 more than one quarter of the generation in Japan. The materials industry also related with the CO2 emission by the mining and extraction of numerous amount of raw materials in foreign countries. Furthermore, as materials are used in automobile, housings, and other products in the stage of using, the materials-selection gives great effect on the CO2 emission through the consumption of fuels. This relates to the CO2 emission of the technical area of transportation and that of livelihood.

However, only the curtailment effect inside an industry of material can be estimated, but, it is hard to say that it had become the optimal measure which also foresaw the influence which affects other fields where materials technology covers. Then, it is important to grasp the environmental load in the material use not only including a manufacture stage but the stage of use or abandonment in LCA. Moreover, it also needs to be a synthetic method of evaluating not the partial solution of an individual product but the total social effect of material material-substitution I Japan. Therefore, it is necessary to perform effect prediction for every conventional manufacture unit, synthetic effect prediction beyond the evaluation according to product, and data maintenance for it, and to utilize to optimization of the preventive measures from a synthetic standpoint.

Therefore, in this research, by converting into the new material technology with which the material took environment into consideration, the curtailment effect of the environmental load in the whole society which is using the material is estimated, and the whole life cycle is considered to research and development of the material which leads to the CO2 curtailment which leads, and promotion of spread and use.

2.Procedure

At the first fiscal year, the existing investigation and existing arrangement of the example of examination which discussed the effect of global warming by the material last year or LCA of a product was collected and the technological information on the approach of reduction of global warming gas emission by the altering materials from the various field, such as steel manufacturing, aluminum manufacturing, plastic manufacturing as providers of material, and the field of electric supplying, of constructions, of vehicle and of household electric equipments as the stand point of the user of material for eco-design were investigated by the hearing and discussion of specialist and engineer of each field. In order to support the quantitative analysis, two databases are prepared. One is the database of CO2 emission in the stage of extraction of metals, and the other is the database of material-flow in Japan. To obtain the content of the database, process data and material trade data are collected and newly arranged in this investigation.

In the second fiscal year should follow the existing investigation and existing arrangement of the

example of examination which discussed the effect of global warming by the material last year or LCA of a product. The item which is an effect and which is expected to be was extracted from these cases which picked up to CO2 reduction, and the quantitative calculation was performed. In extraction, it hit with the “recycle oriented materialization committee” and “environmentally designed materialization committee” which were constituted by the specialist of each material manufacture and material use.
Furthermore, the effect of CO2 curtailment was calculated based on existing process data and existing material flow data to these extraction items. In calculation of the CO2 curtailment effect, although there was much life cycle assessment per product in the LCA-technique existed, it was difficult to argue about the influence in whole our country in consideration of the quantity of production, its saturation level by the difficulty of setting up of the range for technical, etc. moreover changed with analyses, etc. Then, the evaluation which fixed the viewpoint was tried in this work. It aimed at that the CO2 curtailment effect of material conversion extracted a focus to what quantity is effective, and could survey the grade of an important field and its importance from the viewpoint in what field. Namely, the subject is focused on as follows
- materials technology which can be applied if the social condition is acceptable; not the technology which is on research.
- materials technology which is on the way of dissemination at the present and it was aimed at what needs to know the grade of the CO2 curtailment effect in 100% of dissemination.
From the viewpoint mentioned above, the effects of substitution of materials technology are roughly estimated on the conversion of utilization of materials in products such as automobile, housing and so on. And the effect of the conversion of materials into the material which is easy to recycle is also estimated.

In the last year, the effect of typical material substitutions were investigated by use of a social LCA method, which is newly developed. The social LCA method is based on Input-Output Table analysis. In Social-LCA the distribution of model year and its efficiency of input-saving were installed in the I-O matrix which was modified to be extended industrial model to be ease the difference of materials substitution. Further investigation of introducing model were tried. The further study aimed at the developing a basic framework to evaluate different technologies considering various socio-economic constrains that affect the introduction of their technologies into a society, when assuming that the minimization of the total CO2 emission is a societal objective. Based on the frame-work, an inter-temporal optimization model using an input-output table was developed.

3.Results

3.1 The effect of materials substitution in products

About conversion of the material in a product, it decided to evaluate by the following viewpoints.

a) The annual total amount of our country of CO2 generated in the use stage of the target product was calculated, and it was based on it.
b) If the demand present in the state where the material technology does not exist was provided, it had comparison with the guess of CO2 quantity which had probably been generated superfluously at present, and the amount of social influences of object technology at present was estimated.
c) It had comparison with CO2 generating at the time of 100% spread which can apply the technology with the present demand, and it was presupposed that the future is potential.

The products wish were subjected were 1) electric steel in transformer, 2) high tensile steel and aluminum in automobile, 3) stainless steel and aluminum in car of train, 4) heat insulation material in house.

1) electric steel in transformer
The directivity of transformer material which is progressing now -- electromagnetism -- the conversion to a steel plate is equivalent to having cut down 7,020,000t [/year] CO2 to the case where the present power transmission demand is held without material conversion starting Moreover, it is if conversion of a transformer material will be advanced from now on and present technology disseminates through all transformers to the present power transmission demand. It has potential which cuts down 1,670,000t [/year] CO2.

2) high tensile steel and aluminum in automobile
The material conversion in vehicles which is progressing now is equivalent to having cut down 8,400,000 [t/year] CO2 to the case where it is going to hold the present automobile demand with the material technology of the 1970 level, without vehicles conversion starting. Moreover, it is if conversion of a vehicles material will be advanced from now on and all become the material composition of the 2000 level to the present passenger car demand. It has potential which cuts down 1 million [t/year] CO2, and use of ULSAB steel and aluminum body-ization have the possibility of 3,200,000 [t /year] and 4,100,000[t/year] of CO2 curtailment the year further, respectively.

3) stainless steel and aluminum in car of train
The material conversion in train which is progressing now is equivalent to having cut down 1,490,000 [t/year] CO2 to the case where the present railroad demand is held without vehicles conversion starting. Moreover, if conversion of a vehicles material will be advanced to the present railroad demand from now on, it has potential which cuts down 670,000 [t/year] CO2.

4) heat insulation material in house
Application of the thermal insulation material which is advancing now is equivalent to having cut down 2,200,000 [t/year] CO2 to the case where the present housing state is maintained without using thermal insulation. Moreover, it is if use of thermal insulation will be advanced from now on to the present housing state. It has potential which cuts down 19,200,000 [t/year] CO2.

3.2 The effect of materials' change into recyclable one

The effect of recycling on global environmental impact were estimated by using the parameter of CO2 emission on the basis of material flow analysis. Dependency on natural resource is discussed as an appropriate parameter of recycling, and their values of almost metals are greater than one. This means that the current recycling system is still depending on process scraps, not EoL scraps. In spite of the dependence on process scrap, recycling reduces CO2 into 30% ～40%, comparing to the case of all raw materials comes from natural resources. Further reduction is expected by promoting recycling. Furthermore, recyclable design and alloy to alloy recycling can exceed this estimation

3.3 Social-LCA approach

In the case of the application of electric steel, the reduction of CO2 emission in whole Japan was calculated to be 6.4Mt. However the annual reduction of CO2 at the 20 years later was only 0.095Mt-CO2/year. This value is less than the value in the former calculation. This was considered to come from greater effect of reduced input associated with the whole industrial sectors more than the effect of reduction of energy in the utilization sectors induced by the result of energy-saving.
In the case of lightning of automobile, the total effect of lightning during 20 years was calculated to be about 86Mt, and the annual reduction is about 12Mt/year at 20 years later. This calculated value is greater than the value calculated previously. The reason is considered to come from the greatness of the role of transportation in every industrial sectors to be affected the result of fuel saving by lightning of automobile. Further calculation of the applied cases of ULSAB steel (60% high tesile steel structure) and Al frame were also calculated. They will give greater reduction effect of CO2 emission as 15.6Mt-CO2/year and 15.8Mt-CO2/y at 10 years later respectively.
The acceleration cases of substitution were also calculated. In any case of electric steel or lightweightning of automobile, the CO2 emission were calculated to be increased by the induced input of accelerated production of new substitutional models.
For the application of buildings as the heat insulated material, more detailed calculation model was investigated. The effect of the dependence on the boundaries of calculation such as the financial possibility of re-construction, labors population fro construction , or the priorities for the re-construction policy was confirmed. We need the optimum scenario in introduction of substutial model. The calculation model should be improved futher.