CO_2 emission on the process of desulphurization projects during "11th Five-Year Plan" period

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Abstract: China established a national level of principle pollutions (SO_2 and COD) emission that 10 percent reduction of SO2 and COD emission by priority projects, structural adjustment, and environmental management during the "11th Five-Year plan" period. This paper focused on the induced effect to CO_2 emission on the process of desulphurization projects. CO_2 emission related to three parts of desulphurization process: desulphurization facilities construction, desulphurization facilities operation and replacement reaction on the process of desulphurization operation. Energy consumption play an important role when calculate CO_2 emission on the process of desulphurization facilities construction and operation, and balance of materials is the major method to calculate CO_2 emission on the process of replacement reaction in desulphurization. It came up with that 3.43 tons CO_2 discharge when reduce 1ton SO_2 on average during the "11th Five-Year plan" period.

Key words: CO_2 emission, desulphurization, input-output method, priority projects

I. INTRODUCTION

Global climate change is considered an important problem to influent global economic, policy and international relations. China, as a responsible and large developing country, though without the emission caps engagement, still reduces greenhouse gas emission through set goals and established plans of energy-saving and emission-reduction. According to the objectives put forward in the 11th Five-Year plan for national economy and social development, China established a national level of sulfur dioxide (SO_2) emission that the national SO_2 emission is only 22.94 million tons in 2010 compared to 20.1 million tons in 2005. This means china will achieve the target of 10 percent reduction of SO_2 emission to curb the development of acid rain during the "11th Five-Year plan" period (2006-2010). To fulfill the goal, china established national acid rain and SO_2 pollution prevention and control plan in the 11th Five-Years, which presented to reduce SO_2 emission by priority projects, structural adjustment, and environmental management.

China would invest RMB 47bn to support the major atmosphere pollution prevention and control projects so as to increase 15.76 million ton SO_2 reduction capacity during the "11th Five-Year plan" period. The priority projects not only increase the capacity of Chinese atmosphere pollution prevention and control, but also spur economic growth. In this paper, we shall first analyses the induced effect on economy from major atmosphere pollution prevention and control projects during the "11th Five-Year plan" period. Both desulphurization facilities construction and operation all discharge carbon dioxide directly or indirectly because of using lots of energy and resources. This paper will analyses the influence on carbon dioxide （CO_2） emission from new major projects based on the analysis above. We can not only realize the co-benefit action between sulfur dioxide reduction and CO_2 emission, but also provide scientific basis for carbon dioxide emission minimization during traditional pollution reduction, on the process of quantitative analysis on influence on CO_2 emission from SO_2 reduction.

II. PROPOSE INPUT-OUTPUT MODEL

According to national industry classification (GB/T4754-2002) and the requirement of the analysis of SO_2 emission reduction by major project, we built a SO_2 emission reduction model as 13×13 sections, such as agriculture, coal excavating and washing, oil and gas mining, cottonocracy, paper making and paper product industry, Chemical industry, metal smelting and rolling processing industry, other special equipment manufacturing, electricity and thermal force producing and supplying, other industry, building industry, environmental resource and public facility management, other service industry and so on. These sections include energy sectors, significant SO_2 emission sectors, environmental protection facilities construction sections, environment control sections. The paper will update to 2005 input-output table from 2002 input-output table by using RAS measure to adapt the analytical period. When the input-output model is basically equilibrium after a few calculations of iteration, R= [1.45, 2.15, 1.70, 1.37, 3.09, 4.50, 3.25, 0.04, 2.38, 2.52, 2.52, 1.80, 1.71], S=[0.46, 0.88, 0.62, 0.62, 0.44, 0.37, 0.42, 10.29, 0.81, 1.97, 0.42, 0.51, 0.57]. $\hat{R}$ is substitute matrix, and $\hat{S}$ is manufacture matrix. The figured interdependence coefficient of 2005 input-output table is included in the appendix.

III. THE INDUCED EFFECT TO ECONOMICS FROM DESULPHURIZATION PORJECTS

Carry out desulphurization projects consist of the following components. The first project is construction of desulphurization facilities, focusing on the control of SO_2 emission from thermal power generator. All new (expanded) coal-fueled power plants except the extreme-low-sulfur-coal pithead power plants meeting national requirements must construct desulphurization facilities when constructing the principal part of the plant. Any coal fueled power plants failing to meet national SO_2 emission standards or total emission limit must install fume desulphurization devices or take other measures to meet their targets. The second project is flue gas desulphurization projects for sintering machines of iron and steel industry. The third project is construction desulphurization facilities for other industries. The forth project is SO_2 emission control for boilers. All these projects will reach RMB 47bn.

China will construct 611 desulphurization facilities reaching 184 million KW for existing in-service thermal generation sets which will reduce 6.6 million tons SO_2 per year, and install desulphurization facilities reaching 250 million KW for new (expended) coal-fueled power plants which will reduce 7.2 million tons SO2 in 2010. It will reduce 55.52 million tons SO_2 totally if we suppose to achieve annual target as 42%, 27%, 32%, 9% and 0% during “11th Five-Year plan” period. China has to invest RMB 38.864bn in daily operation, if we suppose that the operation cost of desulphurization is RMB 700 per ton.

Pollution control facilities investments play a very important role to the economic development. Studies have showed that pollution treatment investment not only essential to provide necessary condition for reaching environmental target, but also expand domestic demand. Both desulphurization facilities construction and operation related to national economy. According to GB/T4754-2002, desulphurization facilities construction belongs to other special equipment manufacturing and desulphurization operation is main subject in environmental resource and public facility management. Basic on the fundamental principle of input-output model, the induced effect to major sectors from desulphurization construction and operation respectively to shown in the following table. From the table 1 we can see that metal smelting and rolling processing industry is most affected by desulphurization construction and chemical industry is affected the most by desulphurization operation.

Table1 TABLE 1 THE INDUCED EFFECT TO MAJOR SECTORS FROM DESULPHURIZATION CONSTRUCTION AND OPERATION

	the induced effect to major sectors from desulphurization construction/RMB 100 million	**the induced effect to major sectors from desulphurization operation/RMB 100 million**
1	46.06	37.70
2	27.54	17.88
3	22.00	15.97
4	26.18	15.08
5	21.81	13.56
6	101.57	67.27
7	250.18	44.77

8	4.94	0.62
9	55.74	32.14
10	406.69	297.00
11	5.36	17.61
12	0.75	4.31
13	206.80	133.54

1:agriculture; 2:coal excavating and washing; 3:oil and gas mining; 4:cottonocracy; 5:paper making and paper product industry; 6:Chemical industry; 7:metal smelting and rolling processing industry; 8:other special equipment manufacturing; 9:electricity and thermal force producing and supplying; 10:other industry; 11:building industry; 12:environmental resource and public facility management; 13:other service industry the same below.

IV. THE IMPACT TO CO_2 EMISSION FROM DESULFURIZATION PORJECTS

CO_2 emission related to three parts of desulphurization process: desulphurization facilities construction, desulphurization facilities operation and replacement reaction on the process of desulphurization operation. Energy consumption play an important role when calculate CO_2 emission on the process of desulphurization facilities construction and operation, and balance of materials is main measure to calculate CO_2 emission on the process of replacement reaction in desulphurization.

A. calculate CO_2 emission based on energy consumption

The energy sector is usually the most important sector in greenhouse gas emission inventories, and typically contributes over 90 percent of the CO_2 emission and 75 percent of the total greenhouse gas emission in development countries.[2] CO_2 emission depends on the major energy consumption, because CO_2 come from carbon combustion, including coal, oil and natural gas. We can calculate the relevant energy consumption showed in table 2, according to the major sector energy consumption coefficients, as well as the previous induced effect to major sectors from desulphurization construction and operation during the "11th Five-Year plan" period.

Table2 THE INDUCED EFFECT TO MAJOR ENERGY FROM DESULPHURIZATION CONSTRUCTION AND OPERATION

	Coal consumption/10,000t	**Oil consumption/10,000t**	**Gas consumption/100 million m3**
1	8.41	0.00	0.00
2	192.51	0.00	0.07
3	2.49	10.22	0.62
4	25.48	0.00	0.01
5	87.32	0.01	0.02
6	402.77	90.30	5.55
7	1022.45	0.02	0.71
8	1.41	0.00	0.01
9	1516.63	0.13	0.27
10	1266.29	583.11	1.67
11	1.37	0.00	0.00
12	0.00	0.00	0.00
13	11.36	0.59	0.15
tatal	4538.48	684.39	9.07

We can determine Chinese special CO_2 emission factors to be shown in the table 2 based on effective CO_2 emission factors from IPCC and the Chinese special the standard coal coefficient corresponding major energy.

Table3 CO_2 EMISSION FACTORS FOR MAJOR ENERGY

	EFcoal/t/t	**EFoil/t/t**	**EF 天 gas/t/10,000m3**
CO_2 emission factors	2.055	3.065	0.218

Coal CO_2 emission= $EF_{煤炭}$ × coal consumption

Oil CO_2 emission= $EF_{石油}$ × oil consumption

Gas CO_2 emission= $EF_{天然气}$ × gas consumption

B. calculate CO_2 emission on the process of replacement reaction

Desulphurization facilities are mainly divided as three paths: coal desulphurization, combustion desulphurization and flue gas desulphurization, and the emphases in this paper are the last two methods. The most common method of desulphurization is using sulfur-fixed agent, most of which are Ca-based sorbents, such as limestone, marble, acetylene sludge and so on. The stable calcium sulphate formed when Ca-based sorbents have replacement reaction with SO_2 at high temperature, therefore the molecular weight of CO_2 emission equal to the molecular weight of SO2 reduction.

$$CO_2 \text{ emission} = SO_2 \text{ reduction} \times 44/32$$

V. CONCLUSION

It will discharge 3.43 tons CO_2 when reduce 1ton SO_2 on average during the "11th Five-Year plan" period. In other words, it will discharge 190bn tons CO_2 during the process of desulphurization from 2006 to 2010, 39 percent of which from desulphurization construction and 61 percent of which from desulphurization operation.

As the end treatment measure to air pollution control, desulphurization projects reduced lots of traditional pollutions, but discharge more greenhouse gas into the atmosphere, especial CO_2 emission which arouse public attention just recently. Cleaner production, energy-saving and other treatment measure to reduce pollutions at the source, are the better measure for enterprises to reduce traditional pollutions, as well as ultimately reduce greenhouse gas.

This paper only considered the CO_2 emission on the process of desulphurization which can be analyses by using input-output model, without considered different influence in different condition and other greenhouse gas emission on the process of desulphurization, which will arise in developing my research approach.

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Appendix interdependence coefficient of 2005 input-output table

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.1931	0.0775	0.0390	0.3411	0.1373	0.0923	0.0929	0.0980	0.0738	0.1791	0.1676	0.0970	0.0842
2	0.0257	0.0876	0.0363	0.0482	0.0564	0.0857	0.0853	0.0586	0.2657	0.0573	0.0453	0.0460	0.0309
3	0.0207	0.0326	0.0291	0.0356	0.0365	0.0656	0.0483	0.0468	0.0432	0.0889	0.0461	0.0411	0.0295
4	0.0178	0.0299	0.0181	0.3770	0.0417	0.0366	0.0409	0.0557	0.0317	0.0794	0.0439	0.0388	0.0380
5	0.0194	0.0297	0.0172	0.0393	0.4255	0.0518	0.0399	0.0464	0.0318	0.0700	0.0403	0.0349	0.0424
6	0.2169	0.1501	0.0970	0.2955	0.3772	0.7193	0.1999	0.2161	0.1387	0.3077	0.2321	0.1731	0.1324
7	0.0492	0.1907	0.0874	0.0829	0.0868	0.1188	0.6549	0.5323	0.1123	0.2073	0.3162	0.1152	0.0775
8	0.0008	0.0042	0.0032	0.0047	0.0021	0.0027	0.0033	0.0105	0.0028	0.0025	0.0039	0.0016	0.0019
9	0.0515	0.1610	0.0921	0.1088	0.1145	0.1678	0.1526	0.1186	0.1228	0.1104	0.0935	0.0827	0.0645
10	0.3501	0.5954	0.3457	0.5920	0.6017	0.7239	0.8566	0.8653	0.6385	0.7703	0.8718	0.7642	0.5574
11	0.0073	0.0130	0.0066	0.0104	0.0110	0.0110	0.0113	0.0114	0.0119	0.0107	0.0119	0.0453	0.0305
12	0.0015	0.0015	0.0008	0.0018	0.0017	0.0023	0.0017	0.0016	0.0022	0.0017	0.0016	0.0111	0.0042
13	0.2132	0.4084	0.2208	0.3844	0.4389	0.4145	0.4246	0.4400	0.4211	0.4088	0.4369	0.3436	0.4030