STUDY ON GREEN LOGISTICS OF COAL ENTERPRISES BASED ON CIRCULAR ECONOMY

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Ai-bin LI[1], Min ZHOU[1], Feng QIN[2]

[1] China University of Mining and Technology, School of Management Xuzhou, Jiangsu, CHINA

[2] China University of Mining and Technology, School of Environmental Science and Spatial Information, Xuzhou, Jiangsu, CHINA

xkblab@cumt.edu.cn

ABSTRACT

In this paper, we introduce green logistics based on circular economy to coal enterprises. First, we analyses the basic theories of circular economy and green logistics, and then dissertates about the relationship between circular economy and green logistics. On the basis of the analysis of the non-green factors of coal logistics system, we establish green logistics system of coal enterprises based on circular economy from all sides of the enterprises' logistics activities. Study we have done suggests that the core of circular economy is green logistics, and it is very important for coal enterprises to carry out green logistics management in the circular economy course, realizing the transformation from contaminative logistics to green logistics, saving and reusing resources, protecting environment, increasing economic benefit and promoting the sustainable development of coal industry.

Key words: Circular economy, Green logistics, Coal logistics, 3R principle, Environmental protection.

*Supported by the 111 Project (Project No.B07028)

INTRODUCTION

The twentieth century is an era when the human civilization develops the fastest, yet an era when the Earth ecologic environment and natural environment are damaged the most seriously: the traditional economic development mode featured with massive production, massive consumption, massive wastage leads to resources waste, damage and imbalance of supply and demanding, which constrains the sustainable development of economy and society. In 1992, worldwide nations reached an agreement on the sustainable development, and then German and Japan etc. developed countries and some developing countries positively explore means for the sustainable development and come up with the circular economy mode[1]. China government is also actively making and carrying out scientific development strategy speeding up the pace to develop circular economy. Circular economy

refers to, in the system of various producing essential factors, shifting the traditional linearly increased economy depending on resources consumption to the economy relying on recycling resources, during the whole course of resources input, enterprise production, products consumption and recovery of wastes. Yet in this process, flows of goods and materials or what we call extensive logistics will inevitably come into being. Facts have already proved that the circular economy is usually based on the intensive production inside of the enterprise and sound recycle of materials flow, and the "3R" principle of circular economy expand the category of modern logistics. To build and protect the harmonious ecology environment, and to decrease the occupation of resources for the aim of sustainable economy development, green logistics came about[2].

China is the biggest country in terms of both coals production and consumption. Coal accounts for up to 70% of the national one-off energy consumption, and its crucial role can't be taken place of by other energy in short times. However, the traditional way of mining and utilizing the coal has done great harm to the environment. At the same time, we partially pursue the production and economy benefit while ignoring the multi-purpose development and social benefit. At one hand, the recovery rate is low and associated deposits aren't made full use of, which follow resources are largely wasted. For another thing, the pollutant caused in the course of producing, transporting and utilizing, such as coal gangue、mine water、coal dust、coal soot and poisonous gas haven't been disposed timely and technically, which leads to the pollution of surrounding environment. In view of pollution caused in the course of producing, processing and consuming as well as the characteristics of energy enterprises, it's vital to attach attention to coal saving, environmental protection and multi-purpose utilization. So suggestions about promoting the coal industry to develop soundly from the State Council (Chinese Committee of National Development and reformation, 2005) pointed out that within about five years, we must establish a circular economy system based on the core of producing and processing coal, multi-purposely utilizing resources and harnessing the environment of coal mines. And in July 2nd of 2005, the coal industry was formally fixed as the first experimental unit in China for developing circular economy. The radical purpose of circular economy is to protect the lessening environmental resources and to improve the efficiency of distributing environmental resources. Therefore, it's the essential way to develop circular economy for the sustainable development of coal industry while the realization of shifting to green logistics mode is the key of circular economy of coal Enterprises.

Since a series of environmental problems will come about in the process of mining coal resources, it has become a focus both abroad and home how to reduce the negative social effects resulted from resources exploration and keep the coal industry development sustainable. For example, some related papers (such as Alyson, 1997; Philip, 1997; Beatre, 1999) issued on *Natural Resources Forum* sponsored by UN, mostly focus on the mining areas environment and sustainable development. "The research on several important fields of sustainable development in coal industry" organized and implemented by China Coal Mining Association in 1995, can be regarded as relatively influential and exceptional achievement compared with similar one in coal industry. This project for the first time studied thoroughly about the sustainable development in coal industry from micro to macro, and it really produced great influence. Hereafter, many researchers also made study

on the contents and structure of technological system concerning sustainable development in coal industry, the evaluation methods of sustainable development (Wang Yujun et al,1999), the implication of sustainable development in coal industry (Zhou Dequn et al, 1999), the coordinated theory and nerve-manipulating system on sustainable development in coal industry (Zhang Yuxiang et al,1998), the theory on the optimal consumption of mining resources in the project of sustainable development (Wei Xiaopin et al,1999), The concept and implication of mining areas' sustainable development plus materials flow in the producing system of mining areas (Tang Wangjin, 1999), the mode research on sustainable development of mining areas(Zhou Dequn et al,2002), external environment of sustainable development pattern selection in Chinese mining areas(Chen Yuhe et al,2002) and so on[3-6], definitely they achieved a lot. In the context of sustainable development, some domestic scholars also made some related "green" research about coal enterprises, the main of which are: the green technology in coal mining (Qian Minggao,2003), green mining(Xing Maojian,2002), green mine areas (Jiang Fuxing,2005)[7-8]. All in all, at present the research on coal industry's sustainable development is mostly focused on theory, while research based on circular economy is rare. Logistics is the main form of resources flow, building up the circular economy society can't be separated from the support of green logistics, and hence it's an important complement for coal enterprises' sustainable development research to study green coal logistics based on circular economy.

GREEN LOGISTICS BASED ON CIRCULAR ECONOMY

Circular economy

In the 1960s, American economists came up with the concept of circular economy arguing that it's necessary for mankind's economic developmental model to shift from single linear economy to circular economy[9]. Circular economy or materials-closed-loop-flow economy refers to a production process of multi-purposely using energy and wastes in the way of cleaner production guided on the sustainable development principle. It requires making the economic activities organized into a closed flow of "resources-products-regenerative resources", of which the characteristic is the low input and high utilization of natural resources, and low discharge of wastes or even "zero discharge" (see Fig.1). The purpose of circular economy is to radically eliminate the sharp-pointed confliction between environment and development, reducing the influence and damage towards natural environment by economic activity to the minimum. Speaking essentially, circular economy is a kind ecological economy, which requires to make use of the natural resources and environmental capacity, according to the ecological laws, to realize the ecological and green status of economy activities, guide mankind's production activities blending the cleaner production, using resources, ecological designing and suitable consumption[10].

Circular economy is based on the 3R principle of reduce, reuse and recycle, which means reducing resources input, reusing the consumed products, and recycling the wastes. In practical activities, circular economy has three different stages: the single cleaner production, the ecological industry among enterprises symbiosis and the resources recovery after products consumption, which form the "resources-products- regenerating resources"

cycle within the whole society, achieving closed flow of materials of circular economy. All in all, circular economy is to make use of natural resources an environment capacity according to ecological laws and to realize the ecological alteration of economic activities, which is the destined choice and vital guarantee of implementing sustainable development strategy.

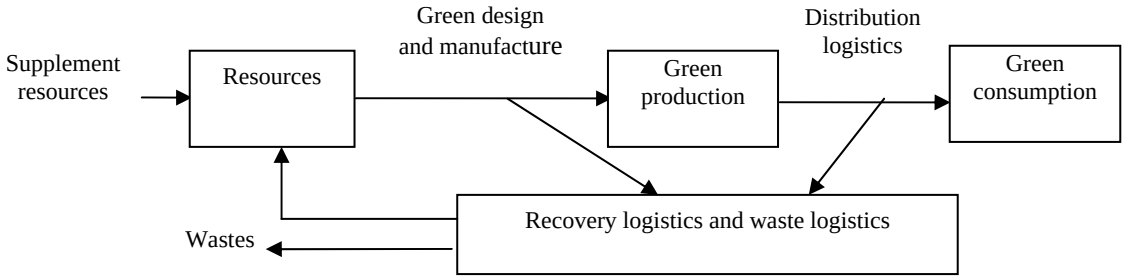

Figure 1.: System mode for circular economy.

Meaning of green logistics

Green Logistics is a new concept put forward until 1990s, which still hasn't an identical definition at abroad and home. Scholars abroad also have different descriptions about green logistics. H.J. Wu and S. Dunn deem that green logistics is an environmentally responsible system, which not only includes realizing the green status of forward logistic process concerning with the obtaining of raw materials, producing, packing, and depositing of products, but also the reverse logistics of getting and disposing the wastes[11]. Jean-Paul Rodriguez, Brian Slack and Claude Comtois think that green logistics is a logistical system compatible with the environment, an environment-friendly and efficient logistics [12]. American Reverse Logistics Executive Council (RLEC) defines green logistics in its research report as follow: green logistics, also called ecological logistics, is the process of understanding and mining the ecological impact of logistics. RLEC also compared green logistics with reversed logistics (RL), holding on the idea that RL is a flow process of products and their packing materials from consuming places to the above originating places, and its purpose is to regaining products value or to make it disposed properly. So it is obvious that RL is just one aspect of green logistics. *Green Logistics*, cooperated by Bjorn N and Petersen in Denmark, defined it as this: Green logistics is the very eco-management about forward logistics and reverse logistics. Seeing the different definition from abroad scholars, we can know that green logistics actually is a meaningful and extensive concept. All the means, methods and process are included in the concept of green logistics as long as they are aimed at reducing the influence towards eco-environment in the logistics course.

Some domestic scholars, combing the sustainable development principle and modern logistics concept, define green logistics as process of plan, manipulation, management and

implementation for logistics system by advanced logistics technology and environment management oriented at the aim of reducing pollutants emission and resources consumption[13]. *Logistics Terms* published domestically in China in 2001, gives the definition of green logistics or environment logistics like this: while restraining the damage to environment in the process of logistics, it also purifies the logistics environment having the logistics resources made full use of [14]. What must be pointed out is that, the referred to green logistics includes all the logistics activities in the forward and reverse logistics.

Relationship between circular economy and green logistics

Materials flow is the essence of all production and industry operation, and materials flow and energy flow are the basis of industry system. It's the Inherent requirement of circular economy and essential characteristics of modern enterprises to realize the efficient utilization of materials and energy as well as closed recycle, to re-integrate the materials flow, energy flow and information flow inside the existing enterprises, to establish the benign materials flow and recycle among enterprises. What referred above is reflected as the rationalization of production logistics inside enterprises, the reasonable configuration and management of the distribution logistics and supply chain, and also it is important contents of green logistics research[10].

In practice, the inherent requirements of circular economy are to realize the benign cycle of materials flow, the reducing amount of resources and to diminish wastes emission and environmental pollution, to improve the proportion of reverse logistics while lessening the proportion of waste logistics, to realize the efficient flow of energy and to improve the transformation rate of energy with the result of reducing waste energy emitted to environment, to try best to reduce activities of transportation, loading & unloading and conveying materials. According to the analysis about green logistics, we can see that green logistics is an important guarantee to implement the above requirements and measures. What circular economy stresses is the reuse of logistics resources and energy, while green logistics will play the main role. Accompanied in the whole process of circular economy, the pros and cons of green logistic process will directly influence the efficient operation of economy. What can be seen from the above analysis, circular economy must pay attention to the development of green logistics, moreover, needs green logistics, and green logistics also enhances the development of circular economy to some extent.

ANALYSIS ABOUT NON-GREEN FACTORS IN COAL LOGISTICS SYSTEM

Logistics system in coal mine (underground mining and opencast mining) is sophisticated, which includes supply logistics, production logistics, distribution logistics, recovery logistics and waste logistics(see Fig. 2).The various links ranging from coal supply logistics to coal waste logistics are all related to non-green factors, which harm the surrounding environment in different degrees. And the main non-green factors are as what Fig.3 shows[15-16].

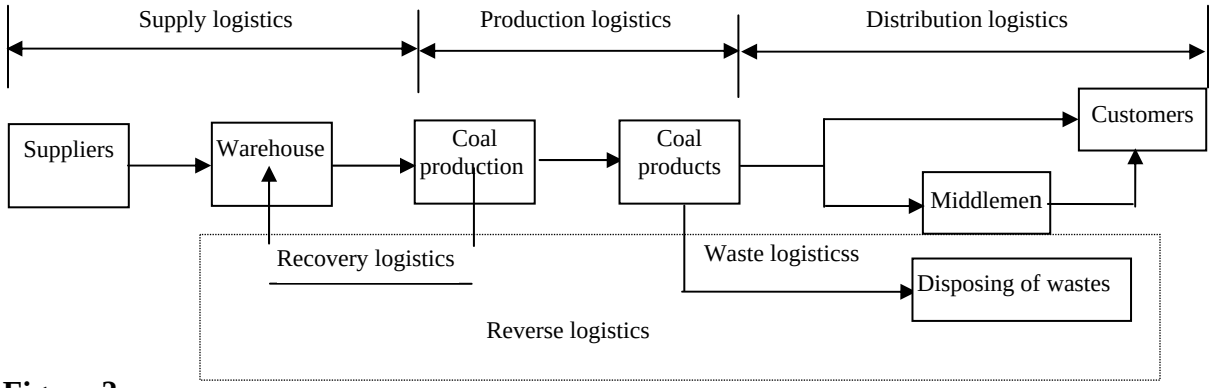

Figure 2.:

Structure of logistics system in coal enterprise.

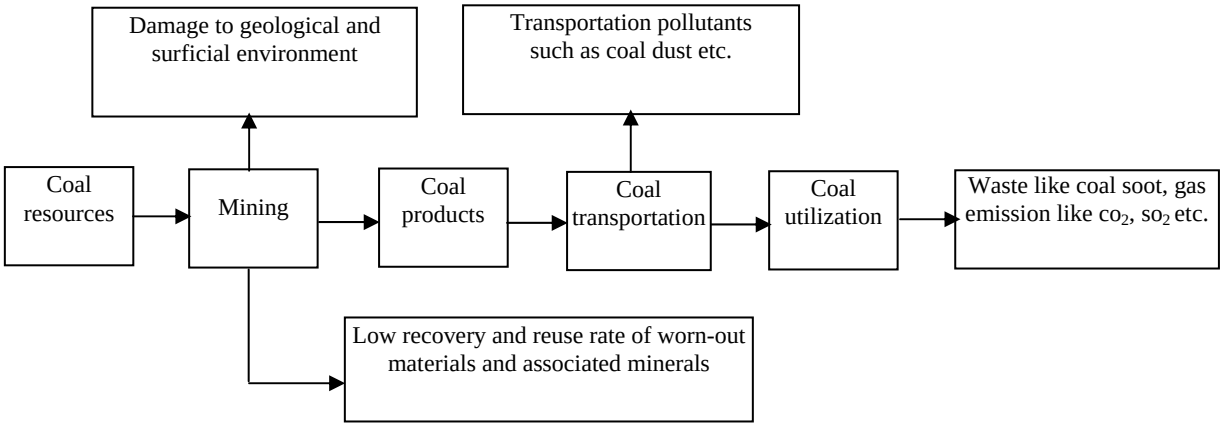

Figure 3.: Main non-green factors of coal logistics system.

Damage from coal mining to geological and surficial environment

(1) Influence to hydrological environment. Mining coal in a large scale harms the hydrological environment severely and disorders the original aquifer and aquifuge, which changes the drainage, storing and flowing of underground water. Particularly, the appearance of extensive underground mining areas plus surface subsidence result in dry-up of wells in key mining areas and water field changing to dry field leading to the decrease of harvest and increased difficulties of getting produce-water and living-using water.

(2) Subsidence of Earth's surface. At present time, Chinese coal mining mainly depends on underground mining , which causes movement, deformation, caving-in of the overburden strata or even earth subsidence, and this situation affects the surface buildings, agriculture field, irrigating infrastructures, bridges, railway and electrical lines in various degrees.

(3) Affection to environment by coal gangue. Coal gangue is waste produced in the course raw coal mining, washing processing. Generally speaking, about 15%---20% coal gangue is produced during coal mining process. The affections of coal gangue are indicated in the main aspects of taking up a great deal of space, great emission of toxic gases such as CO, H_2S, SO_2 which pollute the air severely due to the spontaneous ignition of some coal gangues, certain toxic maters from coal gangue seeping to soils or underground water due to the eluviations of rainfall and wind-weathering and direct influence by piles of coal gangue to the beautification of environment.

(4) Coal dust and soot pollution from coal production system and washing plants. Great amount of coal dust and soot produced in the process of coal transportation, breaking-up and screening not only result in the waste of resources but also pollutes the atmosphere badly. Moreover, part of the inhalable particles does harm to human health. Due to its smallness, lightness and easy-drifting-with-the-wind, coal soot causes uneasily-treatable secondary pollution compared with coal gangue.

(5) Water pollution from coal mining and washing. Coal mining and washing not only consumes a great deal of water, but also brings about large amount of industrial waste water. Water pollution from coal mining comes out in four aspects: first, pollution to water from mine drainage; second, pollution to environment from coal washing; third, pollution to water from coal gangue eluviations; forth, pollution to water from life wastewater. All these affecting-water-quality pollutants leave the water containing tremendous suspended substance, heavy metal and other toxic matters, which harm the plant, animal and humankind.

(6) Air pollution from coal mining. Air pollution from coal mining is mainly from gas called coal-bed methane, a kind of much severer greenhouse gas compared with CO_2, which is the origin of serious coal-mining security accidents. The coal industry in China emits more than 1.2 billion cubic meters gas per year, accounting for about one third to one forth of all the emission amount of the world. Yet, the rate of gas utilization merely makes up 15 to 20 percent of the pumped-out gas, largely lagging behind of other coal producing nations and causing severe air pollution.

Environmental affection from coal transportation

Coal is abandoned and missing along the road during its transportation resulting in a great deal of coal dust and pollution to the air. According to a statistics, coal transportation wastage is generally 2%--3%, and the most can be up to 6%. Taking China as an example, we produce 2000 MT coal per year, so the transportation wastage is as much as 48-60MT, thus obviously, it causes great pollution to environment and alarming losses.

Environmental pollution from coal burning

At present, more than 80% of coal is used in the form of heat energy by burning. As in known to all that toxic gases such as CO, H_2S and wastes such as coal ash ,coal cinder are

brought about during the process of coal burning, which cause great pollution to environment.

Low recovery and reuse rate of worn-out materials and associated minerals

Compared wit other sectors, the proportion of reverse logistics in coal logistics is much higher, including the treatment of coal gangue, recovery, maintaining and reusing of materials which can ensure that coal mine producing is normal. Besides enormous recyclable materials in coal mining, partial materials have to be disposed as waste due to severe damage or inability to be restored. Thus, these materials enter the social waste recycling via enterprises waste disposing system. As for the common enterprises, the lower the recycling rate, the better, especially when their products are flowing in supply chain, because this will reduce the extra cost. While in the coal industry, where product materials are not taken as ultimate products, the more the used-materials are got back, the better. In other words, the higher the recycle rate is, the better. Coal and its associated minerals are non-renewable resources, so we should value them carefully. However, the present recycling rate is shear 30% on average, what' worse, small country coal mine is only 10% and the utilizing rate of associated minerals is just 20% or so, which makes the reverse logistics in coal industry more important than other sectors both in scale and vitality.

ESTABLISHMENT OF GREEN LOGISTICS SYSTEM OF COAL ENTERPRISES ORIENTED TO CIRCULAR ECONOMY

Under the mode of circular economy, to realize the alteration from coal logistics to green logistics, we must conform to the principles of resources reduce, reuse and recycle, put the circular economy idea to the entire process of coal logistics, and study & manage various links ranging from mining, transportation, storing , loading and unloading to distribution processing with green techniques. Also the government should make related regulations and policies to establish green logistics system oriented to circular economy for coal enterprises. By doing this, at one hand, we can reduce the harmful influence to environment from different links of coal logistics, at the other hand, we should make greater efforts to improve the recovery utilization rate of coal worn-out materials, associated minerals and wastes, making resources utilized and recycled effectively to achieve the aim of improving the utilization rate of resources and treating environment friendly [17].

Promoting green technique in coal mining actively

Speaking from fundamental concept, green coal mining and related green techniques are to know and treat coal, gas, water and all accessible resources in broad sense. It's essential intention is to avoid or reduce harmful effects coming from coal mining to environment and other resources as much as possible, and its aim is to gain best economic benefit and social effect, promoting harmonious development of economy, society and environment. According to the storing and developing situation of Chinese national coal resources, the main content of the green technique in coal mining should includes water preserving mining, coal mining under building and bed separation grouting to reduce surface

subsidence, partial extraction and backfill mining, simultaneous extraction of coal and coal-bed methane, coal roadway supporting and underground discharge of partial rock refuse, underground coal gasification etc.[7].

Trying best to recover resources and reuse worn-out materials

The first is during the links of digging and mining coal; we should make use of all the accessible resources as much as possible. Besides trying best to improve the recovery rate of coal mining, we should also multi-purposely explore and make use of these entire valuable co-existing and associated resources, such as Kaolin, coal mine methane and mine drainage etc. By doing this, not only can the cost be reduced and utilization rate of resources be improved, but also the possible harm to coal production by coal mine methane and mine drainage can be reduced. The second is during the link of coal mining; we should further enhance the recovery and reuse of waste and worn-out materials and improve the management of repairing and making use of worn-out materials. We ought to improve the recovery and reuse rate of materials and further the efforts of repairing and making use of them for the purpose of lessening raw coal material cost. There are various kinds of coal production and safety-guaranteeing materials; the quantity of them is great as well. At the same time, a lot of them can and need to be reused; also some of them need to be repaired because of errors in using these materials. These materials must be transported out from underground mining work face, roadway, pit bottom and etc. via auxiliary mine, and then be examined and repaired in the ground coal mining machine plant. After being repaired, these materials need to be delivered to materials distribution center reentering producing system.

Carrying out green transportation management

Transportation is rather a key link of coal distribution logistical system. By efficient transportation, we can resolve the distance problem between the coal-producing areas and coal-demanding areas, creating space efficiency of coal and realizing its utilizing value, thus meeting the needs of society. The rationalization of coal transportation largely influences the rationalization of coal logistics. As to how to reinforce the green management of transportation logistics, coal enterprises can set about from the following aspects: First, to choose green transportation strategy and adopt a combined and consistent transportation methods for the aim of improving the utilizing rate of green transportation tools, and to advocate transportation by electrical railway with the result of reducing the emission of waste gas; Second, to pursue effective package of coal product to promote the upgrading of coal logistics in the links of transportation, loading and unloading and distribution processing for the purpose of reducing and avoiding the wastage and pollution in coal transportation; Third, to establish regional coal logistical distribution centers which complete the distribution assignments, taking place of the traditional way of coal transportation directly to consumers in this way, we can improve the coal transporting efficiency and reduce coal transporting wastage and pollution; Forth, to optimize distribution route and carry out common distribution for the purpose of reducing pollution, and to advocate green management strategy[18].

Reinforcing the research and recycle of waste logistics

Reducing waste is the primary principle of circular economy. under the precondition of effective and proper cost, we should positively develop the technique of diminishing and recycling coal wastes to make them become resources, to minimize environmental pollution and maximize the economic and social benefits, whose contents include that we should reduce the amount of wastes by technical and management means on one hand, and on the other hand, we must dispose of the wastes with green technique, and get back and recycle them, changing it into valuable resources. what referred above is concretely reflected in the backward of coal production link. We should explore and make use of low faulty coal by all means. First, we should integratively utilize fuels with low heat-value such as coal gangue, middle-coal, washing-coal, which can be used to generate electricity and produce construction materials and also for other purpose. Second, as for the waste coal which is difficult to be mined, we can make use of it by using underground gasification technique. As a result, we will make use of low faulty coal as much as possible, attaining the aim of improving the production rate of resources.

Prolonging the coal industrial chain based on the aim of efficient utilization

Green logistics oriented to circular economy mode requires to design ecologic supply chain according to supply chain theory, and to make the entire supply chain cooperative and integrated in the aspect of environmental protection for the best rationalization of systematic environment by the intensive cooperation inside various departments of enterprises and between different enterprises. It is concretely reflected in the links of coal producing and using. Adopting advanced technique, by industrial symbiosis among enterprises, we can try best to improve the utilization and transformation rate of coal resources. For instance, we can adopt joint production to develop industries of heat (coolness) supplying by coal gas and so on, and improve the efficiency of heat transformation and utilization by integrating various systems; also we can reduce the influence to environment by pollutants from coal consuming by way of using coal-purifying technique; additionally, we can also improve the added-value of product by developing coal chemical industry and prolong the coal industrial chain. All in all, according to the quality and character of coal in diversifying mine areas and the demanding situation of market, we should further reinforce raw coal preparation, improve quality and increase sort of coal products, develop coal deep- processing, coal chemical industry, multi-joint production and so on, and participate in establishing circular economy system from social aspect for the ultimate purpose of organic unification of economic and environment effect[19].

Establishing and bettering policies and regulations related to green logistics

One of the vital reasons for the government to promote the coal green logistics oriented to circular economy is that there are externalities in resources utilization and environment protection. The crucial role government plays in the promotion of coal green logistics is to make up the failures of market. Therefore, at one hand, we must strengthen the legal system, establish and better policies and regulations related to green logistics; at the other

hand, we must reinforce the effort of implementing laws and strictly regulate the entering and exiting of market. Only if the effect of market system is fully carried out and the inspiring &restraining economic regulations is arranged, can the coal industries improve the awareness of saving resources and protecting environment, and gradually build up the green logistics management. Thus eventually, coal circular economy can develop healthily under the circumstances of market economy.

CONCLUSIONS

The essence of green logistics and circular economy is identical. Green logistics is indispensable to circular economy, moreover, green logistics also promotes circular economy to develop further in some degrees. If we want to make strenuous efforts to promote circular economy, it's really necessary for us to pay attention to developing green logistics. As an experimental unit in china for developing circular economy, coal logistics system from coal supply logistics to coal waste logistics do harms to the surrounding environment in different degrees. therefore it is not only an urgent but pioneer issue to introduce green logistics management into coal circular economy for the purpose of realizing the transformation from coal contaminative logistics to green logistics, saving and reusing resources, protecting ecosystem, and promoting the sustainable development of coal industry, but also an issue concerning a lot with the healthy development of Chinese national economy.

ACKNOWLEDGEMENTS

We would also like to thank financial support from Chinese education Ministry for doctor degree foundation (20050290507).

REFERENCES

[1] LI Dong**,** On the recycling economy type of social development mode of Japan [J].Contemporary Economy in Japan, 2003,130(4):25-30.
[2] WANG Xi-bing et.al. Vein Logistics System oriented to circular economy mode [J].Industrial Technology & Economy, 2005,24(9),88-90.
[3] TANG Wan-jing et al. Evaluation of sustainable development in mining areas [J].Journal of University of Science And Technology Beijing, 1999(2).
[4] WEI Xiao-ping, Simulation of optimum exhaustion theory of coal resource and sustainable utilization in China [J]. Journal of China University Of Mining & Technology, 2000(2).
[5] ZHOU De-qun, Feng Ben-chao. Study on sustainable development mode of mine area [J]. Economic Geography.2002, 22(2):231-236.
[6] CHEN Yu-he, Zhang Yuodi. Research on external environment of sustainable development pattern selection in Chinese mining areas[J]. Journal of China University of Mining & Technology, 2002,31(2):151-156.

[7] QIAN Ming-gao, XU Jia-lin, MIAO Xie-xing. Green technique in coal mining [J]. Journal of China University of Mining & Technology, 2003, 32(4):343-344.
[8] JIANG Fu-xing, GENG Dian-ming. Model research on sustainable development of green coal mining areas [J]. Journal of China Coal Economic College,2001,15(4),357-360.
[9] J.K.A. Brakke and N.R. Zitron. Some generations of the circular city model [J].Division of Mathematical Sciences, 2002, (5).
[10] ZHANG Ze-qiang et al. Ecological industry and circular economy oriented environmental logistics [J]. Hoisting and Conveying Machinery, 2003,(9):5-9.
[11] H.J. Wu and S. Dunn.Environmentally Responsible Logistics Systems. International Journal of Physical Distribution and Logistics Management, 1995, 25(2):20.
[12] Jean-Paul Rodrigue Brian Slack Claude Comtois. Green Logistics. Published in A.M. Brewer K.J. Button and D.A. Hensher eds 2001 “The Handbook of Logistics and Supply-Chain Management”. London: Pergamon / Elsevier. 2001.
[13] WANG Chang-qiong. Green Logistics [M]. Beijing: Chemical Industry Press, 2004:34.
[14] LIU Zhi-xue. Modern logistics handbook [M]. Beijing: China Logistics Publishing House, 2001:1-5.
[15] Tang Xi-feng, YU Jing .Realizing the transformation from contaminative coal logistics to environmental coal logistics[J].mining R&D,2005,25(2).
[16] XU Jin-lin, QIAN Minggao. Concept of green mining and its technical framework[J]. Science &Technology Review,2007,25(7):61-64.
[17] LI Yi-qiang, LI Hua. XU Guohua. Study on enterprise green logistics facing full lifecycle of products[J].Journal of Xidian University (Social Sciences Edition), 2001, 11(4):38-41.
[18] Zhao Wei. Supply chain management under the mode of circular economy [J].Science Research Management, 2005,26(2):50-54.
[19] ZHOU Hong-chun. Development mode and strategy selection for circular economy [J].Coal Economic Research, 2006(1):17-22.