

Application and Development Prospect of CWS Technology

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Abstract. In this paper, the procession of coal-water slurry technology in domestic and foreign development present situation and progress in the field of energy saving and emission reduction, expounds the developing trend of the technology of coal water slurry in China.

1. Introduction

According to the international energy agency statistics, China has become the world's second-largest energy consumer, over the next 20 years, China's oil imports will be comparable to the whole of Europe, huge demand will lead to China's energy security issues become more prominent. The basic characteristics of energy resources in China is weak and less gas, rich coal, coal resources are rich, the third highest ownership in the world, the coal is our country the most reliable and secure energy. Based on energy security, resource structure and realistic national conditions, give priority to with coal energy structure in China in the short term will not change.

Coal-water slurry is developed in the 1980 s a coal base oil fuel, it is made of 60% - 70% of the coal powder, 70% - 30% of the water, with around 1% of the slurry mixture of chemical additives, is characterized by the appearance like oil, good liquidity, low viscosity; Storage stability, not precipitation; In tank trucks, ships or pipeline, and, without a danger of spontaneous ignition on and the fact to use is safer than coal and oil.

Because of coal based fuels with raw coal use direct combustion of low level, so as to cause environmental pollution, the government exert the environmental constraints to the coal enterprise to improve the enterprise of coal base fuel high level using the enthusiasm. In addition, the international oil price fluctuations, also to use the fuel oil heat boiler are of great cost pressure [1]. In the implementation of energy conservation and emissions reduction, advocating building mountains beauty under the new situation of China, coal-water slurry, as a kind of very good generation fuel oil, oil generation of CWS combustion technology is China is in the promotion of clean coal technology is very important one. Vigorously develop clean coal technology, efficient clean use of coal resources in China, to promote energy and the environment coordinated development, meet the needs of the rapid and stable development of national economy, is of great strategic significance.

2. Coal-water Slurry Technology Development Present Situation at Home and Abroad

Until the 1970 s oil is a kind of easy to mining, transport, storage and use of clean fuel is welcomed by people. After the oil crisis in the 70 s, people began to notice the shortage of oil resources has been a serious threat, must use of resources abundant coal and trying to find a best way to to coal and oil. And development of kerosene fuel mix (COM). For the rapid rise of coal water slurry fuel (CWM). To the early 80 s in terms of preparation technology is mature, substantially of coal-water slurry fuel and has many large-scale fire test. Coal water slurry technology development and application of advanced countries are Japan, the United States, Sweden, Canada, Italy, France, Germany, Britain, China and other countries since the 80 s also conducted a series of development research. The research direction is aimed at a domestic situation.

Sweden, according to the characteristic of domestic environmental requirements high pollution is small, about 1981 years ago by Hdsnihgorg company to develop into a named Ceahagel coal-water slurry fuel. Ceabog high combustion efficiency, low NO_x in flue gas, has been hailed as a pollution-free clean fuel [2]. The study focused on fuel boiler. The United States and Japan try successfully on the boiler burning coal-water slurry, the combustion efficiency > 90%, the nozzle

life over 2000 h, flexible and load regulation.

Japan is lean-oil country, more than 99% of the oil is imported from abroad, but it is also a gas-guzzling economy, therefore, the development of coal water slurry Japanese study work has been as the key, and made great achievements.

At present foreign technology of coal water slurry has built a batch of mature CWS factory, has reached the level of industrial applications. Russia don't lobo has built the world's largest coal water slurry preparation - pipeline - power generation project, coal water slurry production capacity of up to 5 mt/a, distance 260 km pipeline, pipe diameter of 530 m, for 6 units of 200 mw power plant unit 670 t/h boiler burning. The pulverized coal burning power plant boiler the original design, change after burning coal-water slurry boiler load adjusting range is 50% 100%, has the high combustion efficiency.

French Amy Lucy power plant is one of the world's most successful slime coal water slurry of users, since 1990, 367 t/h circulating fluidized bed boiler (125 mw) has been discussed. This has made of coal water slurry, the combustion efficiency > 90%.

CWS research work in China started in the late 70 s, early 80 s, with foreign synchronization, immediate cause is the outbreak of the oil crisis in the world, as well as the various countries are looking for in a new energy instead of oil. China is a rich coal, gas, weak country, less so devoted to the research and development of the coal water slurry in our country, and in May 1983 to try the first batch of CWS combustion is developed successfully. In recent years, our country's coal water slurry preparation technologies and fuel technology develops very fast, and reached the international level, has completed the power boiler, power plant boiler, heating furnace of steel rolling, heat treatment furnace, drying kiln furnaces, such as the gasification of coal water slurry engineering test. In the field of environmental protection industry of high-tech, most of the technology in China, the products are behind the international advanced level, and coal water slurry is an exception, China coal water slurry technology in preference to foreign countries, this kind of new energy in China's energy strategy occupies very important position.

The coal water slurry technology has been listed as the key to energy development in China to promote technology, priority to the development of clean coal technology is coal industry one of the key technology. China is a country with rich coal less oil and coal water slurry as a new generation of environmental protection fuel oil, is being more and more enterprises realize that the coal water slurry technology to further improve product structure of coal enterprises, improving economic efficiency of coal enterprises. Coal water slurry technology can solve some environmental and process adjustment problems of coal enterprises. And can use plant organic wastewater (such as papermaking black liquor) OARS made water coal combustion [3]. So is the current reality of coal-water slurry technology, also is the most market of clean coal technology in the 21st century.

3. The Trend of the Development of the Coal Water Slurry Technology

At present, the coal water slurry application development pattern is: the south and the coastal areas in CWS fuel applications is given priority to, the north and major coal-producing area is given priority to with CWS gasification, coal water slurry technology development trend of performance is as follows.

Fuel coal water slurry production toward large-scale pulp mill and the shortage of coal resources of regional development. The national development and reform commission, the clear requirements "coal water slurry production plants to large-scale, stand-alone systems production capacity of 500000 t/a". Experts at home and abroad is a widespread belief "construction megaton CWS factory" for the economies of scale. So fuel coal water slurry in China factory are by single machine production capacity of 250000 t/a small production to the development of large coal water slurry plant. The raw material for pulping with designated supply of coal, coal water slurry of the pulping plant production, storage, transportation and users for the pulp, ensure the quality and quantity of coal water slurry and decrease the cost of using plasma higher requirements are put forward. The pearl river delta, Yangtze river delta and ring in the gulf region economy development quickly, the

demand for energy and the application of coal-water slurry fuel (raw material) consumption quantity is growing rapidly, is now in guangdong dongguan, foshan, fujian, jiangsu and zhejiang area construction megaton and above the user type (regional) could speed up the large pulp plant, such as dongguan in the 1 million t/a pulp mill scale, based on the expansion to 5 million t/a, in order to meet the users was 7 million t in dongguan around with slurry supply.

Coal water slurry production process (equipment) to the clean, high efficiency and low energy consumption. Along with our country the atmosphere PM_{2.5} exceeds bid badly, leads to increased haze weather, the coal water slurry production must be clean. At present, the domestic existing variety of pulping process, the common process is need to put the coal crushing, grinding to a certain size and achieve good gradation, the link control is bad will cause dust pollution to the environment. Production of high quality coal water slurry also must have the perfect technology and efficient equipment, process and equipment of different influences the quality of coal water slurry products, processing cost, energy consumption and production environment [4]. Therefore, only to optimize and improve the pulp production process and makes every effort to compact cohesion between production processes, no dust, no liquid leakage, not run coal, can make the factory to clean coal water slurry production. Coal water slurry production technology core is the crushing and grinding, its power consumption accounts for more than 70% of the whole pulping process. Therefore, developing high efficiency and low energy consumption pulping equipment, is the main way to decrease the cost of coal water slurry production. In recent years, our country has developed a variety of high efficiency and low energy consumption, grinding equipment, has been gradually applied in coal water slurry production, really have played an important role in reducing pulping power consumption. national engineering research center for coal water slurry used to develop the selectivity of coarse grinding and super fine grinding of organic combination of pulping, the addition of ultra-fine coal slurry can dramatically improve the efficiency of coarse grinding machine grinding, make pulping energy consumption is reduced by more than 30%.

Choose to the low rank coal and coal blending coal used in pulping and industrial development, life waste. Coal water slurry production in China has been the problem of narrow coal selection range, more coal used in domestic fuel pulping of coal water slurry is given priority to with medium metamorphic degree of coking coal, and coking coal reserves are scarce and expensive, so expanding scope of pulping with coal, coal water slurry is the premise of large-scale industrial application. At present, the fuel coal water slurry pulping coal selection has to make the transition to metamorphic degree lower coal, but the low rank coal water slurry is poorer, adopts the traditional process can't preparation of coal water slurry of high quality products, it has become the decisive factor restricting the development of coal water slurry industry further. Therefore, it is necessary to develop low rank coal (weak sticky coal, not sticky coal, long flame coal and lignite) pulping technology, solve the problem of tension and expensive pulping with coal.

Expand pulping coal means using the past think cannot pulping pulping of coal, but the coal coal quality characteristics lead to adopt the single coal mixture coal water slurry can not meet the requirement of the boiler burning fuel, thus can be used to make coal blending pulping characteristics between complementary, achieve the purpose of the preparation of coal water slurry with high quality. Characteristics such as high volatile coal is the internal content, low ash melting point, high chemical activity is good, but the water slurry concentration is low, easy slagging combustion; Low content of inland waters, and low volatile coal chemical activity is poor, not easy to ignite and fuel. According to the proportion between the two mixed pulp, not only can solve the burning high volatile coal slagging, into the stiffness problem of poor, but also in order to solve low volatile coal in a boiler non-flammable, to expand the range and reduce the coal used in pulping pulping coal cost. Along with the rapid development of industry and urbanization, municipal sewage treatment plant discharge of sludge, the eduction in industrial production of all kinds of waste such as paper making black liquor, industrial wastewater, such as sorting the coal output increasing, the material composition is complicated, containing bacteria, difficult to disposal, cause serious pollution to the environment. But because of containing a certain amount of organic substances and calorific value, so they can be right amount ground with coal preparation of coal water slurry, can

not only reduce the cost of pulping, save coal and water, can also realize recycling waste resources, broad application prospect.

4. Coal Water Slurry Technology Analysis of the Economy and Environmental Protection

4.1. Application of Coal-water Slurry Technology Economy Analysis

Coal water slurry as energy saving, clean fuel production, mainly reflected in CWS combustion with high efficiency, coal-water slurry boiler thermal efficiency is higher than ordinary coal-fired boiler, these two indicators is intuitive and simple to illustrate the energy saving effect of the coal water slurry products.

Coal water slurry with oil liquid, can pump, atomization and combustion, can replace the oil (gas) in industry, power station boiler, industry boiler burning furnaces, and flue gas discharge light white clean, accord with environmental requirements of the national first class area (scenic area).According to the calculation, 2 t can replace 1 t oil, coal water slurry with light oil (calculated by RMB 3000 / t) compared can save 1000 yuan per ton, economic benefit is significant.Energy saving of coal water slurry is mainly reflected in: (1) 1t CWS about 2.2 t coal can be substituted; (2) in the general industrial and civil furnace coal saving 30%; (3) CWS flame temperature of 1300°C or so, not only lower than the fuel, qiao about 150°C lower than in the pulverized coal; (4) coal-water slurry boiler efficiency of 85% or more generally, the combustion efficiency can reach above 98%.Under the condition of the same output fell by almost 30% of the amount of coal.Raw coal boiler efficiency is about 65% commonly, gas boiler efficiency 90%; (5) 500000 t of coal-water slurry plant raw material coal consumption of about 351000 t (full moisture 6.7%); (6) 10 t coal-fired boiler need to 18 people, coal-water slurry furnace only 6 people [4].

Can be seen from the above comparison, energy-saving effect is very significant of CWS.

4.2. Environmental Impact Analysis of Coal Water Slurry Technology Application

Environmental friendliness of coal water slurry is mainly manifested in: (1) is low sulfur, low ash content of coal water slurry choose coal pulp, after washing coal, sulfur removal is 30% - 40% (removal of pyrite sulfur 60% - 80%), and therefore have relatively low sulfur content in coal water slurry, generally less than 0.8%; (2) in pulping, can according to the situation of raw coal sulfur content, sulfur appropriate reinforcement agent, burning in the furnace, sulfur removal by about 40%, which greatly reduced the emissions of sulfur; (3) center of CWS combustion flame temperature was lower than those of oil 10-20°C, belongs to the low temperature combustion, helping to suppress NO_x formation, can reduce NO_x emissions of 50% 60%; (4) CWS burning rate is as high as 98%, produces soot volume decreased significantly, and greatly reduces the cost; (5) CWS can like oil storage and stable combustion, heat value was worth only half the fuel oil, can be like oil pumping, atomization, storage and transportation, so to avoid the damage from the transportation, loading and unloading, and storage, coal dust and the secondary pollution, also brought significant improvement to the surrounding environment [5].

After analysis found that, in the process of coal-water slurry combustion emissions effect is obvious, greatly improving the environmental friendly, but the main raw material of the preparation of coal water slurry and coal derived from coal, regardless of the selected coal reserves, consider only from the product life cycle, the industry focus on coal water slurry is made to the use of this phase, the raw coal from access to make coal water slurry and the mortar after combustion disposal at various stages in the process of input and output as well as its impact assessment has not been filed almost, this aspect also needs to cause enough attention from the Angle of environment management.

5. Coal Water Slurry Technology Application Prospect

Coal-water slurry as a clean fuel and coal gasification raw materials, with high efficiency, energy saving, less pollution, running costs are relatively low, and can guarantee the advantage of safety

supplies, by including the Yangtze river delta, the pearl river delta economic developed regions such as the government and the environmental protection department attaches great importance to, and is recognized by more and more enterprises and application of coal-water slurry technology has larger development space and market prospects [6].

5.1. Generation of Coal-water Slurry Fuel Oil still Has Market Development Potential

Our country is a coal as main energy state, "coal oil and coal for oil" energy policy is an important energy policy in our country. Can look similar to heavy oil, coal water slurry pump fluid fuel will have a certain market space, the current in the pearl river delta, Yangtze river delta region there are still a lot of fuel users, such as petrochemical industry should bring along their own boiler fuel, light textile, printing and dyeing, leather and other industries such as the large amount of heat conduction oil furnace, domestic these fuel) (kiln furnace users because of the price of oil (gas) tight supplies and rising, economic pressure, oil burning high sulfur furnaces (kilns) user caused by high sulfur content in oil is also more serious environmental pollution, therefore, coal-water slurry as the most realistic generation of clean fuel oil combustion, will still has a large market potential.

5.2. Coal-water Slurry Application in Industrial Furnaces

Our country has 600000 sets of industrial boiler, the vast majority of layer for industrial boiler combustion, with small boiler as the main body, and among them cause coal utilization efficiency is low, pollutant emission is serious. As countries for environmental requirements of increasingly stringent, and the rapid development of urbanization, the city's industrial park and the implementation of centralized heating or cogeneration neighborhoods, burning clean fuels, the development of clean coal water slurry fluid fuel, by advanced spray - suspended and fluidized - suspension combustion way, improve the efficiency of coal combustion, reduce soot emissions, will be to complete the national government and the enterprises put forward the task of energy-saving emission reduction targets of the best choice.

5.3. Coal Water Slurry Gasification Has Broad Market

Our country is currently use coal gasification device most populous country in the world, coal gasification technologies of coal water slurry feed, for example, have the Texaco gasification process, the domestic independent research and development of four nozzle to the gasification process and grade of oxygen flow bed gasification process and multivariate slurry gasification process, such as the coal gasification technology in coal-water slurry as raw materials, adopting mature technology to production to produce fuel coal slurry gasification coal slurry, the gasification of coal slurry concentration increased by more than 65%, the coal water slurry gasification has important significance for the development.

Production in China and in the synthetic ammonia system of coal, coal to methanol, dimethyl ether, coal to olefin, coal oil, and coal gas, and many other coal chemical projects, QiTou using coal-water slurry pressurized gasification. But coal chemical projects with high internal waters, oxygen/carbon ratio is big, poor grindability and lower metamorphic grade of coal into a pulp hard, pulping process for more conventional single mill (rod mill and ball mill, coal slurry particle size grading is not reasonable, poor concentration is low, rheological property and stability were problem, seriously affect the efficiency of gasification of coal water slurry gasification and gas production effectively. Therefore, the use of advanced pulping technology and equipment, improve the gasification of coal water slurry into slurry concentration, and thus improve the efficiency of gasification of coal water slurry and gas production, is currently the most pressing demand of coal water slurry gasification technology at home and abroad.

5.4. Coal-water Slurry Pipeline Transport Market Has Development Prospects

Coal-water slurry is like oil can flow of slurry, suitable for pipeline transport. With the increase of dosage of coal water slurry and coal in our country, strained, with the coal water slurry will become the main coal water slurry transportation pipeline. At present, the coal water slurry by the mode of transportation of the pulping plant to the user is mainly short tank car, pulping plant

internal and furnace for pulp before pulping production enterprises and between boiler adopts slurry pipeline, this has played an important role in CWS pulping and combustion. But these pipes are shorter, long distance, large range of coal water slurry is transportation problem, greatly limits the application of coal-water slurry in economically developed areas such as southern China, also makes these areas to other energy products, such as oil dependence, this to a certain extent, increased pressure on China's oil imports. If for coal-water slurry pipeline transportation, the cost is only 30% of the train, 15% of motor transport. According to the market demand, therefore, timely to develop economically viable pipeline transportation of CWS technology and related equipment, will be building concentration, large coal water slurry preparation plant create favorable opportunity, also made it possible to short of CWS burning clean fuel coal area.

6. Conclusion

Coal water slurry with the advantages such as high efficiency, energy saving, environmental protection, in recent years at home to get fast development. As domestic fog days is increasing, and the construction of large coal chemical projects, coal-water slurry industrialization scale will continue to expand. Therefore, coal-water slurry technology also has the very big development space. Need to build large, centralized, and environmentally friendly coal-water slurry fuel coal water slurry production factory, also need to develop long distance pipeline transportation of CWS technology and its equipment; CWS gasification needs to further broaden the pulping of coal, development of new energy efficient pulping technology and equipment, the concentration of the gasification of coal slurry has been further improved, the pulp and further reduce the cost; Should lay particular stress on development of CWS gasification market technology applications, in order to make clean fuel, raw material coal water slurry technology get steady development.

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