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Plasma Arc Burner for Pulverized Coal Combustion

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Abstract : Development of new highly efficient plasma arc combustion system of pulverized coal is presented. As it is well-known, coal is one of the main energy carriers by means of which electric and heat energy is produced in thermal power stations. The quality of the extracted coal decreases very rapidly. Therefore, the difficulties associated with its firing and complete combustion arise and thermo-chemical preparation of pulverized coal becomes necessary. Usually, other organic fuels (mazut-fuel oil or natural gas) are added to low-quality coal for this purpose. The fraction of additional organic fuels varies within 35-40% range. This decreases dramatically the economic efficiency of such systems. At the same time, emission of noxious substances in the environment increases. Because of all these, intense development of plasma combustion systems of pulverized coal takes place in whole world. These systems are equipped with Non-Transferred Plasma Arc Torches. They allow practically complete combustion of pulverized coal (without organic additives) in boilers, increase of energetic and financial efficiency. At the same time, emission of noxious substances in the environment decreases dramatically. But, the non-transferred plasma torches have numerous drawbacks, e.g. complicated construction, low service life (especially in the case of high power), instability of plasma arc and most important – up to 30% of energy loss due to anode cooling. Due to these reasons, intense development of new plasma technologies that are free from these shortcomings takes place. In our proposed system, pulverized coal-air mixture passes through plasma arc area that burns between to carbon electrodes directly in pulverized coal muffler burner. Consumption of the carbon electrodes is low and does not need a cooling system, but the main advantage of this method is that radiation of plasma arc directly impacts on coal-air mixture that accelerates the process of thermo-chemical preparation of coal to burn. To ensure the stability of the plasma arc in such difficult conditions, we have developed a power source that provides fixed current during fluctuations in the arc resistance automatically compensated by the voltage change as well as regulation of plasma arc length over a wide range. Our combustion system where plasma arc acts directly on pulverized coal-air mixture is simple. This should allow a significant improvement of pulverized coal combustion (especially low-quality coal) and its economic efficiency. Preliminary experiments demonstrated the successful functioning of the system.

Keywords : coal combustion, plasma arc, plasma torches, pulverized coal
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