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Review

The calculation of fluorine plastic economizer in economy by using the equivalent heat drop

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A B S T R A C T

With the increasing demand of energy saving and emission reduction, low temperature economizer (LPE) is more and more utilized in the heat recovery plant of the coal-fired power plant and because of the obvious advantages in material properties the use of fluorine plastics low temperature economizer has gradually become extensive. In this paper the equivalent heat drop method is utilized to calculate the improvement on net work output as well as the decrease on standard coal consumption rate of the coal-fired power plant system which adds the fluorine plastic economizer. The calculation results indicate that the improvement and decrease are different when the low temperature economizer locates different position of the system and under the same situation, the more stage extraction should be utilized as far as possible to achieve better energy saving effect. In addition the economic and environmental advantages of fluorine plastic economizer are compared with those of the metal economizer. On the economic benefit, the fluorine plastic economizer is significantly greater than the metal economizer and at the same time the carbon emission reductions of fluorine plastic economizer are significantly greater than those of metal economizer.

Contents

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Nomenclature

AD	total saving [kg or m^3]
AE	CO_2 emission reduction [kgCO_2e]
b	coal consumption [g/(kW·h)]
CI	cash inflow
CO	cash outflow
COND	condenser
EF	CO_2 emission factor [kgCO_2e/kg or kgCO_2e/m^3]
EN	N_2O emission factor [kgCO_2e/kg or kgCO_2e/m^3]
SC	seal cooler
GWP	global warming potential value
H	equivalent enthalpy drop of extraction [kJ/kg]
HPT	high pressure turbine
h	enthalpy [kJ/kg]
IPT	medium pressure turbine
IRR	internal rate of return
k	discount rate
LPT	low pressure turbine
N	power generation [kW]
n	calculation period of the project [year]
NPV	net present value
Q	total heat [kJ/h]
P	heating power [W]
q	heat [kJ]
RHTR	reheat treatment
S	heating area [m^2]
T	dynamic payback period [year]
t	t year
W	work done by the new steam [kJ/kg]

Greek symbols

γ	hydrophobic flow heat release [kJ/kg]
τ	feed water enthalpy rise [kJ/kg]
η	efficiency
α	extraction steam share

Subscripts

c	exhausted from the turbine
g	generator
f	fuel
i,j	i, j level extraction steam from the turbine
in	entering of the steam
m	mechanical
out	going out of the steam
t	t year

1. Introduction

Today the energy conservation is widely needed in the world. Improving the utilization of existing energy facilities has become a major. The heat recovery technology came into being in this engineering field and was given popular attentions. The heat recovery technology in the coal-fired power plant is likely to improve the operating efficiency of the entire plant [1–4]. According to the use of the heat recovery technology, now the operating efficiency of the whole plant in European is 37%–44%.

The temperature of the boiler exhaust gas is one of the main indicators for boiler performance assessment. It affects the thermal efficiency of the boiler, and thus affects the coal-fired power plant efficiency. Choosing as low as possible temperature of boiler exhaust gas in the coal-fired power plant is beneficial to improve the boiler thermal efficiency, but too low temperature of boiler exhaust gas can cause condensation of the water in the exhaust gas, and it will result in low-temperature corrosion of the rear heating surface. So the temperature of the boiler exhaust gas is generally selected at 120–140 °C, rarely below 120 °C [5].

In the current market, most of the plants utilize the technology of the wet limestone in flue gas desulfurization (FGD) in china [6,7]. Since the best desulfurization temperature is 50 °C, the flue gas temperature should be dropped to 50 °C in the desulfurization process by spraying water and then further desulfurization can be done, as a result of which, the energy and water consumption are increased. The additional water evaporates into the exhaust gas and increases the exhaust gas emissions. So from the considerations of the economic and energy saving, reducing the boiler exhaust gas temperature is the inevitable choice [5].

Now there are two ways to reduce the gas temperature and recover the waste heat of the exhaust gas. One has effect on the original thermal system, the other one has no effect on the original thermal system, and the installation of low pressure economizer in the downstream of exhaust gas is the latter one.

The low temperature economizer is widely utilized in the current market. It installs at the downstream of the exhaust gas, particularly between the electrostatic precipitator (ESP) and the FGD. It has attractive advantages such as simple structure, little effects on the original thermal system, low investment, and reduction of coal and water consumption.

Many people have researched this field for a long time. Wang et al. [8]studied low pressure economizer in a 600 MW power plant. The LPE located between the pressurizing fan and FGD. The performance of the three installations were compared and in optimized installation the overall coefficient of heat transfer was 37 W/m^{2}K and the static pressure loss was 781 Pa. The saving of standard coal equivalent was 2–4 g/(kWh). Wang et al. [9]developed a new waste heat and water recovery technology which was based on the nanoporous ceramic membrane capillary condensation separation mechanism. The heat from flue gas was devoted to water vapor and its latent. The quality of the recovered water was