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Process optimization for pellets production

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Abstract

Nowadays, it is important to make industries more and more energy efficient. When we look at pellet production, energy consumption improvements are those with the strongest effects. Optimization methods for drum dryers and combined heat and power plants (CHP) are offered in this paper, as these are the main thermal energy sources in pellet production.
Drum dryers are used to dry sawdust used for pellet production. It is important to look at the efficiency of the drying process and the problems caused by human factor. A method of automatic drum dryer implementation is offered in the paper.
However, CHP have proved to be more efficient for pellet production with reduced CO_2 emissions when compared to drum dryers. CHP can be divided, based on consumer type as CHP in central heating system and industrial CHP. The former provides thermal energy for consumers in cities, and the latter provides it for local factories and industrial groups. There is a drop in thermal energy consumption over the summer, giving an opportunity to use the remaining thermal energy for cooling needs. Finding solutions to increase heat capacity is important to increase electricity production from CHP and improve plants' economic efficiency. A solution offered in the paper is remaining thermal energy use in absorber coolers needs.

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Keywords: drum dryer; CHP; TP; optimisation; automated control system

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1. Introduction

The main parts of a drum dryer system are a boiler and a rotating or drum dryer [1]. It is meant for large scale drying of materials and uses flue gas as a heat carrier. The drying process can happen when flue gas makes a connection to the source material.

Industrial tri-generation is the production of electricity, thermal and cooling energy in the same plant. A lot of CHP are turned into tri-generation plants (TP). The capacity of TP is optimized to decrease plant operation costs, which leads to better economic results, when compared to a standard system [2–4]. The use of cooling that is gained from thermal energy is limited due to little knowledge of the subject and high investment costs.

The various applications of absorption systems are studied by authors [5]. Their conclusion is that absorption cooling technology has a huge potential to transform the remaining thermal energy to useful cooling energy.

The best known device for this technology is an absorption cooler that can be used to recover thermal energy and produce cold water. Absorption cooling can be used over the summer to effectively use thermal energy [6]. Cooling options in industry are studied by authors [7–9], where they look at locally produced thermal energy. They say that it is important to study each absorption cooler and case, because effectiveness is not always achieved, when compared to cold water production. However, these cases are not focusing on maximization of profit. There are different objectives found in studies, for example, optimization strategies based on thermal and cooling energy production load [10–12], TP impacts on environment and profit [13, 14].

Nomenclature

€	euro	η	efficiency
η_n	total efficiency	η_R	minimal total efficiency for receiving grant
CO_2	carbon dioxide	CHP	combined heat and power plant(s)
EU	European Union	MWh	megawatt hours
MWh_e	electricity megawatt hours	MWh_{th}	thermal energy megawatt hours
P_{et}	electricity price in period, €	$P_{ht}{}^c$	thermal energy price for cooling in period, €
P_{ft}	fuel price in period, €	P_{ht}	thermal energy price in period, €
S_{RT}	specific grant for a single case, €/MWh_e	q_3	chemically incomplete combustion losses
q_4	mechanically incomplete combustion losses	q_5	heat losses in environment
W_e	electricity production, MWh	W_h	thermal energy production, MWh
$W_e{}^R$	possible extra electricity production, without grant loss, MWh	W_f	fuel consumption, MWh
$W_h{}^H$	thermal energy amount used for heating, MWh	$W_h{}^c$	thermal energy amount used for cooling, MWh
W_{et}	electricity production in period, MWh	W_{ft}	fuel production in period, MWh
$W_{ht}{}^c$	heat for cooling energy production in period, MWh	t	period of one hour
$W_{ht}{}^H$	thermal energy used for heating	TP	tri-generation plant(s)

2. Methodology

2.1. Optimization of Drum Dryer drying system

Improvements of this process include automatic air feed guarantee in the furnace to increase effectiveness of both – the furnace and the drum dryer [15]. Effectiveness of the furnace is determined by heat balance Eq. (1):