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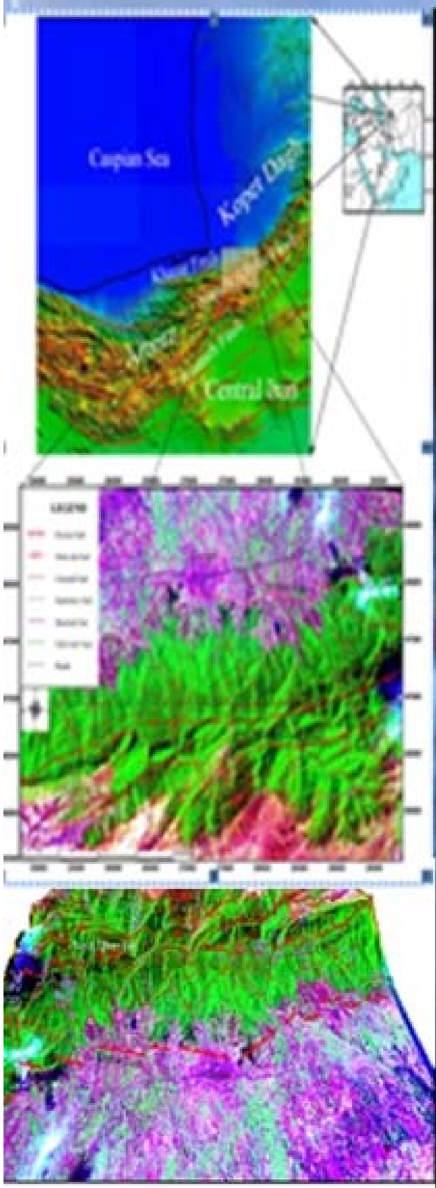

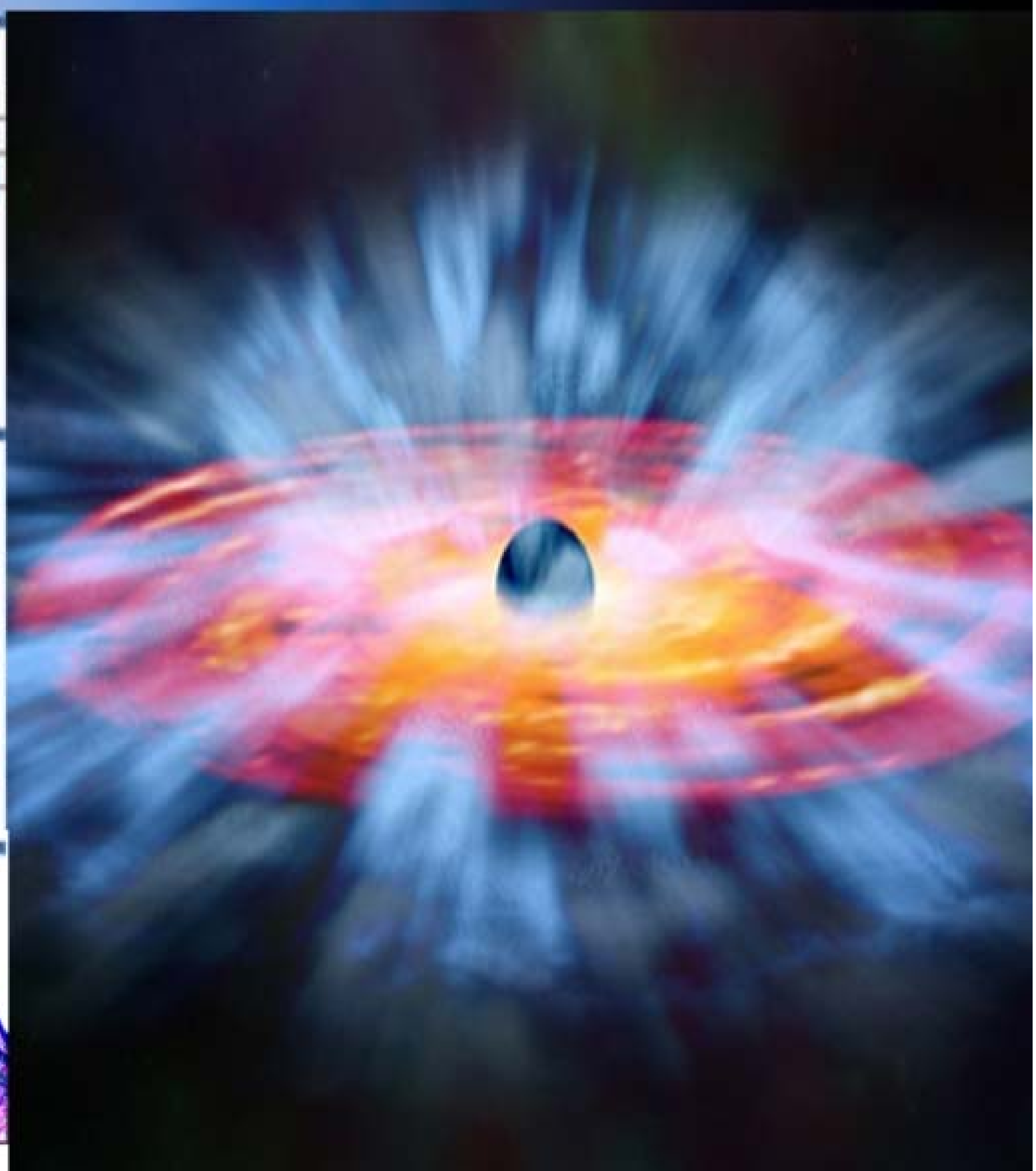

Special Issue on 5th SASTech 2011

NASA

From Editor in Chief

The International Geoinformatics Research and Development Journal (IGRDJ) try to share the knowledge of the recent science and technology to the environment and people.

This issue contains ten peer reviewed papers from SASTech 2011. They are on different aspects of science and technology. In this regard, I would like to inform you that the 5th SASTech was successfully organized during 12-17 May 2011 in Mashhad, Iran. I and on behalf of IGRDG appreciate Dr. Mohammad Reza Mobasheri, the president of Khavaran Institute for organizing such big event in Iran. More than 350 people had participated in this symposium. You will read the papers in this issue as a special issue from 5th SASTech 2011. Since there have been a lot of interests from people around the world for SASTech; the committee has decided to organize the 6th SASTech in Malaysia during 24-25 March 2012. For more information please visit http://www.6thsastech.khi.ac.ir/

IGRDG (www.igrdg.com) has been trying to invite IEEE and other international society to join for 6th SASTech 2012. I am very happy to inform you that there will be a workshop on “LIDAR remote sensing” by Prof. Jonathan Li from University of Waterloo, Canada. There will be also a workshop from Prof. Indubhushan, RMIT Australia on "Ecologically sustainable housing (EcoHome)”. IGRDG has been trying to move to Vancouver, Canada and experience a new challenging environment for a better development. Successfully we made it happen and in a next few months will be announced officially. Target is to establish “GLOBETECH CORPORATION LTD. R&D FLEXI FOR GEOINFO MUTI-MEDIA AND GEO-BUSINESS CENTER OF EXCELLENCY”.

On a closing note, we welcome all related conferences for joint partnership and scientific collaboration and to publish special issue from their event in IGRDG. We are very concern about the quality of the articles and the journal. Our editorial team have been trying to work out to qualify for the ISI and IF figure. I welcome all researchers, scientists, academicians, managers, directors and students to send papers and share their knowledge in this content. Welcome you all and look forward to receive your comments and suggestions that can help us for better quality in future issues, please.

Dr. Saied Pirasteh

THE WORD OF GUEST EDITOR

In 2011, I chaired the 5th International Symposium on Advances in Science and Technology (5thSASTech), held in Mashhad, Iran. The main goal of the symposium was to cast a thorough look at the advances in science and technology all over the world. It was particularly interested in presenting a good opportunity to the young scientists to present themselves to the scientific world. The symposium also aimed to encourage the participants to direct their future works toward the demand of the society.

As part of the on-going discourse on the environmental issues, there is a strong need for more research to mitigate the effect the human interferences in the world. As the Mashhad symposium made clear, there is a lot happening in the environment where a special care is demanded.

The symposium thus throws an academic searchlight on many issues which have marked the current scientific research activities as a whole in many countries. The contributors to 5thSASTech tackled many important issues in the field of Civil Engineering, Electronics and Communication, Computer Engineering and Computer Science, Architecture and Urban Studies all at the edge of science and technology. Due to the limitation imposed by the journals, only few papers have been selected for publication in a special issue. The selection was based on a peer review by distinguished reviewers.

The 6thSASTech symposium will be held in Kuala Lumpur, Malaysia on 24th and 25th of March 2012; where I invite you to actively participate in this very big event and enjoy the scientific environment made available to you. I am looking forward to meeting you there.

Dr. M. Reza Mobasheri
Guest Editor, IGRDJ

CONTENTS

Green House Gases Emission Reduction in Cement Production Process by Driving Forces Distribution

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Abstract

Cement is one of the most coveted commodities on the planet. it is used extensively in the development of the world's global infrastructure. This paper presents an investigation on the effects of temperature gradient distribution by the aid of a secondary burner on environmental effects of cement production process. For this reason, the burning system of the cement production (kiln & preheater) process was simulated in four thermal areas. The obtained results show that, for cyclone preheaters, fuel injection into the secondary burner up to a proportion resulting in the minimum temperature required for elite formation in the kiln burning zone is suitable. For shaft preheaters, however, according to percent calcinations, there exists an optimum proportion. In both preheater systems, the amount of greenhouse gases emission decreases considerably with increasing the ratio of the fuel injection into the secondary burner. The higher the production capacity, the higher the amount of decrease in greenhouse gases emission. In other words, use of secondary burner is more advantageous for kilns of higher production capacities.
Keywords: greenhouse gases, cement production, secondary burner.

Introduction

Reducing the environmental impact of cement production is an important step towards a sustainable cement industry and for a sustainable society. Cement is the hydraulic binder in concrete and mortar, and concrete is the second most consumed material after water. The energy- and material-intensive production process and the immense production volume (around 3.3 billion tons in 2010) make the cement industry a substantial resource consumer and greenhouse gas producer. Globally, cement production is responsible for 7% of industrial fuel use and 5% of total anthropogenic greenhouse gas emissions. Two promising approaches to making the cement industry more sustainable are switching to alternative resources and enhancing production technology

Nowadays, due to energy and environmental considerations, it is crucial to apply suitable methods by which reductions in both energy carriers' consumption and green house effects would be possible. Among different energy consuming industries, cement industry as a strategic one has a major role in energy carriers' consumption. In this industry, the burning system including preheater and rotary kiln is the core of the cement production process and the main consumer of the fuel.

The application of energy analysis and thermal improvement have been developed in various industries, including cement production, by Kääntee et al.[6], Choate[4], Koroneos et al.[9], Kawaes[7], Sogut & Oktay[11], Zeman & Lakcner[13] and Worrell et al.[12].

Cement industry is a well-known industry with lot of related references providing the exact process data to the users. For example Kurt[10], Kohlhaas & Labahn[8], Duda[5], Boateng[3] and Alsop[1] are useful references in cement industry. The combination of the cement production and energy subject can give some useful results. The main principle in this research is based on process rate effect on Greenhouse gases emission. This factor can be reduced if the process operation conditions could be closer to reversible situation. Using of the secondary burner can result in a more suitable temperature gradient distribution leading to decreased heat transfer rates and hence improvements in system operation.

Cement Burning System

Cement burning system has been widely development in recent fifty years. Figure 1 shows a modern cement burning system. As can be observed from figure 1, the kiln feed, in the form of a dry powder, injected into the cyclone preheater initiates the heat transfer process with the hot gasses during its downward movement. This heat transfer inside the preheater leads to physical and chemical changes including: preheating, dewatering and partial precalcination. Before entering the kiln, the raw meal passes through precalciner which has burners for a better precalcination process. In fact the basic difference between the old and the modern burning systems is the usage of precalciners. Precalciner has significantly reduced the kiln duty resulting in a lower thermal load in the burning zone and therefore inducing a more stable and smooth operation with considerably decreased operating costs (Ashrafizadeh[2]). The major reason for these improvements is high efficiency heat transfer in precalciner (fluidized bed heat transfer). The emergence of precalciner system has encouraged the owners of the cement industry to use the same philosophy to explore simple and economical modifications. One such modification has been the installation of a secondary burner for some fuel injection into the preheater.
The prevalent type of preheater that is widely used is cyclone or suspension preheater shown in Figure 1. This type of preheater has an additional duty of separating solid and gas phases besides its main duty of heat transfer. Another type of preheater from a relatively old technology is shaft preheater. As the name shows, the preheater is simply composed of a vertical column providing conditions for heat transfer between countercurrent flows of hot gases and kiln feed. A schematic diagram of the shaft preheater is shown in Figure 2.

Burning System Modeling

Fuel injection into the secondary burner has many different effects on the cement burning system among which the most important ones are as follows:

1- Temperature profile change
2- Gas velocity change
3- Change in the contact time between gasses and raw materials
4- Precalcination degree change
5- Mass and energy balance change

The above items are the functions of the four basic variables including:

- The combustion quality in the secondary burner
- The proportion of fuel injection into the secondary burner
- The excess air proportion in the combustion process
- The location of the secondary burner

The best location for the secondary burner installation is the duct between kiln and preheater to minimize the changes in the gas velocity profile and to eliminate any need for structural changes in preheater. Moreover, the contact time between the raw meals and hot gasses will be maximum resulting in a higher degree of calcinations in the preheater. Combustion quality is related to numerous operational conditions. The most important conditions include:

- Burner type
- The mixing quality of the combustion air and fuel
- The excess air proportion

Atmospheric burners are more advantageous compared to the other types for which the required air is normally supplied through the kiln resulting in a relatively low mixing efficiency in the secondary burner due to the high volume of gases. To determine the optimum proportion of fuel injection into the secondary burner, the following important points should be considered:

- The required thermal energy for sintering process in the kiln burning zone must be completely supplied.
- The gas velocity should not exceed the acceptable limit at the kiln inlet for preventing excessive dust load.

Due to the close relations between all the above mentioned parameters and also due to the complexity of the process, the considered thermodynamics system, i.e. the burning system including kiln and preheater, is divided into four thermal areas for more simplicity in the modeling. These thermal areas shown in figure 4 include:

1- Firs area from the main burner to the end of the kiln
2- Second area from the end of the kiln to the secondary burner location
3- Third area from the secondary burner to the calcinations zone inside preheater
4- Fourth area from the calcinations zone to the top of the preheater

As the fuel injection into the secondary burner affects the precalcination degree, for any proportion of fuel injection into the secondary burner an initial guess has been considered for the precalcination degree. If all the other factors remain constant, then for any given proportion of fuel injection into the secondary burner there exists a unique value for the degree of precalcination. This unique value, of course, is that making complete coincidence between kinetics and dynamics equations. Considering all the above mentioned points, Figure 5 shows the algorithm has been considered for the model.
As the residence times from the kinetics and dynamics equations are equal, the model accepts the percent calcinations and calculates the other parameters. The green house effects are the main part of these calculations.

Results and Discussion

Table (4) represents the results obtained for different proportions of fuel injection (α) into the secondary burner for both cyclone and shaft preheaters at three different production capacities and two different amounts of excess air.
As seen in Figure 6, the temperature of the first and the second areas rise with increase in the proportion of fuel injection into the secondary burner, whereas the temperatures of the third and the fourth thermal areas decrease.
The maximum temperature of the kiln burning zone should not be lower than 2200 ^{oC}, this can be considered as the limiting factor for the amount of fuel injection into the secondary burner. As seen in Figure 7, in shaft preheaters for any production capacity there exists a maximum point for precalcination degree as the ratio of fuel injection into the secondary burner increases.
The situation in cyclone preheaters, however, is different. Figure 8 shows that the precalcination degree continually increases with increase in the ratio of the fuel injection into the secondary burner.
Such a difference between the two types of preheaters is due to their structural differences. According to the obtained results, in shaft preheaters the temperature effect on gas residence time is more announced than cyclone preheaters.
Table 5 shows the decreasing amounts of exergy losses and greenhouse gases generation for natural gas fuel with 12% excess air.
Figure 9 shows the annual reductions in greenhouse gases for three different capacities. As seen, the amount of greenhouse gases emission decreases considerably with increasing the ratio of the fuel injection into the secondary burner. The higher the production capacity, the higher the amount of decrease in greenhouse gases emission. In other words, use of secondary burner is more advantageous for kilns of higher production capacities.

Conclusions

Temperature gradient distribution by installation of a secondary burner has positive effects on the environmental functions of cement production process. The higher the production capacity of the kiln, the higher the decrease is in the greenhouse gas emission. Structural differences between shaft and cyclone preheaters results in different behavior in variations of precalcination degree with the ratio of the fuel injection into the secondary burner. As the ratio of the fuel injection into the secondary burner increases, in shaft preheaters the precalcination degree passes through a maximum whereas in cyclone preheaters it increases continually.

NOMENCLATURE

T	temperature (oC)
X	degree of calcinations in preheater
α	fraction of fuel to secondary burner
t	time (sec)

Subscripts

cy	cyclone preheater
d	dynamic
sh	shaft preheater

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Table 1: A typical average chemical composition for cement raw meal

	Mass percent
$CaCO_3$	75.5
SiO_2	14.4
Al_2O_3	3.6
Fe_2O_3	2.4
H_2O	0.5
$CaMg(CO_3)_2$	2.5
K_2O	0.5
SO_3	0.5

Table 2: A typical average chemical composition for natural gas as fuel

	Volume percent
CH_4	77.73
C_2H_6	5.56
C_3H_8	2.4
C_4H_{10}	1.18
C_5H_{12}	0.63
CO_2	5.5
N_2	7

Table 3: A typical average chemical composition for Portland cement clinker

component	Mass percent
CaO	66
Al_2O_3	6
SiO_2	22
Fe_2O_3	4

Table 4: Effects of the ratio of the fuel injection into the secondary burner on burning system parameters

8% excess air							12% excess air					
α	**T_1**	**T_2**	**T_3**	**T_4**	**X_{cy}**	**X_{sh}**	**T_1**	**T_2**	**T_3**	**T_4**	**X_{cy}**	**X_{sh}**
Capacity: 2000 ton/day												
0	2640	945	945	390	13	24	2560	1036	1062	376	22	25.3
0.1	2400	939	1038	394	23	26.3	2330	1013	1152	387	30	26.6
0.2	2152	859	1082	414	29	26.15	2085	925	1196	420	35	25.9
0.3	1890	720	1100	451	33	24.1	1835	794	1214	467	39	23.6
0.4	1620	534	1105	497	36	20.5	1580	599	1203	517	41	20.2
Capacity: 2300 ton/day												
0	2645	960	960	409	11	22.8	2565	1062	1062	397	21	25.4
0.1	2405	950	1058	417	23	26.5	2327	1044	1152	407	32	26.2
0.2	2155	894	1114	433	30	26.1	2085	990	1196	444	38	24.7
0.3	1900	771	1144	474	35	23.8	1836	860	1214	495	42	22.3
0.4	1635	600	1161	528	39	20	1580	665	1203	548	44	19.2
Capacity: 2600 ton/day												
0	2650	965	965	424	11	23.4	2570	1151	1151	411	22	25.6
0.1	2410	1086	1086	433	24	26.7	2330	1074	1236	424	37	23.9
0.2	2155	1169	1169	453	33	25.3	2086	1064	1281	469	43	21.5
0.3	1905	1213	1213	503	39	22.3	1837	956	1298	527	47	18.9
0.4	1670	1215	1215	556	41	18.9	1584	745	1300	581	48	17.2

Table 5: Decreases in green house generation with the ratio of the fuel injection into the secondary burner (fuel: N.G, excess air = 12%)

α	Decrease in CO_2 generation (mole/s)	Decrease in H_2O generation (mole/s)
Capacity: 2000 ton/day		
0.1	9.9	18.8
0.2	20.9	39.7
0.3	32.03	60.7
0.4	40.7	77.03
Capacity: 2200 ton/day		
0.1	12.3	23.31
0.2	24.6	46.7
0.3	38.2	72.4
0.4	50.6	95.8
Capacity: 2600 ton/day		
0.1	13.6	13.6
0.2	28.3	28.3
0.3	41.9	41.9
0.4	59.2	59.2

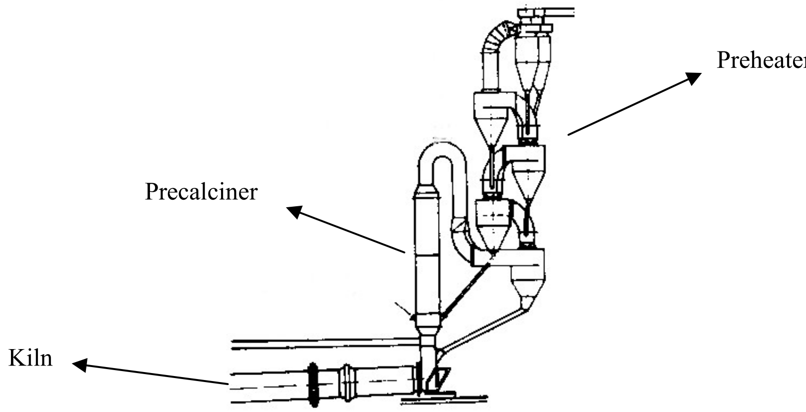


Figure 1: Modern cement burning system

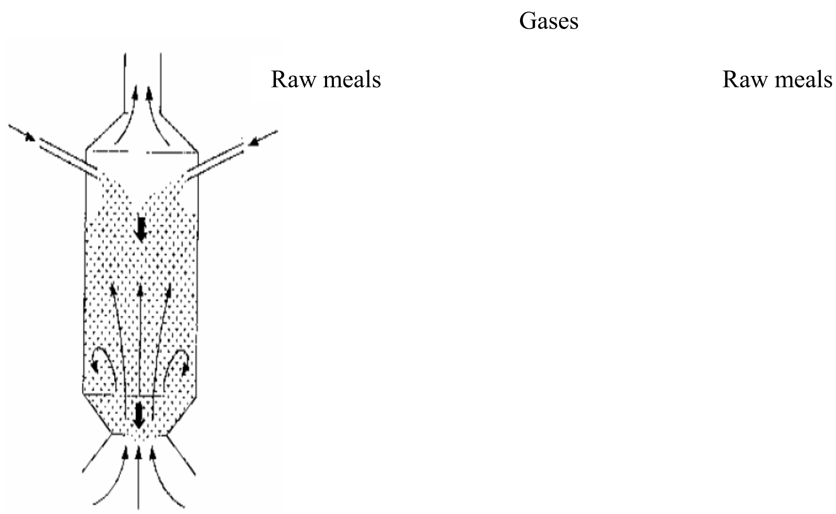


Figure 2: Shaft preheater

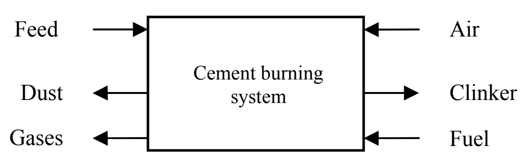


Figure 3: Inlet and outlet factors of the burning system

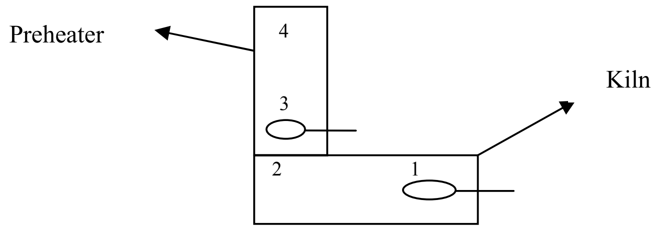


Figure 4: Thermal areas of the system

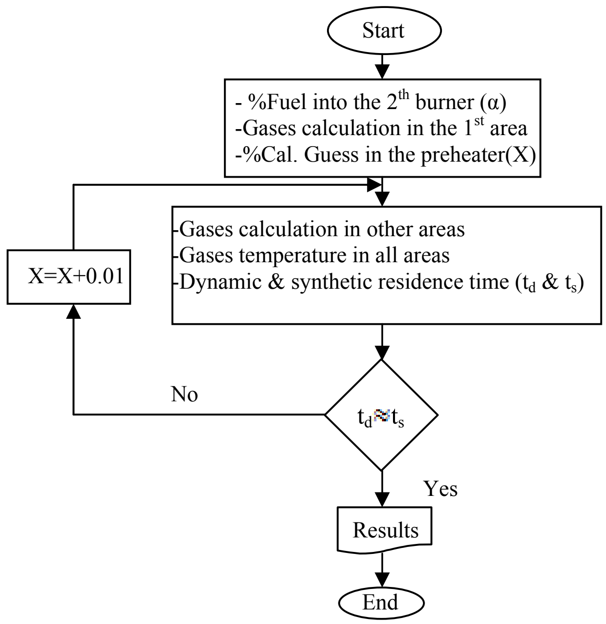


Figure 5: The model algorithm

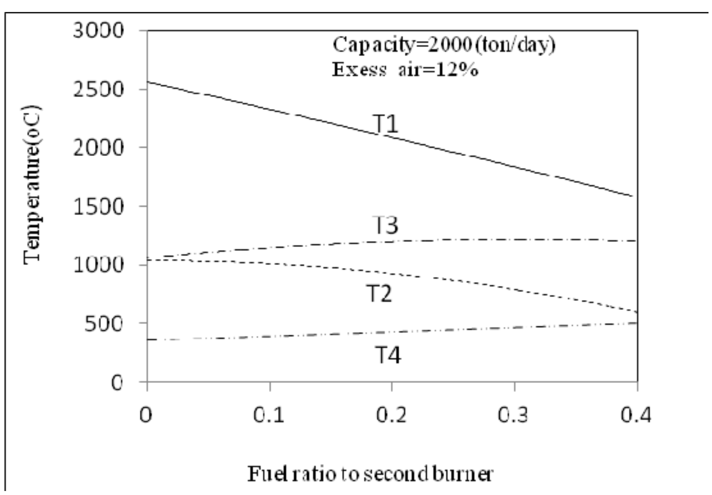


Figure 6: Temperatures of the four thermal areas versus the ratio of the fuel injection into the secondary burner

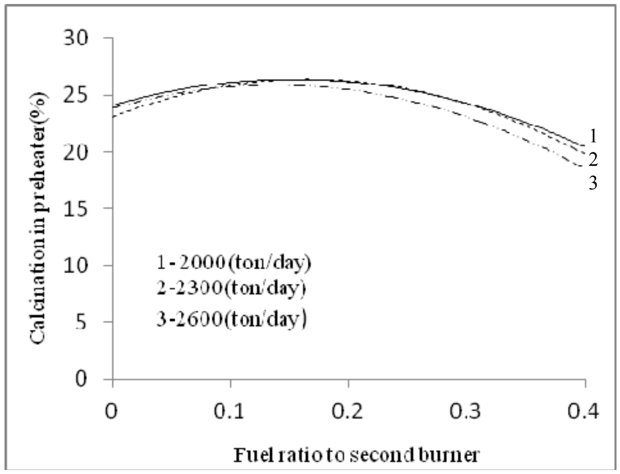


Figure 7: Precalcination degree versus the ratio of the fuel injection into the secondary burner in shaft preheaters

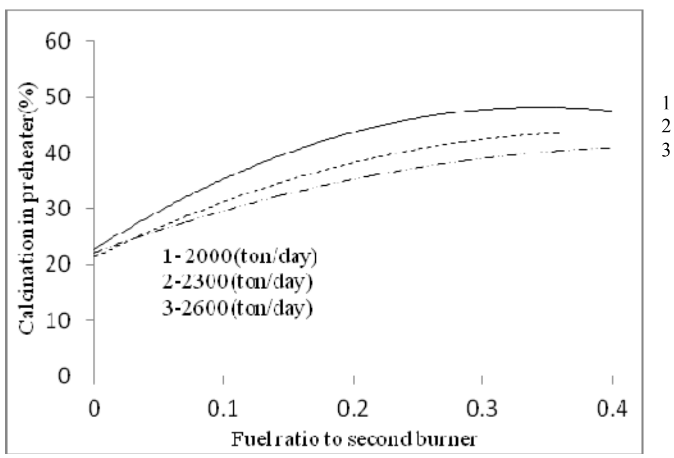


Figure 8: Precalcination degree versus the ratio of the fuel injection into the secondary burner in cyclone preheaters.

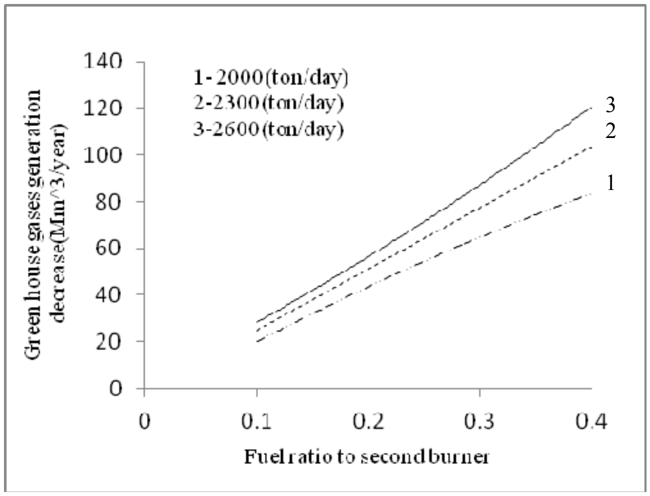
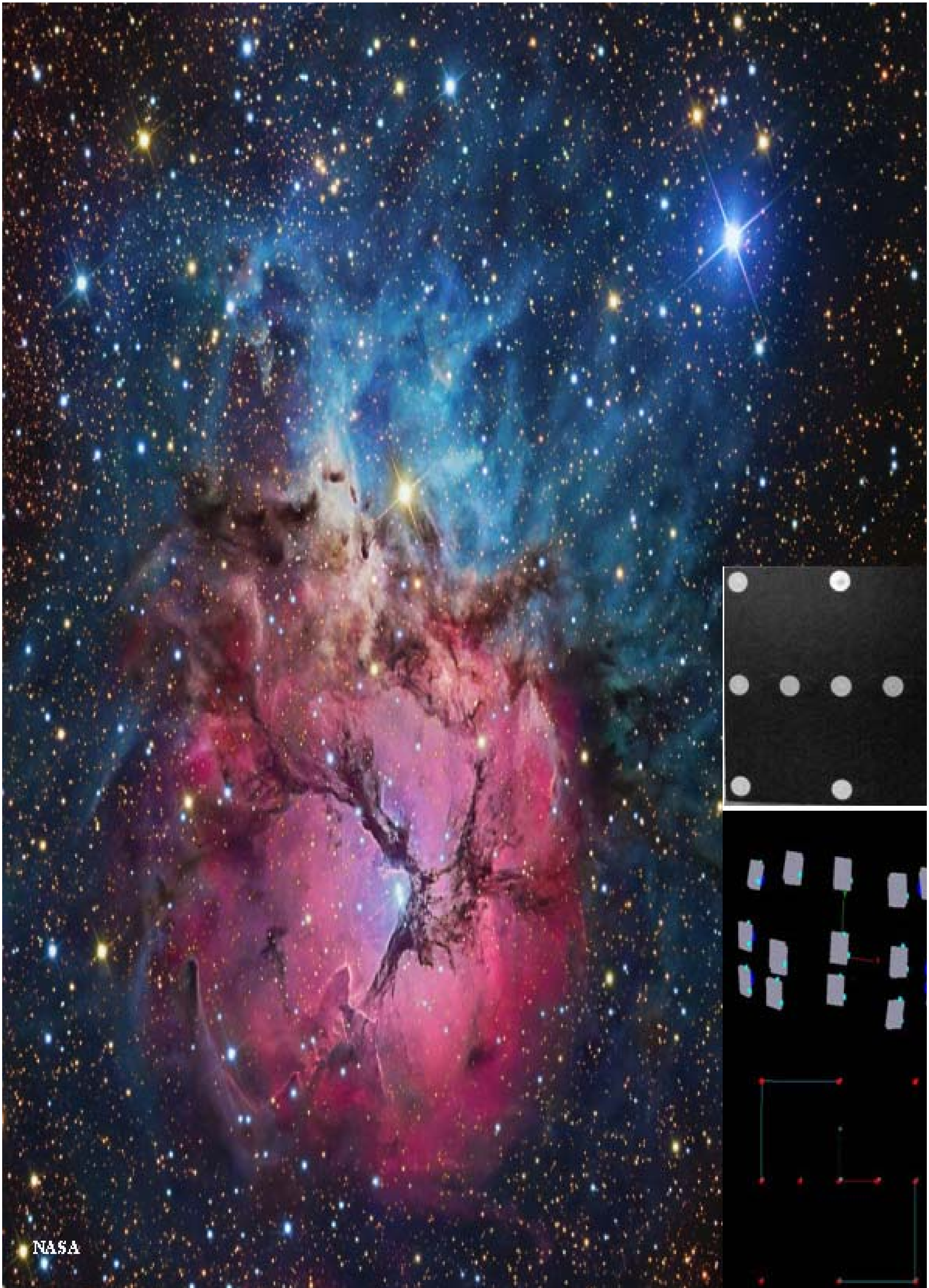


Figure 9: Annual decrease in green house gases emission versus the ratio of the fuel injection into the secondary burner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