بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

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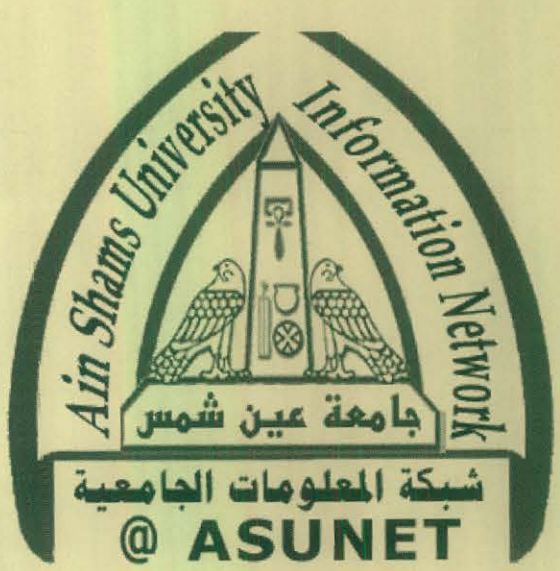
To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%



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بالرسالة صفحات

لم ترد بالاصل

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

EFFECT OF SWIRL MIXING ON THE COMBUSTION PROCESS

by

Mahmoud Mohammed Kamal Abd El Aziz
B.Sc.Mechanical Engineering, Power Section, 1998

A Thesis Submitted In Accordance With The Requirements For The Degree Of Master Of Science

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Statement

This dissertation is submitted to Ain Shams University for the degree of Master from Mechanical Power Engineering Department .

The work included in this thesis was carried out by the author in the Mechanical Power Engineering Department, Ain shams University, from 3/4/1999 to 11/9/2001.

No part of this thesis has been submitted for a degree or a qualification at any other university or institute.

Date: 9/12/2001

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ABSTRACT

Effect Of Swirl Mixing On The Combustion Process

An experimental work was carried out to investigate the effect of the swirl mixing on the performance of a liquid fuel flame in a confined chamber. The swirl was generated by a vanned double swirler splitting the combustion air into two streams called primary air (close to the burner nozzle) and secondary air (surrounding the first stream).As the aerodynamic field of this swirl burner is tailored by the variation of the two swirl angles introduced to both streams, this study was aimed to investigate the variation of the diffusion flame performance with changing the inner and outer swirl angles independently. A group of eight swirlers were constructed to study all combinations of 45.° and 60.° swirl angles between the inner and outer streams producing both the co -swirl and the counter-swirl cases.

Flame temperature and species concentration were measured for the different cases of swirl to determine the double swirl combination that produces :

1- The highest flame temperature.

2- The highest CO_2 containment.

3- The least flame length.

This swirl effect would result in the most intensified flame for the power engineering applications. By the examination of all possible arrangements of double swirl combinations of 45.° and 60.°, a criteria was set to determine the most efficient flame through the investigation of the above three items as a result of the change of the aerodynamic structure between swirl cases according to the following:

1-The more efficient swirl relative direction mode (i.e. co versus counter-swirl).

2-The optimum total degree of swirl imparted to the double swirl burner.

3-The most effective distribution of the swirl intensity between the two swirled streams.

4-The most effective sharing percent of combustion air between the two streams.

5-The most favorable relative angle between the two swirl angles.

In order to achieve the required results, the double swirl burner was fired with an excess air of 24%. To ensure an intensified, non-sooty flame, some parameters were optimized to attain the desired flame for study.

These parameters included the confinement ratio between the furnace and the swirler, the combustion intensity inside the furnace, the fuel injection pressure and the protruding distance of nozzle relative to the swirler face. These parameters were found to have a predominant effect in achieving the highest utilization of the swirl mixing. Because the recirculation in the swirling flame has to occur under a sufficient pressure gradient that may be assisted by a sudden expansion of flow, the first step was to examine different confinement ratios. The experiments asserted that decreasing the swirler diameter relative to the furnace diameter improves the resulting flame characteristics and a confinement ratio of 2.85 was chosen as a fixed parameter. Also, as the completeness of combustion inside certain dimensions through the residence time of reactants is influenced by the rate at which the fuel is burned, the pressure of atomizing and the point of spraying, the experiments were conducted to obtain the most suitable fuel flow rate for the furnace dimensions, the best protruding distance of the fuel nozzle and the effective range of the injection pressures. Those were found to be the most suitable for the burning conditions at values of 2 kg/hr, 12 mm (with negative value) and 12 bar respectively.

The experimental results concluded that the co-swirl mode with the inner stream being swirled more than the outer stream by 15 degree producing nearly equal sharing of the total combustion air supply has the most efficient swirling effect being observed in the highest obtained flame temperature and thermal efficiency with the least amount of un-burned species emission.

Table of contents