Calorimeter process

1. Introduction

The report as a study for nozzle operated under pressure difference from 0. 1 to 10 bars. Under this specification the report discuss the next point.

1. The factor affecting on the nozzle efficiency
2. Application in natural gas
3. Effect of nozzle efficiency on the quality of combustion and how the quality of combustion could be enhanced

1. 1. Definition

The nozzle defined as: device setting in the flow path to achieve change in pressure, temperature and the velocity also it can defined as an mechanical device designed to achieve controlling process on the direction or characteristic of the fuel flow as it exits or entry it can take the shape of an closed chamber or pipe via an orifice .

Reference: http//www. Engineeringtoolbox. com

1- Pressure

We con notice that when the fluids flow through the nozzle as the pressure increased the discharge rate also increased and all other factor remains constant. The relationship between the pressure and discharge from a nozzle exit is

A fundamental equation. The theoretical discharge from any nozzle

Given by the next relation.

Flow rate = CA (2gh) 5

C Means the dimensionless coefficient for the particular nozzle in question.

A Means the area of the nozzle orifice.

h- Means the pressure head applied to the nozzle.

G Means the acceleration of gravity.

As the pressure acts in the nozzle exit it directly affect to the stream of fuel . let us compare in the below figure between the gas stream with different pressure.

1- Differential pressure flow meters

In case of the differential pressure drop this device used to calculate the flow by measuring the pressure drop over an obstruction inserted in the flow. The main idea of the differential pressure flow meter is based on the Bernoulli equation. These achieved by measuring pressure drop signal as function of square flow speed.

p1 + 1/2 ? v12 = p2 + 1/2 ? v22

The most common types of differential pressure flow meters are

a- Orifice plate

With the using of the orifice plate, the fluid flow is measured through the difference in pressure from the upstream side to the downstream side. As showing in figure 1 : this process used in case when dont needs for high accuracy.

b- Venturi tube

Its best used in our case because this apparatus used in case of low pressure drop between the inlet and the outlet of nozzle. In the venturi tube application the flow rate is measured by reducing the cross section flow area in the path of the fluid flow

After the constricted area, the fluid passes through the pressure recovery section. When up to 80 % of the differential pressure generated at the constricted area, is recovered with proper instrument and flow calibrating. The venture tube flow can be less to about ten percentage of its full scale range with proper accuracy.

c- Flow nozzle

The flow nozzle are often used as measuring elements for gas flow application

When the gas accelerated through the nozzle, the velocity increase and the pressure so the gas density decreased and the maximum velocity done in the throat section.

– Recovery of pressure drop in orifices , nozzles and venture meters

After the pressure difference has been generated in the differential flow meter. The fluid passing during the pressure recovery section. By means where the differential pressure generated at the constricted area is partly recovered

2- Variable area flow meter

The rotameter composed of an vertically glass tube with large end in the top section of the main body of the rotameter and metering float which it free move . when the fluid flow causes the float raise in the tube and apply the relation of

Î” P = h * g * P

Where

Î” P = pressure difference between inlet and outlet

H = float recording

P = fluid density

3- Velocity flowmeters

In this process the flow calculated by measuring the speed and calculate the pressure difference from the next relation

p1 p2 = 1/2 p (v22- p v12)

4- Pitot tubes

The pitot tube are one the most used in air flow measurement. The main idea for its operation is in measure the fluid velocity by converting the kinetic energy to potential energy.

5- Calorimetric flowmeter

This device principle for fluid flow measurement is based on two temperature sensors in close contact with the fluid but thermal insulated from each other . one of the two sensors is contactly heated so there are temperature difference between the measurement of the two sensors .

5-turbine flowmeter

6-vortex flowmeter

7-electromagnetic flowmeter

8-ultrasonic Doppler flowmeter

9-positive displacement flowmeter

10-mass flowmeters

11-thermal flowmeter

12-open channel flowmeter

Calorimetric operation theory

The main idea for the operation theory of the calorimetric flowmeter based on measurements for the temperature before and after the nozzle by using two sensor and converting this difference to signal translated by the usage of the gauge indicators . When the fluid flow start passing into the nozzle the heat energy is drawn from the heated sensor and the temperature difference is directly proportional to the fluid flow rate through the nozzle

Advantages and disadvantages of calorimetric flowmeter

Advantages Disadvantages

1-high accuracy at minimum flow rate 1-costs

2- In general lower thermal conductivity require higher velocity for proper measurement. 2-appear cavitations in high speed

3-easy in its operation process 3-normally operates at low range

4-High repeatability 4-low noisy factor

5- high dynamic response 6-high sensitivity

7-small dimension (portable)

Lab application

Calorimetric provides two types of data. The first type is measurement of the heat capacities. This leads to values of the standard entropy St , the enthalpy (or heat content) HT- HS . And the enthalpies and the entropies of rapid phase changes (fusion, vaporization, polymorphism) of a single material. the second type of measurement of heats of chemical reaction (formation from the elements or the oxides , relatively stability of competing phase assemblages , mixing in solid and liquids solutions) either by direct reaction or through a thermchemical cycle such as is involved.

Second application for the nozzle in the calorimeter is to spray the natural gas to burn it inside the combustion chamber. The next figure show example for burner nozzle.

1-Fuel properties and the effects of sprays

Our fuel used in the calorimeter is the natural gas which takes the name of isooctane (C2H6) and it has the next microstructure

Temperature

The temperature difference between the inlet and the outlet of the nozzle also affecting on the nozzle performance this achieved by when the temperature increased this directly effecting on the fuel properties specially in its viscosity so in the petroleum applications for the high viscosity sometimes used heating process for the fuel before path through the nozzle .

Surface Tension

The Surface tension in natural is the tendency of the surface of the liquid to contracting with the smallest possible area. The effect is normally similar to the skin surrounding the body of the liquid and pulling it into the shape, which will have the least amount of the surface area. That shape is spherical shape. Surface tension

Natural of flow

The natural of fluid flow through the nozzle effect on its performance . for example in case of laminar flow the performance of the nozzle will be better than in case of turbulent flow.

In case of found a head it also affect in the nozzle performance.

Cleaning Nozzles

In case of using fluids containing sluts and other dusts it concentrated in the main body of the nozzle which affect on the nozzle path that reduce the flow rate through the nozzle which affect on its performance .

– Spray Patterns

The Nozzles used for oil burners are provided in two different general types of spray patterns, hollow cone and solid cone. These are illustrated in the below Figure. It will be noted in these illustrations that the hollow cone is a spray in which the concentration of droplets is at the outer edge of the spray with little or no fuel in the center of the spray versus the other type of sprays which leads to an weakness in the performance of the nozzle.

Performance improvement

The efficiency of the nozzle depending on several factors it concentrated on

1. Type of sprayer and nozzle of design
2. The percentage of air to fuel ratio
3. Spark method from heaters to use the spark ignition technology.
4. Percentage of carbon on the fuel

So in the next section we discuss these factors which it can affect on the nozzle performance

1- Flammability (burning start)

The classical method for lighting the calorimeter is matching it is not efficient so that we improve the nozzle performance from this side by using the spark ignition technology.

This spark ignition working depending on providing it with fixed voltage from battery to be able get the initial spark to start the burning process

* The spark ignition which get the initial spark to the instrument get its power connected by wire (3mm) which connected also to battery with 12 v .

2- Fuel to air ratio

In the theory of the stoichiometric mixture has just enough air to completely burn burn the available fuel. In natural this is never quite achieved, due primarily to the very short time available in the internal combustion chamber for each combustion cycle. Most of this combustion process completes in approximately 4-5 milliseconds. This is the time that elapses from when the spark is fired until the burning process completed.

The Air fuel ratio is the most common reference term used for mixtures in internal combustion engines

It is the ratio between the mass of air and the mass of fuel in the fuel-air mix at any given moment

For pure natural gas the stoichiometric mixture is approximately 14. 7: 1 or ? of 1. 00 exactly

3-to make a window from the top to see the flame from inside instead of opening the system each time. We must use material Cleary to see out from it and work under pressure 10 bar

$${\rm C_2H_6} + \tfrac{7}{2}{\rm O_2} \rightarrow 2{\rm CO_2} + 3{\rm H_2O}$$

Equivalent ratio

The equivalence ratio of a system is defined as the ratio of the fuel-to-oxidizer ratio to the stoichiometric fuel-to-oxidizer ratio. Mathematically

$$\phi = \frac{\mbox{fuel-to-oxidizer ratio}}{(\mbox{fuel-to-oxidizer ratio})_{st}} = \frac{m_{fuel}/m_{ox}}{(m_{fuel}/m_{ox})_{st}} = \frac{n_{fuel}/n_{ox}}{(n_{fuel}/n_{ox})_{st}}$$

4-carbon percentage in the fuel

Natural gas is an extremely important source of energy for reducing pollution and maintaining a clean and healthy environment. In addition to being a domestically abundant and secure source of energy, the use of natural gas also offers a number of environmental benefits over other sources of energy, particularly other fossil fuels. This section will discuss the environmental effects of natural gas, in terms of emissions as well as the environmental impact of the natural gas industry itself. Scroll down, or click on the links below to be transported ahead.

Conclusion

The report is an investigation to describe the calorimeter process and the system operation with the nozzle performance and the method to improve its performance. So the main objectives from the report are

To understand the basic principle of calorimeter and its necessity in engineering

to investigate different types of calorimeters. The advantages and disadvantages

using these calorimeters in the engineering lab environment.

References

1- http://www. pro-techsolutionsltd. com/PDF/flownozzle. pdf

2- www. EngineeringToolBox. com

3- www. flowmeterdirectory. co. uk/flowmeter_calorimetric. html

4- www. webersensorsinc. com/glossary. html

5- S. Sosin, C. Moldovan, R. Iosub; Designing and manufacturing of a calorimetric micro-sensor for methane detection, CAS International Semiconductor Conference Proceedings, Vol. 2, 2004, pp. 381 384.

6- www. bioline. org. br/pdf? se08021

7-R. Mohan Kumar, R. Muraliddharan, D. Rajan Babu, K. V. Rajendiran, R. Jayavel, D. Jayaraman, and P. Ramasamy, J. Cryst. Growth 229, 568 (2001).

8-K. Meera, R. Muralidharan, R. Jeyavel, and P. Ramasamy, J. Cryst. Growth 263, 510 (2004).