MODULE-3

Furnace Design

Q1: What is naphtha?

A1: It is low boiling refinery stream. Gasoline is made by blending several virgin and treated napthas. FCC naptha is the fraction distilling between 100°F and 430°F.

Q2: What are olefins?

A2: Olefins are hydrocarbon molecules containing carbon-carbon double bonds. The name olefin comes from roots that imply oil former. The general formula for olefins is C_nH_{2n}, where n is 1, 2, 3, etc. Olefins are not found in crude oil, but are formed during cracking reactions in many refinery processes.

Q3: What are the major factors affecting total emissivity? The total emissivity ε_g of a volume of combustion gases is dependent upon?

A3: The temperature T product of partial pressure and effective path length P_L .

Q4: How is total emissivity different from total absorptivity?

A4: The total absorptivity of a gas also depends upon its temperature and partial pressure path length product, but in addition upon the temperature T_s of the source of the radiation that is being absorbed.

Q5: Explain the condition where heat flux is independent of the gas emissivity?

A5: In the case of refractory surface, assuming no heat loses, is in equilibrium with the gases and reradiates all the heat falling upon it. The total radiation flux within the enclosure is equal to that emitted by a blackbody at temperature T_g . Under these circumstances the heat flux to the sink is independent of the gas emissivity.

Q6: Write the simplifying assumptions for well stirred furnace model?

A6: The following simplifying assumptions are made:
(1)The hot gases are perfectly mixed and at a uniform temperature, T_g.(2)The heat sink is gray and has a uniform temperature, T_1.(3)The refractory surface is radiatively adiabatic, that is to say it radiates all the heat that is receives.

Q7: Describe in brief function and simple construction of furnaces?

A7: Furnaces are used throughout the industry to provide the heat, using the combustion of fuels. These fuels are solid, liquid or gaseous.
Furnaces consist essentially of an insulated, refractory lined chamber containing tubes. Tubes carry the process fluid to be heated, and sizes are device for burning the fuel in air to generate hot gases. A great variety of geometries and sizes are used, and much of the skill employed in their design is based on experience. However, all furnaces have in common the general feature of heat transfer from hot gas source to a cold sink.

Q8: Describe the heat transfer process inside furnace ?

A8: The flames heat up the tubes, which in turn heat the fluid inside in the first part of the furnace known as the radiant section or firebox. In this chamber where combustion takes place, the heat is transferred mainly by radiation to tubes around the fire in the chamber. The heating fluid passes through the tubes and is thus heated to the desired temperature.
The gases from the combustion are known as flue gas. After the flue gas leaves the firebox, most furnace designs include a convection section where more heat is recovered before venting to the atmosphere through the flue gas stack.

Q9: What can be the possible modes of heat transfer?

A9: A fuel-fired furnace consists of a gaseous heat source, a heat sink, and a refractory enclosure. Heat is transferred to the heat sink by radiation and convection from the hot gases and by reradiation from the refractory walls. In developing any model of the process, it is necessary to consider two heat transfer phenomena
(1)The heat emission from hot gases containing combustion products, i.e. the heat source.(2)The heat absorbed by the tubes, taking into account their geometrical configuration and material properties (the heat sink), composed of primary heat transfer from hot gases and secondary heat exchange with the refractory walls.

Q10: What is the arrangement of convective and radiant section in a furnace and what can be the possible reason for this?

A10: The convection section is located above the radiant section where it is cooler to recover additional heat

Q11: List the broad area where furnaces may find application in petrochemical industry?

A11: In petrochemical industries, furnaces are used to heat petroleum feedstock for fractionation, thermal cracking, and high-temperature processing. Usually, these furnaces are fired by oil or gas.

Q12: Give the percentage of excess air required to ensure complete combustion for different fuels?

A12: Typical values are 10% for gaseous fuels, 15 to 20% for liquid fuels, and 20% for pulverized fuel, although lower percentages can be achieved with efficient burners.

Q13: What is the reason behind luminescence in flames and what type of fuels exhibit this behavior, explain with the help of an example?

A13: When solid particles are present in the furnace gas stream they become incandescent, radiating both heat and light, so producing a glowing or luminous flame. Gaseous fuels burn with a nonluminous flame, but liquid and solid fuels produce luminous flames due to the presence of particles of carbonaceous material. For example, soot or coke resulting from the incomplete combustion of the hydrocarbons and mineral matter originally in the fuel. In general, solid fuel produces a more luminous flame than does liquid fuel.

Q14: What are the main sources of radiation for nonluminous flames?

A14: Carbon dioxide and water vapor are the main sources of radiation for nonluminous flames.

Q15: List the factors affecting rate of heat transfer by radiation from the hot gases?

A15: The rate at which heat is transferred by radiation from the hot gases to sink depends on the emissivity of the gas emissivity of the sink surface and also on the relative size of the sink.
This is because the unconverted refractory lining radiates back into the furnace heat that it has received from the flame, and some of this is absorbed by the heat sink.

Q16: Describe briefly about furnace models and various methods used?

A16: The full mathematical description of practical furnaces is exceedingly complex, combining aerodynamics, chemical reactions, and heat transfer, and computer programs are necessary for detailed solutions. Advanced methods of calculation may be divided into zone methods and flux methods.

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