FILM COATING INDUSTRY VOC WASTE GAS TREATMENT CASE STUDY

1. Overview

The waste gas comes from the oven of a coating production line with a web width of 980 mm and a line speed of 25 m/min. The solvent consists of 90% ethyl acetate, 10% toluene and a small amount of isopropanol. The total exhaust flow rate is 15,000 m^3/h at a concentration of 8,927 mg/m^3, which is far above the concentration required for autothermal operation of the regenerative thermal oxidizer (RTO); there is therefore ample surplus heat available for recovery.

2. Process Route

A 15,000 m^3/h rotary RTO is used to treat the oven exhaust from the coating line.

The heat released by the VOCs in the waste gas decomposed through RTO combustion is transferred, via a hot-air heat exchanger, to supply heat to the coating machine, on the premise of meeting the RTO operating requirements. The designed recovered hot-air flow rate is 15,000 m^3/h, and the hot air is supplied to the fresh-air inlet of the coating machine oven.

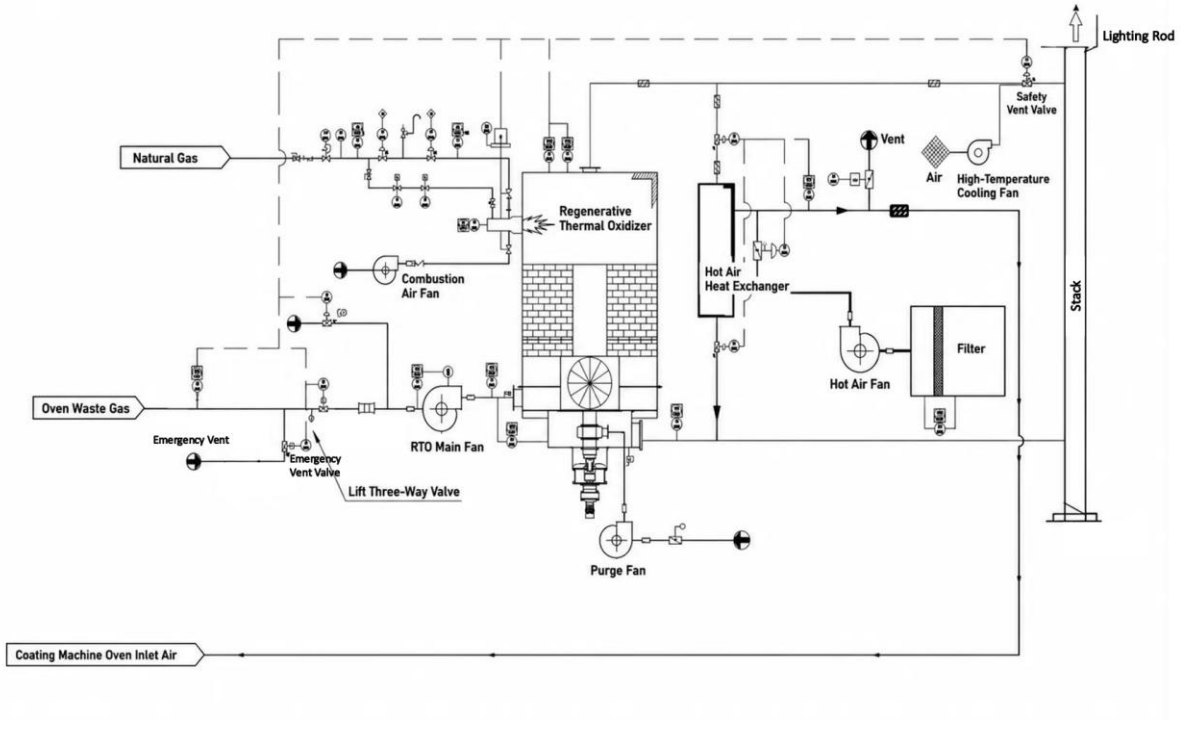

Fig. 2-1 Treatment Process Diagram

3. Working Principle

3.1 Autothermal Operation

An RTO consists of several regenerative chambers and one combustion chamber. The waste gas first passes through the regenerative chambers and is drawn into the combustion chamber. While passing through the regenerative chambers, the waste gas absorbs heat from the ceramic media and its

temperature can rise to several hundred degrees Celsius, so that oxidation and decomposition can proceed smoothly. When the VOC concentration in the waste gas is sufficiently high, the energy released by VOC oxidation is enough to oxidize the subsequent incoming waste gas, so that no additional fuel is consumed — this is the autothermal operation of the RTO. After the VOCs are decomposed, the treated clean air has a high temperature and carries a large amount of thermal energy; this clean air stream leaves the RTO through another set of regenerative chambers and transfers its thermal energy to the ceramic media in those chambers. The temperature difference between the RTO inlet and outlet gas streams can be as low as 40 °C, meaning that most of the thermal energy is retained within the RTO for reuse — this is the concrete manifestation of the RTO's high thermal efficiency.

3.2 Waste Heat Recovery

When the VOC concentration in the waste gas is high enough that the heat generated significantly exceeds the thermal energy required for autothermal operation, the surplus heat can be recovered and utilized. The high-temperature flue gas carrying the surplus heat is directed through the high-temperature bypass ductwork to the heat exchanger, where the heat is transferred to the heat-transfer medium. In this project the heat-transfer medium is hot air, which can be used directly by the coating-line oven, accommodates a very wide temperature range, and costs very little. Fresh air filtered through a filter can serve as the heat-transfer medium; it is introduced into the heat exchanger to absorb the heat of the high-temperature flue gas and is then directed to the coating machine. Because hot air has a relatively low specific heat capacity, hot water, steam or thermal oil may be used for waste heat recovery under different operating conditions.

4. Treatment Performance

NMHC ≤ 30 mg/m^3