CHEMICAL INDUSTRY VOC WASTE GAS TREATMENT CASE STUDY

1. Components and Concentrations

This project treats the process exhaust gas from the production workshop of a chemical plant. The waste gas contains a variety of organic compounds together with small amounts of acid and ammonia. The specific waste gas parameters are as follows:

Waste Gas Source	Waste Gas Composition	Waste Gas Concentration (mg/m^3)	Waste Gas Flow Rate (m^3/h)
Workshop process exhaust collection	Xylene, isopropanol, ethylene glycol dimethyl ether, butadiene, acrylonitrile, propylene, toluene, methanol, esters, trace sulfuric acid, hydrochloric acid, ammonia, etc.	2,500	30,000

The waste gas is at ambient temperature and atmospheric pressure.

2. Process Route

There is an alkaline scrubber & dehumidification tower up stream of the RTO. It removes the acidic constituents in the waste gas as well as the moisture introduced during alkaline scrubbing, so as to minimize the formation of free water, which would absorb heat and also cause rusting. Only after this step is the waste gas delivered to the regenerative thermal oxidizer (RTO) for oxidation.

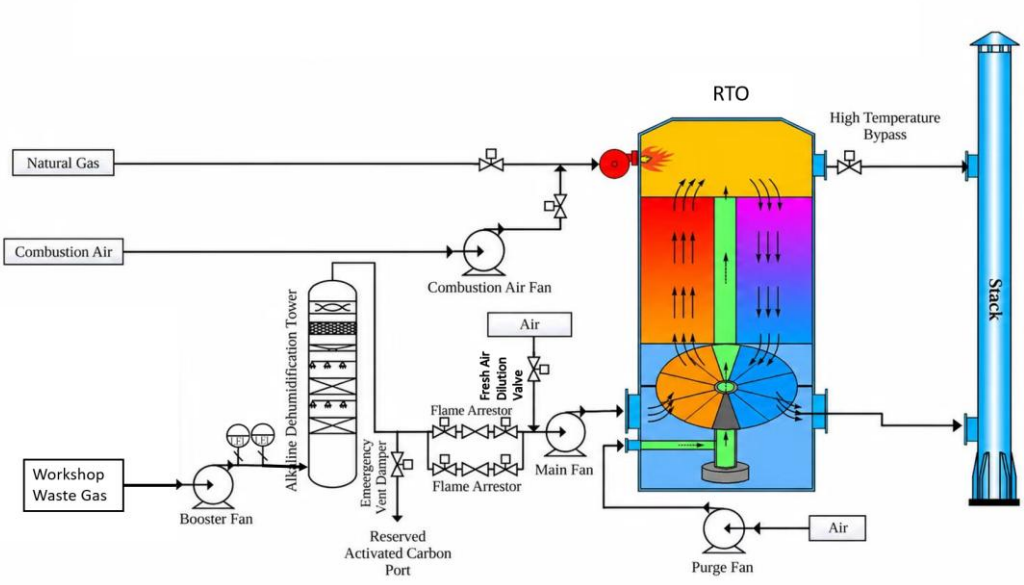

Fig. 2-1 Treatment Process Diagram

Because the acidic substances have already been neutralized, the RTO can be fabricated from Q235B carbon steel, and there is no risk of secondary pollution; therefore no special post-treatment measures are required.

3. Working Principle

The composition of the waste gas is relatively complex and contains a variety of compounds. However, apart from sulfuric acid, hydrochloric acid and ammonia, most of them are organic; and apart from acrylonitrile, most are composed only of carbon, hydrogen and oxygen. Therefore, no matter how numerous the compounds are, they can all be oxidized at high temperature. This is the fundamental principle by which an RTO can efficiently treat volatile organic compound (VOC) waste gas.

To achieve higher thermal efficiency, the waste gas containing these organics first passes through the regenerative chambers and absorbs the heat stored in them. As a result, by the time it enters the combustion chamber it already has a very high temperature, so that oxidation can start smoothly. After the VOCs are fully decomposed into water and carbon dioxide, the purified gas leaves through another set of regenerative chambers, and its heat is absorbed by the chambers to preheat the incoming waste gas yet to be treated.

However, the waste gas contains some inorganic acidic constituents, so alkaline-scrubbing pretreatment is necessary; otherwise the gas not only fails to meet the discharge standard but also corrodes the RTO equipment. The gas is sprayed and scrubbed with alkaline wash liquor inside the spray tower, where the acidic inorganic gases in the waste gas fully contact and mix with the alkaline mist and undergo a neutralization reaction, achieving good gas–liquid two-phase contact and removing the acidic inorganic constituents from the waste gas.

The purpose of dehumidification is to remove moisture from the waste gas. After alkaline scrubbing, the waste gas contains a large amount of water vapor, which tends to form condensate accumulation in the RTO system and thereby poses a certain operating risk to the equipment; the waste gas entering the RTO must therefore be dehumidified. The dehumidification is designed as three stages. The gas first passes through a swirl-plate stage for preliminary dehumidification, then through a baffle-plate stage; the baffles dehumidify the waste gas, and their sinusoidal profile makes them resistant to clogging. After the baffle-plate stage, the gas enters the packed-bed dehumidification layer, which offers the highest dehumidification efficiency. After the three-stage dehumidification, no free water remains in the waste gas, thus ensuring normal and safe operation of the RTO system.

4. Treatment Performance

NMHC ≤ 30 mg/m^3