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TECHNOLOGY AND INSTALLATION FOR PURIFICATION AND NEUTRALIZATION OF ACID GASES

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Abstract: *A clean environment is an indispensable human right. Economic and technological development leads to pollution of both the air and water. This article presents a method for purifying gases from technological processes contaminated with acids. The absorption apparatus is a packed bed column. Packed bed columns have a large contact area between gases and liquid streams, which allows for absorption at low hydraulic resistances of 10-15 mm water column. The packing used is a honeycomb with vertical walls made of ceramic material, which has very high acid resistance and a long service life. The liquid is evenly distributed over the filling by an liquid distributor, followed by a redistribution layer of bevelled Raschig rings. A solution of (NaOH) is selected for absorption.*

Keywords: *ecology, absorption, bed*

INTRODUCTION

During the industrial manufacturing of sensors at Sensata Technologies Bulgaria, gaseous emissions are generated within the production facilities. The production site is located in Tsaratsovo village, Maritsa municipality. The installed ventilation system, with a nominal capacity of 6,000 $m^3 \cdot h^{-1}$, is designed to capture these emissions. Pollutants are present in both gaseous and aerosol phases. The primary contaminants include, hydrogen fluoride (HF), nitric acid (HNO_3), and silver nitrate ($AgNO_3$). The concentrations of these species exhibit temporal variability, and the gaseous phase is characterized by pronounced acidity.

The proposed gas treatment method involves chemical absorption using an aqueous sodium hydroxide (NaOH) solution in a packed-bed absorption column. The column is equipped with structured honeycomb packing elements featuring an inscribed circle radius of 20 mm and a height of 60 mm fig.2. Above this section, a liquid redistribution layer composed of stacked Raschig rings fig.1 (50 mm in diameter, beveled at 16°) is installed. The absorbent solution is automatically regulated to maintain a pH range of 8–10. The liquid level within the column is continuously monitored: when the level decreases, water is added; when it exceeds the setpoint, excess liquid is discharged via a hydrosiphon.

EXPOSITION

Design brief for an acid gas purification plant

The quantity of contaminated gases to be treated is 6000 m^3/hour, the temperature varies, the maximum being 60 ^oC. The concentration of water vapour in the gases is unknown. The concentration of pollutants is variable over time, the exact quantities are unknown. The pollutants are in both gas and liquid phases. The pollutants are: hydrogen acetate (HA_C), hydrogen fluoride (fluorine HF), nitric acid (HNO_3), and silver nitrate ($AgNO_3$).

Purified gases to meet environmental requirements.

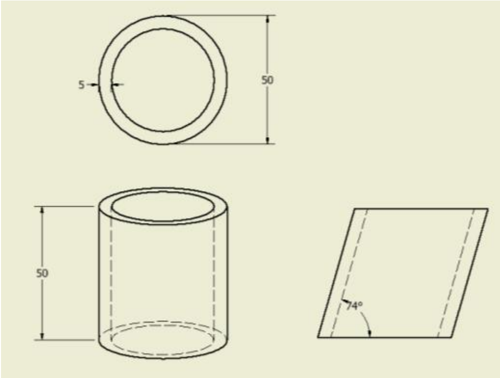

Fig.1 Raschig rings

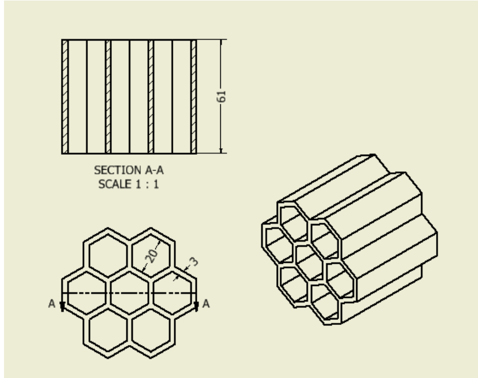

Fig. 2 Honeycomb packing

SOLUTION

Efficient Acid Gas Purification Using a Packed Bed Column

The purification of acid gases presents a significant challenge, particularly due to the fluctuating concentration of impurities in the gas stream. To address this, a packed bed column (absorber) is employed, which enables excellent contact between the contaminated gases and the sodium hydroxide (NaOH) absorbent solution.

In this setup, an ordered honeycomb packing is selected for its low hydraulic resistance and relatively low cost. The packing material is acid-resistant ceramic, which ensures durability under corrosive conditions. However, a notable drawback of this type of packing is its inability to redistribute the liquid phase vertically, due to its rigid vertical walls. To overcome this limitation, an additional packing layer is placed above the honeycomb structure to evenly distribute the liquid jets from the liquid distributor across the column’s cross-section.

For this purpose, we utilize an ordered packing of Raschig rings fig.1, beveled at an angle of 16°. Each layer of Raschig rings is rotated 90° relative to the previous one, and the total number of layers must be a multiple of four. In our case, eight layers of this packing were used.

The performance of the installation has proven to be highly effective. The system exhibits low hydraulic resistance - less than 15 mm of water column - which contributes to reduced operating costs. Additionally, the dosing system operates efficiently and economically, adjusting to the varying concentrations of impurities in the incoming gas stream.

A schematic diagram of the proposed acid gas purification system is presented in the fig. 3.

Operation of the Proposed Installation

Polluted gases enter the absorber (1) through the gas duct (16). They are introduced below the packing support grid, then pass through the packing elements 4,3 where they come into contact with the NaOH solution in the liquid phase. This contact initiates a mass transfer process, resulting in the neutralization of the acidic components in the gas stream.

Due to the incoming gas temperature of approximately 60°C, the gases are humidified to the adiabatic evaporation temperature as they pass through the absorber. This process causes partial evaporation of the circulating water, which is automatically replenished via the make-up system (8).

The concentration of pollutants in the inlet gas varies over time. To ensure consistent performance, the system includes a pH monitoring 11 and control mechanism that maintains the solution within a range of pH 8–10 (6). This allows for effective neutralization regardless of fluctuations in impurity levels. Accumulated salts in the system are periodically discharged through the drain (14) to prevent buildup and maintain efficiency.

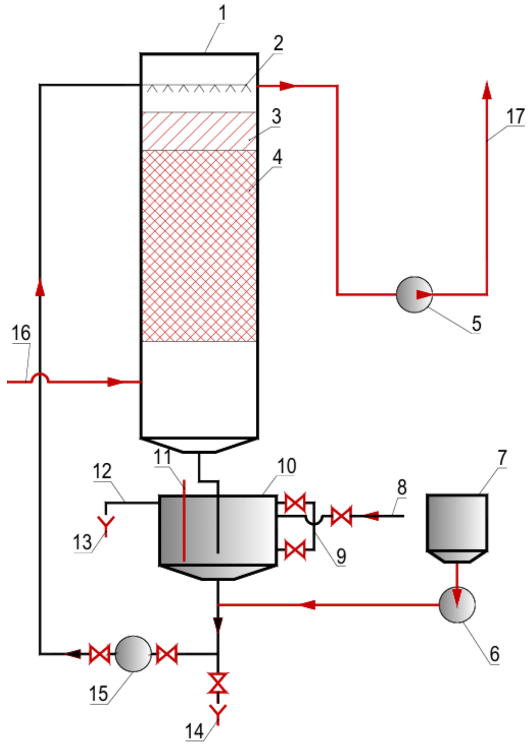

Fig. 3 Absorber 1, 2 liquid distributor, 3 redistribution layer , 4 base layer, 5 fan, 6 dispensing system, 7 tank for solution of NaOH, 8 system for top up with water, 9 level sensor, 10 tank, 11 sensor for Ph 12 spillway, 13,14 drain , 15 circulation pump,16 inlet polluted gases, 17 purified exhaust gases

Overall, the described system demonstrates excellent performance. The purified exhaust gases meet environmental standards, confirming the effectiveness of the proposed design.

Figure 4 shows the developed installation.

Fig. 4 Shows an existing acid gas cleaning installation

CONCLUSION

The installation described above solves the problem of acid gas purification by using fillings with low hydraulic resistance that are resistant to acids and bases. The automatic Ph maintenance system solves the problem of purification in the case of explosive contaminated gases. Since the temperature of the incoming gases at 60 °C continuously carries water vapor with the outgoing gases, the automatic level monitoring system in the device is essential.

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