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1985: Hydrogen Sulphide Odour Control at Pelt Processing Plant. Chemical scrubber removes over 97% of hydrogen sulphide

Odour Control at a Pelt and Hide Processing Facility

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Introduction

Auckland Farmers Freezing Cooperative Ltd has just completed a new centralized automated processing facility for processing pelts and hides produced by AFFCO owned works. The plant will be the largest of its kind in New Zealand and will process up to 40,000 pelts per day. At the plant the green pelts are batch pickled in Challenge Cook processors. Approval to build this facility in the centre of fast growing Manukau City Industrial Area was given by the Manukau City Council on the condition that the plant complied with the Clean Air Act and that at the plant boundary no nuisance would occur as a result of odour from the site.

To achieve this proper plant had to take care to ensure:

1. Strict housekeeping methods were employed to avoid smells from outside storage bins, drains, etc.
2. Liquid waste treatment methods were non-odorous
3. All foul air in the processing plant was captured
4. All foul air was properly treated and vented appropriately to atmosphere

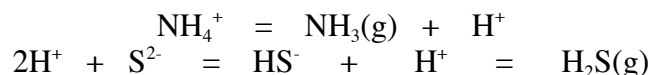
This paper looks at the treatment of the foul air stream collected from the main processing units.

Design Overview

A packed wet scrubber is the most used odour control equipment for removing the malodorants produced by this type of industry. The Clean Air Act [1] states that the best practical means must be used to control air emissions. The Department of Health encourages the use of chemical additions of sodium hydroxide and sodium hypochlorite to control these odours. To meet the requirements of no odour nuisance at the plant boundary, it was decided to design the odour control system to maintain odour levels at the plant boundary to below odour threshold values (detectable levels).

Odours Generated

The pelt and hide processing plant uses sodium sulphide, ammonium salts, and other chemicals with the result that hydrogen sulphide, other sulphides, ammonia, mercaptans and some other malodorants are generated. The quantities of malodorants are pH and concentration dependent and vary during the process reaching peaks during sulphide washout and acid addition. Two of the chemical equilibrium set up are as follows:



Work was done with AFFCO in quantifying these malodorants and information was provided by the NZ Leather and Shoe Research Association. Using specially designed air collection hoods fitted to the 12 processing vessels, a foul air stream of up to 700 cubic metres per minute (25,000cfm) was expected to contain the malodorant concentrations given in Table 1.

TABLE 1

Malodorant	Maximum Expected Concentration (ppm)
Hydrogen Sulphide	60 to 100
Ammonia	150 to 300
Methyl Mercaptan	2
Dimethyl Sulphide	0.33
Methyl Sulphide	No information
Trimethyl Amine	0.13

Odour Reduction Efficiencies Required

For the malodorants given in Table 1, the odour threshold levels and some of the benchmark levels suggested by the Department of Health for odour levels at the plant boundary are given in Table 2. The odour threshold level is that concentration at which the malodorant is first detected. It must be noted that odour threshold levels are subjective and vary from reference to reference [3,4].

It is quickly obvious that the main odour reduction required is for hydrogen sulphide which needs to be reduced from up to 100 ppm in the plant foul air stream to only 0.0081 ppm at the plant boundary so as to be undetectable. This means a reduction efficiency of 99.99 percent or a reduction of 1250 times so that it is undetectable at the plant boundary.

TABLE 2

Malodorant	Odour Threshold Level (ppm) Dept of Health [3]	Benchmark levels suggested by Dept of Health for odour levels at boundary (ppm – 3 min value)
Hydrogen Sulphide	0.0081	0.025
Ammonia	5.2	2
Methyl Mercaptan	0.0016	0.005
Dimethyl Sulphide	Not stated	0.0015
Methyl Sulphide	Not stated	0.0005
Trimethyl Amine	0.00044	0.0005

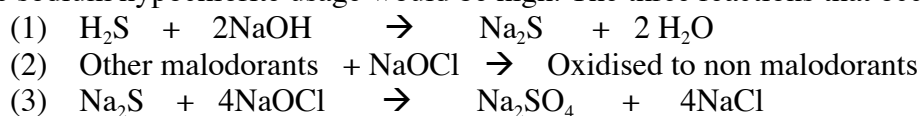
Stack Dilution Effect

Atmospheric dispersion of odour was calculated for a 14.3 metre high stack with a 760 mm diameter discharge nozzle. Under worst case atmospheric conditions a dilution factor of 250 times was indicated for a 3 minute average period [8,9]. Given the required hydrogen sulphide level at the plant boundary of 0.0081 ppm, then with a 250 to 1 stack dilution, the maximum level of the hydrogen sulphide in the stack emission should be just over 2 ppm. There was a continuing liaison with the Department of Health in their capacity as advisors to the licensing authority Manukau City Council. It was agreed the stack emission should be limited to 3 ppm (5 mg/cu.m.) hydrogen sulphide.

Wet Scrubber Process Design

The wet scrubber is required to reduce the hydrogen sulphide from 100 ppm maximum to 3 ppm or by 97 percent. It is also required to reduce methyl mercaptan from 2 ppm maximum to 0.4 ppm.

Initially a traditional vertical wet scrubber with a single packed bed was considered with sodium hydroxide and sodium hypochlorite additions being made to the one recirculating stream. However when chemical consumption was analysed it was found that the sodium hypochlorite usage would be high. The three reactions that occur are:



Based on a hydrogen sulphide emission rate of 22kg per day derived from plant studies, it was estimated that the cost of chemicals could be \$10,000 per year for sodium hydroxide and \$100,000 per year for sodium hypochlorite. This level of chemical consumption was unacceptable.

The solution was to stop the third reaction occurring by isolating the spent liquor of the sodium hydroxide reaction from the incoming sodium hypochlorite solution. In this way the sodium sulphide formed is prevented from being oxidized by the sodium hypochlorite. This was done by designing a horizontal crossflow scrubber with two separate packed beds [1]. In the first bed the circulating is dosed with sodium hydroxide to achieve 97% removal or better of hydrogen sulphide. The sodium sulphide formed is retained in solution and discharged in the continuous overflow that is kept separate from the second bed. In the second bed the circulating liquor is dosed with sodium hypochlorite to remove residual hydrogen sulphide and other malodorants. Any sodium sulphide formed in this bed is chemically oxidized by sodium hypochlorite to sodium sulphate. It is anticipated that chemical savings by not allowing the sodium sulphide to be oxidized by sodium hypochlorite would be of the order of \$80,000 to \$90,000 per year.

The one problem with this solution was that the sodium sulphide contained in the continuous bleed from the bed recirculation system could not be fed straight to the effluent sewer due to its ability to react to give off corrosive hydrogen sulphide in underground sewers. Based on 22kg per day of hydrogen sulphide being treated, then sodium sulphide would be formed at the rate of 50kg per day. However the sodium disposal problem was easily handled by passing the sodium sulphide containing solution direct to the on-site catalytic oxidation sulphide treatment plant that handles the plant's liquid effluent treatment requirements. The process involves batch aeration using manganese sulphate as catalyst. The plant oxidizes sulphides at running costs of about \$0.40 per kilogram of sulphide, so would cost only \$1600 per year representing a very economic way of treating the sulphide.

It must be noted that it was considered that a scrubber with a single packed bed with just sodium hydroxide additions might give the desired scrubbing efficiency. However, this was considered too marginal for providing equipment performance warranties. Also the Department of Health considers the "best practical means" to be a scrubber using chemical additions of both sodium hydroxide and sodium hypochlorite so did not fully endorse a single bed sodium hydroxide scrubber. The plant operators also required a system that was not marginal. Therefore a single bed sodium hydroxide scrubber was not considered further.

Crossflow Scrubber Installation Design

The air collection hood and ducting are all fabricated in fiberglass to give corrosion resistance against hydrogen sulphide. Each hood is fitted with an automated damper that opens when the odour generation cycle of the processing was reached. The scrubber, ventilating fan and stack are also built in fibreglass for the same reason. The ventilating fan was fitted with a variable AC drive so that the ventilating rate could be totally carried to suit the level of production.

The two packed beds in the scrubber were filled with Type 2R Tellerette tower packing made of polypropylene. The total residence time of the two beds is 0.85 seconds. All chemical additions are by automatic control using pH and ORP probes to control the sodium hydroxide and sodium hypochlorite additions respectively. The crossflow scrubber also offered a number of other advantages when compared to a vertical packed tower to offset the slightly higher cost:

1. More compact plant layout with less ducting
2. Lower pressure drop through scrubber
3. All equipment at more accessible level for plant maintenance
4. More flexible scrubber operation – at times of low odour emission only 1 of the 2 beds need be irrigated and still meet odour control requirements.

Operating Results

At the time of writing this paper the plant had just been commissioned and had not reached the stage where full production had been reached. Tests done to this stage had shown the scrubber was removing at least 97% of the hydrogen sulphide plus the mercaptans. The results of one series of measurements are given in Table 3. The odour concentration were measured using Draeger tubes. This method, while not always giving totally accurate measurements because of chemical interference, is an excellent technique because of its ability to give instantaneous results.

TABLE 3

Malodorant	Concentration at Scrubber Inlet	Concentration at Scrubber Exhaust	Removal Efficiency
Hydrogen Sulphide	25ppm	0.5ppm	98%
Mercaptans and other sulphides	70ppm	Trace	98% plus

In order to minimize chemical consumption plant personnel decided to stop sodium hypochlorite additions and irrigate the second bed with water only until it was found necessary to add the sodium hypochlorite. The results given in Table 3 were with the scrubber operating in this manner.

Continuous hydrogen sulphide monitoring equipment is currently being installed in the stack and will be connected to the plant's alarm system. The high level of mercaptans measured in the scrubber inlet could not be readily explained. Draeger tube measurements of mercaptans are subject to interference especially from sulphides so the accuracy of the figure is questionable. The important point is that the scrubber is removing the gases from the air stream.

Conclusion

A horizontal crossflow scrubber with two separate beds irrigated with sodium hydroxide and sodium hypochlorite dosed solutions respectively was installed to control odours generated from a pelt and hide processing plant build in a metropolitan location. The two bed design and the flexibility of operation it gives has allowed chemical consumption to be minimized. The scrubber is successfully removing over 97 percent of hydrogen sulphide and other malodorants from the plant foul air stream. Treatment of the sodium sulphide formed in the scrubber by a separate catalytic oxidation process is far more economical than chemical oxidation in the scrubber using sodium hypochlorite.

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