

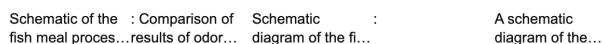
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Odor removal from a Fish meal plant by oxidative

Odor removal from a fish meal plant by oxidative scrubber (a pilot study)

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Abstract

In this research, unpleasant odor component from a case study of fish meal (Guil powder, Guilan, Iran) has been removed by utilizing a wet scrubber and two oxidative scrubbers. A GC/MS method was used to monitor the TMA (source of unpleasant odor in fish meal industry), H₂S and DMS on external air of production process. The utilizing of Hypochlorite as oxidative and a 2.7 meter packed section lead to increase the performance of odor removing as best as possible. The result showed that the treatment system which include 3 stage (water spray, first scrubber and second scrubber) have the individual removing efficiency of TMA as 60%, 26%, 12%, respectively. The samplings of external liquid of stages showed a decreasing trend of COD (200, 168, and 96 mg/l) and BOD (89.6, 66.4, and 35 mg/l); which confirm the performance of deodorization. However, in this study, the total removing efficiency of TMA and trace sulfur compound were 97% and 100% respectively.

Key words: fishmeal, oxidative scrubber, TMA(tri-methyl-amine), deodorization, removal efficiency

1. Introduction

Fish meal is a generic term produced from a nutrient-rich feed ingredient commonly used for poultry and other domestic animals diet. It can be made from almost any type of seafood but is generally manufactured from wild-caught, small marine fish that contain a high percentage of bones and oil [1]. Generally, fish meal process, begins with the fish cooking at 60°C in a continuous cooker. This process coagulates the protein and ruptures the cell walls to release the water and oil. Further, the liquid effluent is filtered off in a filter press. The obtained solids are introduced to a rotating drier and finally are cut and crumbled to obtain the commercial fish meal product. The liquid stream contains oils and suspended solids (fats and

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proteins). This stream is passed through two centrifugation steps in order to recover a high fraction of the suspended solids; which are fed back into the drier [2, 3].

During processing of fish meal, unpleasant odorous gasses are emitted in large scale plants. Due to more strict standards and increase in the number of complaints by neighbors and residential proximities as well, the importance of managing odorous emissions at these facilities has become more significant in recent years [4, 5].

Although there is limited evidence that serious risks to physical health occur through odorous emissions from fish meal plants; some research report that odor source substances can cause health effects such as eye, nose and throat irritation, headache and drowsiness; and possibly aggravate allergies, asthma and bronchitis [6].

The main reason of odorous emissions during the fish meal process are heating, drying and cooking of fish tissues which in both steps odorous gasses are emitted [5]. Typical odorous compounds encountered in fish meal plants include alcohols, carbonyls, sulfur compounds, amines and ammonia. Major odorous gases from fish meal plants consist primarily of hydrogen sulfide (H₂S), tri-methylamine (TMA) and dimethyl sulfide (DMS) [7, 8 and 9].

Modification of the process, dilution in atmosphere, dissolution of odor in a liquid (wet scrubbing in a mist or packed tower), oxidation of odor with air and modification of odor perception are five odors control methodologies were identified by the United States for National Resource Council [10]. In addition, there are several other classifications for odorous treatment systems. For example, Burgess [11] classified treatment of these gasses into three categories. Biochemical systems (bio-filters, bio-scrubbers), chemical systems (chemical scrubbers, thermal oxidation, catalytic oxidation, ozonation) and physical systems (condensation, adsorption by activated carbon, absorption by clean water scrubber). Among these various methods, scrubbing is the most effective solution in order to remove odorous gases at wide flow rate ranges (1000-100000 $\frac{m^3}{hr}$). Especially, because of high contact times, high removal efficiency, economic aspects and simplicity, chemical scrubbing in packed bed tower is established as a main choice for controlling odors in odor abatement [12].

Several chemical substances are used in this method as chemical oxidizer agent. Couvert [17] used a sodium hypochlorite solution to scrub a gas containing CH₃SH, H₂S, and NH₃. They reported the removal efficiencies of these gasses 96, 99.5, and 99%, respectively; Soroush [18] reported the removal efficiency of TMA, H₂S, and DMS by using a wet scrubber system.

Domeno [18,19] sampled the vented gas from a stack of a factory producing maize derivatives which was treated by a two-stages scrubber. The system composed of the first scrubber using only water-scrubbing and the second one using aqueous NaOCl and NaOH solution as a scrubbing liquor [14, 15].

Since, there are positively little studies related to the packed bed efficiency in fishmeal plants; in this study, the suitability of a wet scrubber and multi stage oxidative packed bed scrubber for the removal odorous gases from a fishmeal plant was evaluated. During the experiment, chemical characterization of the odorous air before and after the deodorization process according to GC/Mass was done. According to the analyzing of data, the performance of scrubber over each pollutant were presented and discussed.



2. Materials and methods

1-2- Production Process

The case study of this fish meal plant produce 24 ton/day of Kilka fish and located near the human inhabitants. The raw materials were dehydrated in continuous steam cookers at 180°C under 3 atm during 20 min while utilizing water stream. The dehydrated material was pressed to remove fish oil from fish meal. The process air is captured on this equipment was mixed to the ambient air of the facility and then oriented to the pilot plant deodorization devices. Fig 1 illustrated the summary diagram of plant operations and primary setup (highlight zone) for absorption of unpleasant emitted vapors.

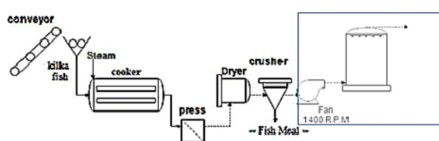


Figure 1: Schematic of the fish meal process and primary deodorization system

2-2- Treatment Improvement

For improving the odor removing, a wet scrubber and two oxidative scrubbers were utilized, subsequently. Fig 2 shows the configuration of new air treatment setup beside previous operation (high light zone).

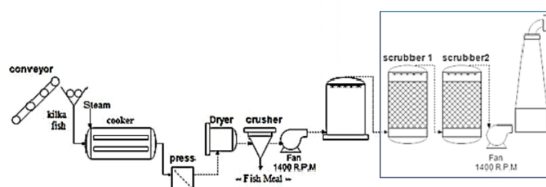


Figure 2: Schematic diagram of the fish meal process and new air treatment setup

The deodorization system, treat about 8000 $\frac{m^3}{hr}$ of a mixture of steam and non-condensable gases emanating from cooker, then process gasses are picked-up on one dryer. The Pilot scale of multi stage scrubbing system was a sequential treatment system, which collected and treated emissions from the partial enclosed cooker as they exited from the fish meal plant.



Clear water scrubber, firstly treated emissions, after that they were passed into the two packed bed scrubbers with hypochlorite (5-10 ppm) as the chemical oxidant, so in this step mainly absorption and chemical reaction occurred.

The whole scrubbing system is made of polyethylene and PET packing in these two scrubbers. The odorous gases are then carried into the gas scrubber where absorption and chemical reaction occur. The packed bed scrubbers is constructed of a 6 meter height and 1 meter diameter column and contained a 2.7 meter packed bed section of randomly packed with PET Packing. In addition, the top of the column holds a demister head packed for removing entrained droplets from the gas stream. The entire column sits on top of a vessel,

which served as the scrubbing solution reservoir. A circulating pump withdraw scrubbing solution from the reservoir and pumps it up to the top to be sprayed down on the packed bed, counter current to the gas flow.

2-2-Method of Gas sampling

To investigate the efficiency of odor source removing gas, concentrations on sampling points (presented in Fig.3) in the deodorization plant was monitored. The gas samples were collected in Gas sample bags and were analyzed immediately to avoid sample deterioration. Fig.3 illustrates 4 points on the gas stream, which have analyzed.

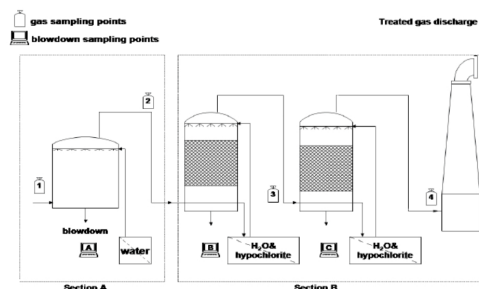


Figure 3: A schematic diagram of the sampling points and deodorization equipment at pilot plant scale

Gas samples (300ml) were taken from the inlet and outlet of the deodorization unit and from the room air at the plants. The gas samples were immediately placed on ice and analyzed within 24hr. The sampling system consisted of a Vacuum-Chamber and a pump (handmade) to draw vacuum on the chamber. Lines were purged for 1–2 min before sampling and were taken on the positive pressure side of fans.



The analysis of industrial emissions by gas chromatography coupled to mass spectrometry was used to quantify the compounds concentrations and to augment the efficiency of the air pollution control devices. The specifications of GC/Mass apparatus are described in Table 1.

Table 1: The specifications of GC/Mass apparatus

GC/Mass apparatus manufacture	Varian	Chrompack
Model	CP-3800-GC	CP-9001-GC
Detector	NPD*	SCD**
Method	ASTM E-346	ASTM D-5504

* NPD: Nitrogen phosphorous Detector.

** SCD: sulfur chemiluminescence Detector.

3-2- GC/Mass analysis of samples

A 1 μ L Acetonitrile solution (100 ppm concentration) has utilized for calibration of amine compounds analysis. Beside, 50 μ L H₂S (15 ppm concentration) proceed for calibration of sulfur compound analysis. After obtaining internal standard samples, the analyzer would run. Then, basic samples would inject to analyzer in 10 μ L content. Further, samples have run by GC and trend of curve detection could be evaluated. As a result of GC/Mass run outlet; Fig.4 and Fig.5 inform the pick detection of TMA and sulfur compound for 1 point (Fig.3), respectively.

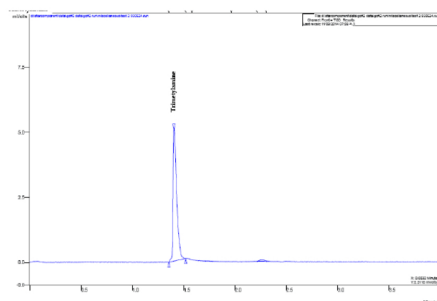


Figure 4: The sample of GC/Mass runs for TMA in gas phase



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