NATIONAL FOOD AUTHORITY
Quezon City

DESIGN AND DEVELOPMENT OF DUST CONTROL SYSTEM FOR NFA BATCH RECIRCULATING DRYERS

by

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NATIONAL FOOD AUTHORITY MONITORING SYSTEM
REPORT FOR COMPLETED RESEARCHES

PART I. BASIC INFORMATION

1. Research Title	**DESIGN AND DEVELOPMENT OF DUST CONTROL SYSTEM FOR NFA BATCH RECIRCULATING DRYERS**
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3. Agency Involved	National Food Authority Technology Resource Development Department Technical Research Division
4. Research Sites	NFA, Nueva Ecija Branch Office
5. Funding Agency/Amount	National Food Authority/ ₱
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6.1. Date Started	August 2001
6.2. Date Ended	November 2001
7. Development Zone	Facility Development
8. Technology Level	Grain Post Harvest Technology

PART II. TECHNICAL REPORT

TITLE

DESIGN AND DEVELOPMENT OF DUST CONTROL SYSTEM FOR NFA BATCH RECIRCULATING DRYERS [1/]

by

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ABSTRACT

Design and development of the prototype Dust Control System (DCS) was undertaken from August to November 2001. Fabrication was done in NFA, Nueva Ecija branch office with the direct assistance of personnel in the Technical Services Section. The unit was installed and integrated in one batch recirculating dryer located at warehouse # 4 of Cabanatuan Grain Center. The DCS that was developed is targeted to complement NFA's batch recirculating dryers. The study aimed to design and develop a DCS appropriate to NFA batch recirculating dryer installations. It was designed to be simple, easy and requires less labor to operate. The system was tested mainly to determine its dust control performance and advantages in drying operation. These include the evaluation of the appropriate locally available sprayer nozzle that can produce enough water droplets that can able to scavenge impurities and fugitive (respirable) dust particles out from drying air. It was observed during the testing that the DCS developed was effective to draw large impurities and dust particle out from the drying air. The impurities were filtered by the mist introduced in the system. Although some technical problems occurred during the testing, it was noted that the dust control system developed was effective in collecting impurities and controlling fugitive dust during drying.

After the evaluation, it is recommended that further testing and evaluation of the developed DCS shall be undertaken to intensively evaluate and assess the needed modification and improvement of the prototype before effecting the final reproduction.

1/ A research project conducted by the Technology Resource Development Department of the National Food Authority from August to December 2001.

2/ Food Technologist II, Research Analyst II, Assistant Division Chief, and Division Chief respectively Technical Research Division, Technology Resource Development Department, National Food Authority

B. PROJECT DETAILS

I. TITLE : **DESIGN AND DEVELOPMENT OF DUST CONTROL SYSTEM FOR NFA BATCH RECIRCULATING DRYERS**

II. PROPONENT : Technical Research Division
Technology Resource Development Department
National Food Authority

III. RATIONALE

Dust pollution is common to our ricemills, dryers and bulk handling facilities. This poses health hazard not only to our own personnel but also to nearby residential communities. If not properly addressed, this will surely create serious problems that will eventually peril our different grain's postharvest operation. In some cases the problem of dust emissions emanating from our grains processing facilities caused serious environmental and legal problems. Some field offices were already legally sanctioned by proper government authorities.

Originally, most of NFA warehouses were designed purposely for grain storage. With the continuous acquisition of various post harvest facilities particularly mechanical grain dryers NFA warehouses now are used as grain storage and processing centers. During the past years dust control programs were not given enough attention. Due to the intensified milling and drying operations, these have became increasingly necessary. Some of NFA facilities were installed with accompanying dust control system/ dust collection accessories but in most cases ineffective, or much worse non-functional, due to poor maintenance.

With the given scenario and concern there is a need to urgently solve the problem common to all NFA batch recirculating dryers. The study aims to design and fabricate a prototype dust control system that will eventualy arrest and eliminate the problem of dust pollution.

IV. OBJECTIVES

1. To develop a Dust Control System (DCS) that will eventually reduce or eliminate dust pollution in the operation of Batch Recirculating Dryers (BRD).

2. To fabricate a prototype DCS for NFA's batch recirculating dryers.

3. To test and evaluate the technical appropriateness of the prototype in relation to NFA drying operation.

V. MATERIALS AND METHODS

A. **Materials**

Plain GI Sheet (gauge #26)	Flat Bar (1/8" x 1" x 20 ft.)
Brass Extension tube	Hose Clamp
Agricultural Sprayer Nozzle	Water Hose 8 mm diameter
Hose fitting	Power Sprayer

Other Material used

Plastic Drum	Blind rivets (1/8 and 3/16)
Hand Riveter	Drill Bit
Tread Seal Tape	Welding Rod
Capscrew and Washer (1/4 x 1")	Tie wire
Acetylene	Sealant

B. **Methods and Procedures**

1. Design and Development

Based on the requirement of existing NFA owned batch recirculating dryers, a prototype of the system has been developed. It was made of locally available materials, and it was fabricated without requiring high-tech facilities.

The system composed the following main components:

a. *Vertical Dust Stack* - This is a cylindrical metal tube made to confine air and dust mixture from the dryer. The stack was made of five (5) cylinders with 2.50 ft. diameter and 4 ft. in height. The cylinders were bolted together forming a 20 feet long single vertical stack. Each cylinder was provided with 10 inches square window to serve as an access in cleaning and adjusting the sprayer nozzle during and/or after operation. The five cylinders were made of plain GI sheet (gauge #26). To add stiffness in forming the cylinders, a flat bar was welded and riveted in the opposite end of it. Sealant was applied to all joints and overlaps of the stack to avoid leakage during operation.

b. *Mist Sprayer* - Four agricultural sprayer nozzles of different sizes were used to produce a water mist inside the dust stack. They were strategically positioned inside the cylinder. They were located at 4 ft. interval beginning from the lowest cylinder. The two lower nozzles were designed to produce a very fine mist spray while the other two upper nozzles were designed to deliver larger spray particles. All nozzles were directed downward to produce densely packed fog droplets inside the stack. Linking the four nozzles and the power sprayer is an 8 mm water hose. Each set of nozzle was connected to a discharge outlet of the power sprayer.

c. *High Pressurize Water Sprayer* - One unit of electrically operated power sprayer was used to supply and deliver pressure in the system. The unit can produce a maximum pressure of 40 kg/cm^2 and a maximum discharge of 25 L/min.

d. *Water Lines* - An 8 mm diameter water hose was used to linked the nozzles and the power sprayer.

e. *Hood* - Two (2) hoods are located in the lowest cylinder to linked the fan exhaust and aspirator of the dryer with the vertical dust stack. The hoods were designed to project downward flow of air and impurities exiting from the dryer. This allowed a lesser upward velocity impact of air exiting from the dryer exhaust.

f. *Baffles and Overhead Cap* - Three (3) baffles were placed inside the dust stack to provide greater surface impact of dust and air coming out from the dryer exhaust. A conical overhead cap was positioned on the topmost portion to limit the spread of air exiting from the dust stack.

2. System Integration

The dust control unit was made integral to the whole drying system of the existing batch recirculating dryer. The DC unit was connected to the dryer exhaust. It was installed outside the warehouse.

3. Fabrication and Installation

a. Fabrication and installation was done in NFA, Nueva Ecija Branch Office. It was done through the assistance of TSD field personnel. Fabrication was undertaken without requiring hi-tech equipment. Connection and joints were made by the use of simple acetylene and electronic welding, capscrew and blind rivets. The fabricated unit was integrated to one batch recirculating dryer in the area.

4. Test and Evaluation

Testing was conducted using dried palay. During the evaluation, three levels of test were made, namely; mist capacity test, dust control performance and operational evaluation of the prototype.

a. Mist Capacity Test

The system was tested to determine the appropriate mist capacity that is effective in knocking down fugitive (respirable) dust during drying. Technically, it is difficult to impact micron-size dust particles that is why the existing designs (using inertial separation) are ineffective in controlling dust pollution. By the introduction of water droplets where size is comparable to the size of dust particle, there is a greater chance to control dust pollution. When fine droplets are sprayed inside the dust stack, adherence and contact occurred between water droplets and dust particles until the droplets grows to critical size and it will gravitate. It is important to produce densely pack fog droplets inside the dust stack so that the dust particles have a little or no chance of escaping. It was observed during the test that, fine mist were more effective in knocking down dust particles only, some were blown or carried out from the stack due to the high airf velocity of exhaust fan of the dryer. It was further noted that the four nozzles (1 set mist spray nozzle and 1 set fine spray nozzle) used during the testing were enough to draw out large impurities and dust particle from the drying air.

b. Dust Control Performance

During the test and evaluation, drying was done without the use of the DCS prototype. It was noted that dust particles and large impurities were freely suspended, scattered in the drying place. It can be described that distance traveled by the impurities and respirable dust particles were greater without using the prototype It is sad to note that considerable amounts of dust were carried through the nearby communities. By the integration of the prototype in the drying operation, it was observed that dust pollution was minimized. The DCS has a high potential to eliminate dust pollution especially those fugitive (respirable) dust that the existing designs (inertial separation) could not able to collect. Mist spray was observed effective in knocking large and small dust particles out of the drying air. It was further observed that the suspension time of the dust particles and its spread in the nearby surroundings was limited. (*Please see attached documents).*

C. Operational Evaluation

The system needs one labor to operate the prototype. The labor can be the dryer operator himself. Operating the DCS is simple. During drying, just turn on the water and electric supply to start the system. Droplet size can be adjusted through regulating the pressure produced by the power sprayer. Droplet size decreases as the pressure increases. Water discharge can also be controlled by regulating the pressure supplied by the power sprayer (maximum discharge 25 L/min). In one aspect however, the material (GI sheets and flat bar) used to fabricate the dust control unit was observed to be inappropriate (thin). It might not last long at continuous drying operation. During operation, small and large impurities were deposited at the base of the dust stack. Since the system was observed to have minimal water consumption, the slurry produced (mixture of fine dust particle and water) were allowed to flow in the drainage canal.

VI. RESULTS

The following pictures will demonstrate the performance of the prototype Dust Control System:

Figure 1

Figure 2

Figure 3

Pictures showing the pollution produced during drying operation. Figure 1 shows the dust particles were blown or carried out from the dryer by the exhaust fan. Figure 2 & 3 shows the escape of fugitive (respirable) dust particles from the dust stack. Dust particles were freely suspended and scattered in the environment. In the picture, the DCS was already connected with the dryer exhaust but water sprays were not yet introduced.

Figure 4 Figure 5 Figure 6

Pictures showing the dust control performance of the prototype. In this stage water sprays were already introduced in the system. The dust pollution *(pls. See previous picture)* produced during drying was eliminated with the integration of the prototype DCS.

VII. CONCLUSION AND RECOMMENDATIONS

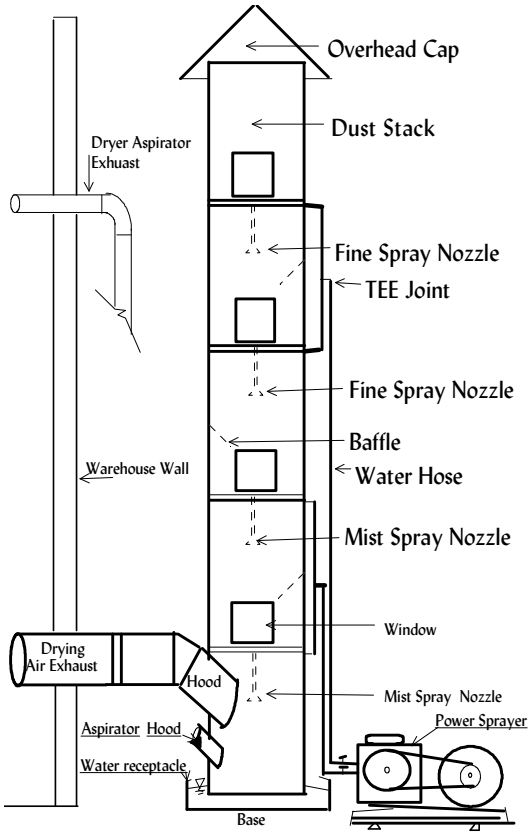
The ineffective and much worse absence of dust control system of NFA drying facilities posed problems on dust pollution. The intensified drying operation of the agency worsen the situation. Directly affected by this issue is our grain processing operation, the nearby community and the personnel in our grain processing centers. It is known that dust particle (silica) from palay can contribute to health related problems. Even the agency's good warehouse keeping program, clean and green program, etc. were threatened by ineffective dust control system. To give a solution to these problems, the study was developed. The study aimed to design and develop a DCS appropriate to NFA batch recirculating dryer installations. It was designed to be simple, easy and requires less labor in its operation. This was tested and evaluated to determine its dust control performance and advantages in drying operation. After the test and evaluation, it was proven that the DCS developed is effective in controlling dust pollution in the operation of batch recirculating dryer. It is therefore, concluded that the objectives of the project were achieved.

However, based on the foregoing result of testing and evaluation, the following are recommended;

1. The vertical dust stack should be made of more rigid and durable materials.
2. To include in the design the best method in disposing the slurry (mixture of waster, impurities and dust) during drying operation.
3. To conduct further test and evaluation of the prototype to come up with established data on the required mist capacity, water consumption and dust control efficiency of the system.
4. A series of actual/field testing be undertaken to evaluate the actual performance of the prototype.
5. To consider in the design how to diffused the upward velocity impact of the drying air to avoid the escape of mist in the stack without affecting the drying performance of the dryer.

DCS SET-UP

Picture showing the actual set-up of the Prototype
In warehouse #4 of Cabanatuan Grain Center



Drawing showing parts and
accessories of the Prototype

PICTORIALS

Pictures showing the researcher during the conduct of the study.