IN-DEPTH SURVEY REPORT
CONTROL OF DUST IN A TEXTILE DYEING TRANSFER OPERATION

at

Logisco Corp
Charlotte, NC

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INTRODUCTION

The National Institute for Occupational Safety and Health conducted an evaluation of control techniques for reducing occupational exposure to dye dust in a textile dye transfer operation The purpose of this evaluation was to determine the efficiency of various techniques for controlling exposure of weigh-out and transfer operators where dry powder dyes were removed from large drums and weighed into smaller containers Because the toxicity of these powder dyes is not well defined, it is prudent to control employees' exposure as far as practical The goal of this study was to determine the efficiency of two available techniques to control this exposure

Dry powdered dyes of many chemical types are used extensively in the coloring of textiles These dyes are typically provided in bulk containers holding up to several hundred pounds and are removed as needed in measured amounts to be used alone or combined with measured quantities of other dyes to produce a desired color This process where the powders are scooped from open containers and dumped into smaller containers is the time of greatest potential exposure to employees

To reduce workers' exposure during transfer operations, NIOSH, in collaboration with the Ecological and Toxicological Association of Dyes and Organic Pigments Manufacturers (ETAD), investigated two control solutions 1) the addition of a "de-dusting agent," typically a light oil, to the dye to reduce the dye's tendency to become and stay airborne, and 2) the size of the containers used to ship and store the dyes

Previously, a commercially available down draft hood designed specifically for use in the weigh-out and transfer operation and installed in a dye house in Brooklyn, NY, had been evaluated in a prior NIOSH study that indicated it was effective in the reduction of dye dust in the work environment Evaluations of the effectiveness of the de-dusting agent and the container size were also conducted during that prior study but were inconclusive principally due to the effects of the hood

The addition of a de-dusting agent to reduce dye dustiness is a common procedure for materials manufactured and shipped in the US, and is thought by some in the industry to significantly reduce airborne (i e , inhalable) dye dust concentrations Varying amounts of oil are mixed with the dye by the manufacturer, with a concentration of about 1% w/w as a nominal maximum

Many of the dyes of interest are shipped and used from standard 55 gallon plastic drums, and previous studies had shown that the occupational exposure of employees during the transfer would increase as that employee was required to reach lower into the barrel as the dye was used[1] Therefore, the concept of using short or "half" barrels, similar in diameter but smaller in height than a standard barrel, was developed with the hope of eliminating the need for the weigh-out operator to reach so far into the barrel that his head (i e , breathing zone) was placed into this area of high dust concentration

A study was designed to test these two variables (dustiness and drum size) and their interactions in either the presumed "controlled" or "uncontrolled" mode Tests were conducted in a work area containing no local exhaust ventilation (i e , down draft hood), using dye to which a maximum amount of de-dusting oil had been added and to which no oil was added, and scooping the samples from both the short and the standard sized drums

METHODS

Since the primary emphasis of this work is to control inhalation exposure to dye dust, the essential measurements were those of dye dust concentration in employees' breathing zone during the transfer operation under the control conditions of interest To collect these concentration data, a simulated powder transfer operation was established in which an experienced employee opened and scooped dye with specified dustiness level from full or half barrels, as specified, into brown paper bags The bags were folded and set aside until the drum was empty The air monitoring was then discontinued and the dye was returned from the bags into the drum to be used in subsequent replicates of the test conditions That drum was then replaced by one of the selected size containing dye of the dustiness level required for the next run, and the process was repeated Each test consisted of approximately 20 minutes of air

monitoring and 30 minutes for clean up and preparation for the following test During these tests the worker was wearing personal protective equipment as described below

This simulated operation compressed a normal day's transfer of powder into each test run This was possible since, under normal plant operations, the transfer of powder is an occasional task performed as required during the working day, and for the tests conducted in this evaluation a worker was dedicated full time to this task only During each test the worker transferred 110 lb (50 kg) of dye into approximately 43 bags This is comparable with the volume of work measured in a study conducted by the U S Environmental Protection Agency[2] which determined that, in a series of dying operations, a worker weighed out a mean of 125 lb (56 7 kg) (range 4 6 to 626 kg [2 1 to 284 lb]) of dye in a day while doing a mean of 60 transfers

To estimate breathing zone exposure to dye, environmental samples were collected by drawing air through a midget impinger containing 15 ml of distilled water and clipped on the worker's lapel Due to the high molar absorbtivity of these materials, a statistical limit of detection of approximately 2 μg per sample and a limit of quantitation of approximately 6 μg per sample was achievable using a Hewlett Packard Model 8452A Diode Array Spectrophotometer and a 1 cm quartz cell at wavelengths optimized for each dye as described below

Preparation of Standards:

A portion of each dye was dried in an oven at about 80C for about two hours, and for each, an aliquot of about 1 g was accurately weighed out to make a stock solution of 1000 mL with distilled water 10 mL was diluted to 1000 mL to yield a secondary standard with a concentration of 10 µg per mL Working standards were prepared from this and the stock solution

Preparation of Samples:

The solutions were carefully transferred from the field scintillation vials to graduated cylinders with pipettes to avoid loss in spillage which could result from direct transfer from vials to graduates

Analysis of Samples·

A Hewlett-Packard Model 8453A Diode Array Spectrophotometer and a 1-cm quartz cell were used for the absorbance measurements that were taken at a wavelength of 518 nm for the red dye samples Calibration graphs were prepared with concentrations expressed in terms of micrograms of dye per sample The amounts of dye per sample were found by multiplying the micrograms per milliliter by the milliliters of liquid in the impinger

An experimental protocol was developed that was designed to look at both variables (dustiness and drum size) in both the controlled and uncontrolled mode Dystar Remazon Red RB was selected for this work based on its behavior in prior studies It was anticipated that multiple test runs at a rate of approximately 1 test per hour could be conducted during the visit to

Logisco in July 2001 This would produce duplicate measurements for the sampling conditions

Real time monitoring for total airborne particulate was conducted using a Grimm Model 1106 Dust Monitor (Pioneer Emissions Detection and Control, Inc , Wilmington, DE 19803) The primary purpose of this monitor was to assure that there was no residual dust remaining from one test run that would affect subsequent runs This monitor was not a personal breathing zone sampler, but rather was placed in the general area where the transfer operation was taking place It measured total airborne particulate in selected size ranges, so it provided minimal information regarding the worker's inhalation exposure to dye dust

Logisco was selected for this study by ETAD, after consultation with NIOSH, based primarily on availability and willingness to provide necessary facilities Located near Charlotte, NC, this facility is a warehouse with bulk transfer capabilities in a room dedicated exclusively to the testing during the time of this work This room, which measured approximately 48 ft by 39 ft by 19 ft high, contained a local exhaust system which was activated between tests to remove residual particulate from the air prior to subsequent runs The only persons working continuously in this room during the testing were the employee conducting the transfer operation and the NIOSH researchers   The Logisco employee wore white coveralls, gloves and shoe coverings with a full face air purifying respirator during the transfer operation

RESULTS

The airborne concentration of dye, expressed in mg of dye per cubic meter of air, measured during transfer operations in the July 2001, tests are shown in Table 1   Also listed in this table is the status of both of the control techniques being evaluated, either "full" or "short" to indicate the size of the barrel from which the dye was being scooped and "no" or "yes" to indicate if the dye used in that test had been de-dusted by the addition of an oil to reduce dustiness

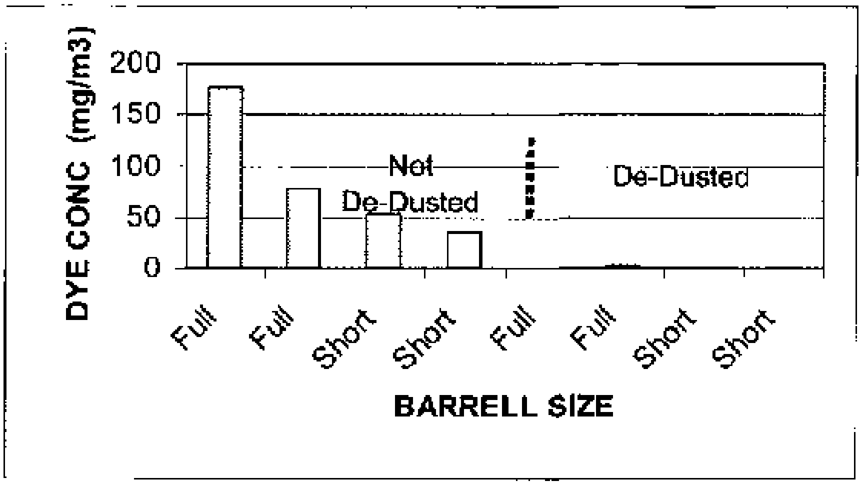
Table 1: Airborne dye dust concentrations

SAMPLE NUMBER	DRUM SIZE	DYE DEDUSTED	DYE CONCENTRATION
L - 2	Full	No	176 0 mg/M^3
L - 4	Full	Yes	0 6
L - 5	Full	Yes	3 1
L - 6	Short	Yes	0 7
L - 7	Short	Yes	1 4
L - 8	Full	No	77 7
L - 9	Short	No	52 7
L - 10	Short	No	36 0

Two samples, numbered L-1 and L-3, were collected using a small barrel that was not the intended "short" drum ETAD had proposed for testing, so these runs were not used in the data analysis below   The dye concentrations measured in these two samples were 196 and 1 0 mg/M^3 for the dusty and de-dusted dyes, respectively, and while no inference is drawn regarding the effect of drum size, these data do confirm the effects of the dust reducing agent seen elsewhere

A plot of the concentrations for the test runs grouped by main control variables is shown below in Figure 1   From this plot a visual comparison can be made of the effect of drum size (large vs small drum), and the effect of the addition of a de-dusting agent (no vs yes)

Figure 1: Airborne dye concentration grouped by control variable



CONCLUSIONS AND OBSERVATIONS

The tests conducted during this investigation confirm previous studies that indicated the addition of a de-dusting agent reduced the amount of airborne dye dust during the transfer operation A reduction of approximately 98% was seen The effect of drum size is not as clear-cut or as dramatic The short drums appear to have reduced the dust level when the dusty dye was used (53 & 36 mg/M^3 vs 78 & 176), but not necessarily when the de-dusted dye was being tested (0 7 & 1 4 mg/M^3 vs 0 6 & 3 1) Subjectively, the worker doing the transfer did comment that the small barrel was easier to work from, due principally to easier access to product These conclusions are consistent with results found by Gressel and collegues [3, 4]

One other observation which potentially affected the measured exposures was a correction made prior to the third test in which the worker was instructed to hold the bag into which the dye was transferred closer to the drum from which the dye was scooped The purpose of this suggestion was to make the transfer easier as well as less dusty, and a correction of this nature is considered to be consistent with typical dye transfer operations This change in procedure had the effect of moving a portion of the transfer task away from the breathing zone sampler, and it appears from a comparison of samples L-2 and and its duplicate L-8 (Table 1) that this reduced the dust concentration by half Since samples L-1 and L-3 were discarded for reasons discussed above, sample L-2 would be the only one potentially affected by this modification of procedure and the only sample for which a duplicate was collected under those test conditions

REFERENCES

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[2] *Textile Dye Weighing Monitoring Study*, United States Environmental Protection Agency, Office of Toxic Substances, Washington DC, April 1990, Pub No EPA 560/5-90-009

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[4] Gressel, M G , Heitbrink, W A , McGlothlin, J D , and Fischbach, T J , "Real-time, integrated, and ergonomic analysis of dust exposure during manual materials handling," Appl Ind Hyg 2(3)1987