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AIR POLLUTION CONTROL IN COTTONSEED OIL INDUSTRY

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Executive Summary

The purpose of the project of the first year was to study of principal properties of aerosols under operating conditions at Cottonseed Oil Mill in Uzbekistan. For this reason equipment for personal and stationary air sampling was purchased and the collaborating researches became familiar with them.

Mass concentration of particles and size distribution of them were studied in hulling - separation department of the Cottonseed Oil Mill in Uzbekistan in the points evenly displaced near by the technological equipment.

The average level of dust concentration measured by the stationary personal samplers was 60.44 mg/m^3. The average value of dust concentration measured by personal samplers attached to the operators was 68.61 mg/m^3. The concentration of dust reached the highest values between each of the pair of huller- separator and in front of it. The concentration of dust measured by the stationary personal samplers reached up to 122.69 mg/m^3 and measured by personal samplers attached to the operators achieved 134.16 mg/m^3. In alley between the hullers the dust concentration is descended. It was found that a major percentage of dust particles measured in hulling - separation room are particles generally considered respirable. Particles 2 μm or less in diameter make up more of half of the all measured particles, particles 8 μm or less cover more of 80% of the number measured particles.

Section I

A) **Research Objectives:** This study was undertaken to develop information on the dust levels, and the particle size distribution in the working environment of hulling-separation area during the normal processing operations in high-capacity hulling-separation processes at cottonseed oil mill in Uzbekistan.

B) **Research Accomplishments**:

Method and Procedure

1. Dust-concentration determination.

The "total dust" mass sampling carried out by personal sampler that was used as a roving sampler in workers breathing zone and at stationary locations were placed stationary personal samplers. Stationary personal samplers were used for "area or fixed sampling" (Hinds, 1999). Open face type 37-mm filter holders (SKC, Inc., Catalog No. 225-1) were mounted at breathing zone height on stands (SKC, Inc., Catalog No. 225-503). A three-piece cassette constructed of polystyrene to hold a 37-mm-diameter filter was used. Dust samples were collected on a 37-mm-diameter polyvinylcloride filters with a 5-μm-pore size (SKC, Inc., Catalog No. 225-8-01). The personal air sampler was attached to a AirChek 2000 pump with NiCad battery pack (SKC, Inc., Catalog No. 210-2002).

The IOM inhalable dust samplers (SKC, Inc., Catalog No. 225-70A) we used as roving samplers. It was a reusable filter cassette with a sampling head designed to better measure a worker's exposure to total airborne particulate. The personal dust sampling device has a cylindrical body 37 mm in diameter. One end of the cylinder contains a flat circular cover cap that has a 15 mm circular orifice with a thin lip protruding outwards. When taking a sample with the IOM Inhalable Dust Sampler, the IOM cassette/filter was weighed as a single unit before (pre-weigh) and after (post-weigh) sampling.

Therefore, all of the dust both on the filter and on the internal walls of the cassette is contained in the data, including the typically larger dust particles; nothing inside the cassette/filter assembly escapes analysis (Mark and Vincent, 1986). The IOM Sampler used with a reusable filter cassette that holds a 25 mm filter with a 5-μm-pore size. The IOM Pump Kit, includes PCXR4 sample pump, charger, single adjustable low flow holder, etc. (Cat. No.224-PCXR4PKB (230V)).

The flow rate of a personal sampler was 2.0 l/min. By that air flow rate the IOM Sampler effectively traps dust particulates up to 100 μm in size (Mark and Vincent, 1986).

Air samples in each distinct work area at the hulling-separation room were collected at locations which provide representative samples of air to which the worker is exposed. The samplers were cleaned prior to sampling. The samplers were calibrated in the laboratory before they are used in the workshop. The orifices were calibrated by use of a wet test meter. After exposure the cassette with samples were shipped to the analytical laboratory in a suitable container to prevent damage in transit. The filters were faced upward (Wesley et al. 1979, Hughs et al. 1981) to insure that the collected dust didn't lost before laboratory weighing.

An analytical balance that has a sensitivity of 0.01mg (Sartorius, model MC210S) used for weighing of the sample. The balance was located in a dust free air-conditioned room with controlled temperature 24°C plus or minus 1°C and relative humidity (RH) 45%. The filters to equilibrate them were held in this environment for a 24 h before each weighing, i.e. before and after exposure. As it recommended (Hinds, 1999) three blank (control) filters and a reference mass of approximately the same weight as the filters were weighed each time as the filters are weighed. Field blanks were collected and used to correct field sample weights. Dust concentrations were calculated by dividing the corrected weight of dust collected on each filter by the volume of sampled air.

In Table 1 is shown data that we have had time to collect only in June 2001 while the mill had reserves of cottonseed of last year. The continuation of the experiments is expected in the first days of September, while the mills will begin to work receiving the cottonseed of harvest of this year.

The total dust concentration is expected being measured by two mentioned types of personal samplers simultaneously, attached to the two sides of each operator.

2. Particle size measurements

Dust samples for particle-size analyses were collected with the same sampling equipment as for dust level measurements (ASHRAE, 1993b; ACGIH, 1983 and 1988; Bernhardt, 1994; Allen, 1990; EPA, 1984; Hinds, 1999).

Allen (1990) wrote that filtration is the simplest method of removing particles from the atmosphere for subsequent analysis. The most efficient filters for this purpose are the membrane filters that consist of cellulose esters. They were used in our experiments. These filters are soluble in acetone, so that was possible to dissolve away the filter and transfer the deposited material to prepared surfaces for further examination. The membrane filter was placed on a dry microscope slide. The slide is inverted over a watch glass half-filled with acetone, the vapors of which render the filter transparent after two or five minutes. The filter is allowed to dry for two to five minutes and is then ready for analysis.

Dust samples were collected on a 37-mm-diameter mixed cellulose esters (MCE) filters with a 0.45-μm-pore size (SKC, Inc., Catalog No. 225-9). Dust samples collected by the IOM Samplers were on a 25-mm-diameter MCE filters with a 0.8-μm-pore size (SKC, Inc., Catalog No. 225-19).

As it recommended (Wesley et al.1979) all samplers we started at the same time and allowed them to run for 30 to 60 min to get an adequate deposit of dust on the filters for particle size measurements. The filters were handled in the same manner as described for filters used for dust-level determinations.

Dust particles were sized with graduated scales, using a standard microscope. The method includes visual determination of particle sizes in which individual particles are observed and measured. The particle size was the projected area diameter in stable orientation in microscopy. The total number of measured particles for one station was about 600.

Particles sizing by standard microscope is the most accurate, but it is very time- and labour-consuming. An Imaging system for particle size distribution measurement is expected to use in the continued experiments.

Results and discussion

The given data is a result of measurements in June 2001 at Cottonseed Oil Mill in Uzbekistan. Then functioning of Mills has been interrupted for reason of run out of the cottonseed reserve. Cottonseed Oil Mills began the maintenance and repair of the technological equipment. The continuation of the measurements will be carried out after about 2 months when the Uzbekistan Cottonseed Oil Mills will get the cottonseed of the new harvest.

In Table 1 is shown the average mass concentrations of particles in the second floor of hulling - separation room. The measurements of dust concentration were carried out near the pair of hullers and shakers of the first and second hulling-separation. The points of measurements were located in the middle of the technological line, between the similar equipment. The averaged mass concentration of dust measured by the stationary personal samplers in points evenly placed near the technological equipment was 60.44 mg/m^3. The average value of dust concentration measured by personal samplers attached to the operators was 68.61 mg/m^3.

Data presented in Table 1 showed that the concentration of dust reached the highest values between each of the pair of huller- separator and in front of it. The concentration of dust measured by the stationary personal samplers reached up to 122.69 mg/m^3 and measured by personal samplers attached

to the operators achieved 134.16 mg/m^3. In alley between the hullers the dust concentration is descended.

Percentage in range and frequency for various ranges of dust particles measured during the hullers and separators operations are shown in Table 2. There are data of particle sizes in zone of men respiration in the sites where dust concentrations were measured. From the size analysis data it transpires that during the hulling - separation processes more of half of the all measured particles have sizes less then 2 μm, and sizes of more of 80% of particles are less then 8 μm. That is dust particles generally considered respirable. This fact imposes stringent requirements upon the amount of the enclosure of suction hoods over the technological equipment and to selection of dust collection equipment. Effective removing of fine dust particles from sucked air is the main requirement to the air cleaning devices.

C) SCIENTIFIC Impact of Collaboration: The collaborating scientists have been acquainted with methods and tools for dust particles concentration and size measurement. They purchased the scientific tools, got training, in order to know, how to use those tools, and began the measurements in Cottonseed Oil Mill in Uzbekistan.

D) Description of Project Impact: The results of the research are anticipated to use in design of local exhaust and dilution ventilation systems of hulling-separation departments at Cottonseed Oil Mills.

E) Strengthening of Developing Country Institutions: Researches of Tashkent Architectural Building Institute have received sets of research tools for airborne dust particles (Shipment List is enclosed). Collaborating researcher Dr. Rashidov visited Israel and got training in

Technion-Israel Institute of Technology, in Israel Institute for Occupational Safety and Hygiene, and in Laboratory of Air Pollution in Israel Ministry of Labor how to use the mentioned tools.

F) Future Work: We are planning to finish during the period from September till November 2001 measurements and data processing of concentration and size distribution of dust particles in hulling-separation department of Cottonseed Oil Mill. There is some delay relating to the Project schedule. We began to accomplish simultaneously the next part of the Project workplan regarding Granular Bed Filters built in the hood of local exhaust ventilation system.

Section II

A) Managerial Issues:

1. We chose the U.S. firm SKC® (SKC Inc. 863 Valley View Road, Eighty Four, PA 15330 USA) and bought sets of research tools for airborne dust particles (Shipment List is enclosed).

2. Our Uzbekistan collaborators didn't have any experience to buy research equipment from abroad. Along with Uzbek collaborators we needed to ascertain the way for safety using of the fund to purchase the required measurement and other research devices according to the workplan of the Project. To ensure against unforeseen troubles we got a joint decision to buy the research devices through Technion. Personal Dust Samplers and another measurement devices manufactured in U.S.A. were shipped to the Technion. The Uzbek representative (Dr. Rasidov) visited to the Technion, has been trained at those tools. Then he took the research devices to Uzbekistan to carry out the experiments due to be done there.

3. Co-PI Prof. B. Askarov collected a research staff for caring out of the Project measurements. Dr. Rashidov Usuf, Head of Heating, Ventilation and Air-Conditioning Department (Cathedra) was involved as a researcher in the Project. I'm familiar with Dr. Rashidov, he is a responsible

and knowledgeable scientist. I was the supervisor of his M. Sc. Project. Doctoral Student Shernazarov Elbek and 2 laboratory assistants were also included in the research group.

4. Along with the Uzbekistan collaborators we chose the Cottonseed Oil Mill (Tashkent, Yangi-Yul) where the experiments will be carried out. We negotiated with the Mill Managers and got their agreement to accomplish measurements there.

B) Budget: $5000 was foreseen in Total Year Total Budget for Materials and Supplies for Israel collaborators. We ask to divide it in two for Equipment $2500, retaining $2500 for Materials and Supplies in the Budget.

C) Special Concerns: Not Applicable.

D) Collaboration, Travel, Training and Publications:

According to the Project workplan the Uzbekistan collaborators got training in Technion-Israel Institute of Technology. We got an agreement with one of the Oil Seed Mills here in Israel in order to train the Uzbekistan collaborators to use the bought devices for concentration and particulate size distribution measurements in workshop conditions. We have accomplished the mentioned experiments.

We arranged also the training of Uzbekistan collaborators in Israel Institute for Occupational Safety and Hygiene, and in Laboratory of Air Pollution in Israel Ministry of Labor how to use the mentioned tools.

We contacted the laboratory for dust particles measurement and agglomeration tools at City University of New York (NY). We visited the laboratory (August, 2000) and have been acquainted with the tools and their functioning. We needed according to the workplan of the Project to study of the particles size distribution of dust of cottonseeds and their elements (kernels, hulls, etc). It's well known that to bring of plant seeds and their co-products into U.S.A. is prohibited. Because of this we had to order the cottonseed particles in U.S. We have addressed

the request to the management of Cottonseed Oil Mill in Lamesa, Texas (Manager Mr. Carl Robertson) and the cottonseed and patterns of dust emanated in cottonseed processes were kindly delivered for us.

E) Request for American Embassy Tel Aviv or A.I.D. Actions. All is OK.

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Table 1. Mass concentration of dust (mg/m^3) in hulling - separation room

Sampler type	Sampler location	Samples	Mean	S.D.	Min	Max
Stationary personal	SP1	6	43.00		36.58	69.86
Sampler	SP2	6	65.09		31.68	84.56
	SP3	4	44.68		23.14	81.34
	SP4	3	65.12		34.85	92.63
	SP5	4	92.86		54.84	122.69
	SP6	4	59.43		28.92	92.98
Average (weighted)			60.44			

Table 1. Mass concentration of dust (mg/m^3) in hulling - separation room

(continuation)

Sampler type	Samples	Mean	S.D.	Min	Max
	6	49.42		34.28	86.52
	8	54.89		35.86	86.35
Personal	8	64.81		41.11	95.27
sampler	6	46.56		32.95	79.63
on operator	8	48.63		33.18	78.18
(roving sampler)	8	86.93		39.84	118.34
	8	92.43		46.83	123.52
	6	88.34		42.63	134.16
	6	66.84		39.12	112.83
	6	81.65		46.93	115.12
Average (weighted)		68.61			

Table 2

Dust particle sizes by sampling location

Station	Percentage in range (upper line) and frequency for various range groups (μm)							
	0.5-1	1-2	2-4	4-8	8-16	16-32	32-64	64-128
1	16.8	35.7	18.2	14.7	7.8	2.80	2.09	2.09
	33.6	35.7	9.1	3.7	0.95	0.2	0.07	0.03
2	19.9	23.1	32.7	9.0	8.3	5.8	0.6	0.6
	39	23.1	16.3	2.2	1.09	0.4	0.02	0.01
3	18.2	28.5	35.8	7.3	8.8	0.7	0.7	-
	36.4	28.5	17.9	1.83	1.1	0.04	0.02	-
4	17.8	23.3	21.7	17.1	9.3	9.3	1.5	-
	35.6	23.3	10.9	4.3	1.2	0.6	0.05	
5	19.7	22.8	23.3	12.4	12.4	7.8	1.6	-
	39.4	22.8	11.7	3.1	1.6	0.5	0.05	-
6	28.0	25.0	24.2	19.9	3.8	3.0	2.3	0.8
	56.0	25.0	12.1	3.2	0.5	0.2	0.07	0.01
7	20.1	26.4	32.1	13.2	6.9	1.3	-	-
	40.2	26.4	16.1	3.3	0.86	0.08	-	-
8	20.8	26.2	30.2	14.1	6.0	2.7	-	-
	41.6	26.2	15.1	3.5	0.75	0.2	-	-