

Current Safety Topics in the

GLASS AND CERAMICS INDUSTRY

*as presented in sessions of the Glass and Ceramics Section
at the 40th National Safety Congress*

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This subject was discussed at the meeting of this section last year. It is so important that some new developments should be mentioned. At least four exhibitors are showing *heat reflective* clothing. It is made of aluminized fabric, and finds use when working

around hot furnaces. We also have a film loaned by Minnesota Mining and Manufacturing Company, which illustrates how this type of material withstands radiant heat much better than ordinary non-reflective fabrics.

Ventilation Problems

Round Table Discussion of Ventilation Problems

Discussion Leader—W. G. HAZARD, Director, Industrial Hygiene, Owens-Illinois Glass Co., Toledo, Ohio. Local exhaust systems are not always well designed. Sometimes the plant is too busy with production. The plant engineer may lack experience. Duct systems are sometimes "out of this world."

Principles involved in exhaust venting were shown by a film produced by the American Air Filter Co., in cooperation with the Michigan State Department of Health. Part One dealt with "Laboratory Experiments" and Part Two with "Practical Applications."

A demonstration with simple apparatus showed the comparative effectiveness of suction and blowing. It was shown that it was possible to blow smoke across the room but suction was effective for only a few inches.

One trouble with ventilating systems is adding too many hoods to the original system.

A motion picture produced by Minnesota Mining and Manufacturing Co. showed the uses of aluminized fabrics for protective equipment. Clothing and shields of this material have a high fire resistance but are still not too durable. Their present uses are for rescue work rather than for general industrial use.

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NURSING**

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at the 40th National Safety Congress*

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Current Topics in

INDUSTRIAL SAFETY

*as presented in the Subject Sessions
at the 40th National Safety Congress*

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Safety Is Basic in Human Relations

By C. G. ROUSCH

Mgr., Westinghouse Electric Corp., Kansas City, Mo.,
Vice-Pres., National Society of Professional Engineers

The industrial accident causes are in about the ratio of 10 per cent, due to lack of proper safeguards in the plant, and 90 per cent due to the human behavior factor which can be changed by proper training.

I presume as safety engineers we are well qualified to handle the 10 per cent factory layout problems, but doubt if we are so well qualified to handle the human factors; therefore, I would like to devote the rest of my time to a discussion of this 90 per cent factor.

Since your work is a 90 per cent problem of education and training of the worker, the problem seems to resolve itself into two parts:

1. Proper methods of approach and presentation.
2. Prestige of your profession.

Methods

The approach and presentation of all programs should be made with enthusiasm and directed to appeal to the emotion of the worker. A story, simply based on statistics (facts and figures) of lost time, deaths, injury, etc., will not be sufficiently convincing.

During the past 50 years we have continued to gather our people into great urban areas, and put them together in large industrial plants. In so doing we have uprooted them from the relatively simple social problems of the family and small community unit.

Your training program must recognize these problems of feelings of insecurity, irritation from fellow workers, strangeness of surroundings and newness of occupation. It must make the worker feel as an integral part of his company and community, and that the company is personally interested in him. Only then will the worker settle down emotionally and become an efficient and safe worker.

The great industrial development and growth of the country produced the rugged individualistic type of business leader. Generally speaking, he refused to accept re-

sponsibility for his workers as human beings. Today top industrial management has begun to recognize this factor and is willing to pay more than mere "lip service" to our program. But they are only willing to accept our program if we can convince them it will be effective.

We also have other problems facing us today. Large labor unions are refusing to consider anything but their own personal desires. The leaders are striving for more and more power regardless of the consequences to business and their membership.

We have a new "so called" liberal group running our government and planning our future economy. As they have obtained power they cease to be liberals who are broad minded, tolerant and clear thinking. Instead they consider that their programs are the only ones desirable and close their minds against all others.

We can note that as our nation has developed we have also developed group thinking that is quite intolerant.

As engineers we probably have had more to do with this country's development than any other particular group. We should not consider ourselves as management, capital or labor, but as the catalyst that supplies the knowledge and skill to combine effectively all these elements for the most good of all our people. We must, therefore, accept our responsibilities to help train and direct human behavior.

In a survey recently conducted by the National Society of Professional Engineers on the problem of better utilization of engineering manpower, we received replies from 495 companies employing approximately 3,000,000 people with 110,000 engineers.

Fifty-six per cent of these companies reported that they had no formal training program. It seems self evident that this is one of the prime reasons for lack of efficient production, labor unrest and accidents. People are simply employed and put to work. No effort has been made to fit the man to the job and to properly indoctrinate and train him.

As an example of the effectiveness of training, let me tell you something of the program of my own company, the Westinghouse Electric Corporation.

Basic Consideration

1. In hiring, the worker is carefully screened to apply the man to the job.
2. A fundamental part of job instruction is along the line of personal orientation and safety.
3. A comprehensive supervisory training program is in effect.

The philosophy stressed is: *Company and employee must have the same objective and pull together—toward the same common good—with safe and efficient operation. We stress the fact that people are creatures of feeling and emotion.*

Our supervisors' training program covers thirteen subjects relative to company policies, cost control, production planning, organizational set-up, etc.

Six of the thirteen items deal directly with problems having to do with human behavior which results in safe workers. These six subjects are:

1. Management responsibilities.
2. Understanding people.
3. Employee training.
4. Accident prevention.
5. Attitudes are important.
6. Motivating employees.

As an example of how these subjects are presented, the following is a brief summary of management responsibilities. As it is developed, again you will note the emphasis placed on the "worker as a creator of feeling and emotion."

1. How people differ as to:
 - Intelligence
 - Interest
 - Habits
 - Temperament
 - Mental health
 - Aptitudes
2. Components of personality and temperament as indicated by:
 - Sociability
 - Depressiveness
 - Shyness
 - Aggressiveness
 - Self Control
 - Selfishness

3. Self Interest as shown by:

- Success, regardless of price
- Gambling to win
- Criminal tendencies
- Lack of sense of fair play
- Material interest

Other main subdivisions:

- Nature of self control
- Emotions
- Your ups and downs
- Tendency to retreat from reality
- Temperament combination
- Discipline and criticism
- Praise (according to temperament)
- Individual motivation
- Grievances (emotional kind)

You might ask, does this program pay off? During the past five years Westinghouse employment has more than doubled with many new plant locations, which means a terrific job of training. The results tabulated below, however, tell the story.

Injury Experience—Westinghouse Plants

Year	Frequency	Severity
1947	4.0	.63
1948	3.8	.51
1949	3.5	.37
1950	3.3	.40
1951	3.4	.43
1952 (1st 6 Mo.)	2.6	.27

Kansas City Aviation Gas Turbine Plant (Put in Operation 1949)

Year	Frequency	Severity
1949	12.0	7.9
1950	2.38	1.2
1951	2.09	.96
1952 (1st 6 Mo.)	1.3	.25

The Kansas City personnel was recruited from people with either limited or no industrial experience, and our training in this plant has been most intensive.

As a conclusion to methods, since approximately 90 per cent of accident cause is failure of the individual—your training program, to be effective, must have full support of top management, it must deal with the characteristics of people and it must be presented with the proper appeal.

Prestige

Your profession as "Safety Engineers" is comparatively new, and as such has not gained the prestige needed.

At the beginning of engineering specialization in this country, the practicing engineer doubted or denied the value of technical training and distrusted engineering graduates. Today, engineering has ceased to be traditional and is becoming recognized as a learned profession. Yours is the problem of gaining recognition for the safety engineer, not only as a man technically qualified, but also as one educated in the study of "human behavior."

I note in the Qualification Standards Bulletin on Registration dated July 13, 1951, several items that deal with human behavior have been indicated. If we fully understand these problems and can get top management to know that we do understand them, and, how to use them, your prestige will immediately be raised. Perhaps when this pamphlet is revised we should stress this part of our qualifications, even more, as today we indicate more emphasis on the technical and statistical work, which accounts for only approximately 10 per cent of accidents.

We might consider the technical side of our qualifications as the foundation upon which the whole structure of safety is built.

As soon as possible we should establish registration for our members as a compulsory item. Registration does not signify that the engineer is immediately more proficient, but it does give you a "Trademark" to sell.

I mentioned professionalism as a trademark or cloak on which to build prestige. Prestige or stature is something that can be conferred or earned, but cannot be demanded. It is built up over years of per-

formance. We can build our stature through good work and also sell the "Trademark" of Registration, such as the medical profession has with M.D. and the legal profession with L.L.D.

It is quite evident, the greater the reputation of the individual or the profession to which he belongs, the greater respect and attention is given to his words and actions.

Conclusion

In conclusion, one cannot live unto himself alone and be acceptable in our society of people. His actions are greatly influenced by his contact with others and by the type and amount of education and training he has received.

Our program must have full support of top management and appeal to the worker. As our knowledge, know-how and prestige increase, our work will become more effective.

I would like to give you my impression of the great value, importance and high calling of our work by quoting John Ruskin:

"It is nothing to give pension and cottage to the widow who has lost her son; it is nothing to give food and medicine to the workman who has broken his arm, or the decrepit woman wasting in sickness. But it is something to use your time and strength to war with the waywardness and thoughtlessness of mankind; to keep the erring workman in your service until you have made him an unerring one; and to direct your fellowman to the opportunity which his judgment would have lost."

The first time a square was prepared we neglected to inform some of the men working in that vicinity, and before anyone noticed, they proceeded to "clean up the mess." We had to start all over again, but we were pleased with the effectiveness of our good housekeeping education.

We have made a collection of dangerous tools like mushroomed chisels, blunt picaroons, etc. We put them on display in a corner of the lunchroom. Under each of these tools is pasted a label giving its history, the reason why it should not be used, and how to exchange it for a safe one.

There is another stunt. Members of the plant safety committee are dressed up in white overalls and carry brooms. They are sweeping up a dirty-looking fellow in unsafe clothing who is identified by a sign as "Mr. Acci-Dent." The slogan used in conjunction with this would be "Let's sweep Mr. Acci-Dent out of our plant."

Finally a stunt which created a lot of discussion among our men and for which we got the fullest cooperation of the local ambulance service. It is 4 p.m., the end of the shift, and the whistle blows. An ambulance drives into the plant, sirens screaming, red lights flashing. It stops at the time clocks. The driver and attendant jump out, open the rear door—but instead of bringing out their dreaded stretcher, they carry out a poster on an easel and set it up in front of the ambulance. The poster reads: "Work safely, and don't let me take you home."

While human engineering is all important, I would hasten to add that we must not neglect to look for "the little things" in the mechanical field. These little mechanical gremlins can best be detected by someone whose eyes have not become over-

familiar with his surroundings. In this connection we have regular inspection tours through all departments by different members of the safety committee. At these inspections, special attention is also paid to the housekeeping of each department. The inspectors, identified by white safety helmets and armbands, carry printed cards stating the housekeeping was found to be good, fair, or poor. The appropriate cards are posted on the departmental notice boards.

These are the little things that we are doing in our plant which help us to prevent accidents. How many and how severe these accidents would have been, we very seldom know.

Only once have I experienced the gratification of proof. This happened not quite two years ago. The plant executive safety council was in session and we were just going through the report of the last safety inspection. One item on the report, a "little thing," was the recommendation to extend the feed rolls operating lever of one of the resaws to bring it within easier reach of the operator. The plant engineer reported this matter had been taken care of. At that moment our first aid man entered the room and informed us that the fingers of the feeder working on that resaw had been caught in the rolls, but, due to the newly installed extension, he had been able to keep his hand from being dragged into the saw. He had a pinched finger, but after proper attention he was able to go back to work.

Had this "little thing" not been found at the last safety inspection and remedied at once, the resaw feeder certainly would have lost several fingers, most likely his entire hand, and possibly even part of his arm.

Many Eyes Hunt the Hazards

By MYRON L. MILLER

Supvr. of Safety, East Pittsburgh Works, Westinghouse Electric Corp.,
E. Pittsburgh, Pa.

In his book, *Industrial Safety*, Ronald P. Blake makes a statement, "With the possible exception of the manager, the foreman carries a greater share of the responsibility for accident prevention than any other one person."

Enlightened management knows the importance of accident prevention, not only from the humane point of view, to prevent personal injury and suffering, but accident prevention aids production.

¹ *Industrial Safety*—Blake, Page 67.

Current Safety Topics in the

**MARITIME
INDUSTRIES**

*as presented in sessions of the Marine Section
at the 40th National Safety Congress*

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Current Safety Topics in the

**METALS
INDUSTRY**

*as presented in sessions of the Metals Section
at the 40th National Safety Congress*

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Current Safety Topics in the

**MINING
INDUSTRY**

*as presented in sessions of the Mining Section
at the 40th National Safety Congress*

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Some Aspects of Underground Environmental Control

By JOHN W. WARREN

Chief Ventilation and Industrial Hygiene Eng., Anaconda Copper Mining Co., Butte, Mont.

The literature abounds with information pertaining to the many phases of man's atmospheric environment. The information available lacks in specific procedures for the prevention and alleviation of concentrations of undesirable atmospheric contaminants.

Control procedures for underground operations become complex and installations difficult due to the physical nature of the surroundings.

It may be of interest to those concerned to present some of the results of experience and experimentation. Much of the material will be a review.

The management of the Anaconda Copper Mining Company has for many years directed the efforts which have achieved control of the underground environment.

The policy of the Anaconda Company in its control of an environmental hazard has always been to improve conditions by proper ventilation, wet methods and any other methods that have been tried and found practical, thus eliminating the use of encumbering gadgets such as masks, helmets and the like. Respirators are used only occasionally and in very few places.

The campaign on dust control began with the adoption of wet drillings in 1918. Conversion of percussion drills then in use was complete by 1926. During a full normal operation in the Butte district an excess of 1,400 drills have been in service at one time.

One of the major undertakings to improve the underground environment was the program to increase the airflow through the mines. The program was formulated by Mr. A. S. Richardson, who has given much toward making mine ventilation the science it is today. His coefficients of frictional resistance to airflow and technical papers have been of great assistance to the progress of mine ventilation. Mr. Richardson conceived and developed the most ingenious scheme for air conditioning in use today.

Knowing that power requirements vary as the cube of the air volume passing through

the system and that resistance pressure losses vary as the square of the volume it can be readily realized what an accomplishment was prosecuted and the economic outlay involved. Actually the air flow was doubled for a power increase of approximately 70 per cent. Normally the power increase would have been 800 per cent. Smooth surfacing was installed in 20 air shafts to reduce the resistance pressure losses. Airways of high resistance were enlarged or paralleled and 23 new, reversible and more efficient main surface fans were installed.

With a skin to skin octagonal air raise of a diameter of inscribed circle 9'. Area = 67 sq. ft. the friction factor = $A \cdot 0.0000000018$.

In a vertical rectangular shaft smooth surfacing is treated and pegged with hardwood dowel pins.

In a horizontal airway long treated smooth surfacing is also pegged.

The Anaconda Copper Mining Company has always cooperated to the fullest extent with the United States bureau of mines, and the assistance from the bureau has been very helpful and constructive. Accordingly, in 1935 the bureau was extended an invitation to make a survey of the existing conditions in the Butte mines.

In 1936 a survey was made under the supervision and direction of Dr. Carlton E. Brown, chemist, United States bureau of mines. The average dust concentration for the Butte mines was found to be approximately 2.05 millions of particles per cubic foot. The survey results supported the findings of surveys made by our own engineers in their investigations both before and since the bureau survey. The free silica content will average about 16 per cent.

A very fruitful research program was prosecuted with the cooperation of the U. S. bureau of mines. One of the major accomplishments benefiting the industry as a whole was the investigation of the relation of dust dissemination to water flow through rock drills. Findings have been published as Re-

port of Investigations #3393. In brief it was found that with all other factors constant, the water flow to the cutting face of the bit should be not less than $1\frac{1}{4}$ G.P.M. All rock drills are now equipped with a water needle which will pass this flow at desirable underground waterline pressure.

Today there is being circulated in the Butte mines an excess of 3 million cubic feet of air per minute. The quantity of air circulated through the mines in one minute is sufficient to sustain life in a human being from the time he is born until he is 21 years old. In weight there is circulated through the Butte mines an excess of 20 tons of air for every ton of rock which is hoisted to surface. This weight includes an excess of 5,000 tons per day being hoisted from the greater Butte project.

A backward curve, centrifugal, safeload, reversible, surface main mine fan with louvre control for selectivity of volume is highly desirable for minute pressure control. Such control is highly advantageous in the event of an underground fire. A shaft house with contained air lock facilitates work and transportation with the fan in operation. Six similar fans having capacities from 225,000 to 250,000 CFM at total pressures varying from 10.0" H₂O to 14.75" H₂O operate primarily exhausting in the district.

A propeller type fan which relies on the change of rotation for reversal of airflow allows efficiency in reverse direction to be greatly sacrificed. The loss of volume is approximately 40 per cent when the fan is not primarily exhausting.

A forward curve blade reversible mine fan operating on a relatively shallow mine has a capacity of 150,000 CFM at 4.30" H₂O.

The Butte district has one forward curved blade fan delivering 275,000 CFM at 14.1" H₂O Static Pressure which is directly connected to a 900 horsepower synchronous motor. This arrangement is by choice a necessity since a low sound level in the area was desirable and mainly because the mine orifice is one of fixed nature. The fan induces the exhaust air flow from the central pumping plant and some exhaust components from surrounding mines.

There are approximately 1,000 auxiliary blowers with a capacity of 3,000 CFM at 6" H₂O S. P. in service in the district. The blowers generally operate, primarily blow-

ing, and are delivering air through over 40 miles of flexible tubing.

There is in excess of 10,000 connected horsepower on ventilation in the Butte district.

An air transmission duct having 38" inside diameter assembled from $1\frac{1}{2}$ " thick Douglas grade A fir staves delivers conditioned air counter-current to very warm drainage water resulting from a high ground gradient at the horizon.

A steel duct made from a 21 $\frac{1}{4}$ " inside diameter spiral circumferential lockseam welded #14 gauge steel pipe is protected inside and outside with a protective coating highly resistant to acid mine waters having a low pH. This type of installation is where the life may be of a semi-permanent nature and where reversible ventilation is permissible.

Plastic air transmission duct, both semi-rigid and flexible, is now undergoing test and preliminary tests indicate it may be of economic value for many types of installations.

With an oblong orifice used on the end of air transmission lines servicing sill headings, the positive ventilation is delivered in a flat tubular pattern at high velocity to the heading sweeping the face downward and out along floor-line. Any concentrations are coursed outward below breathing zone.

All hoisting shafts for safety purposes are maintained as downcast inlets. Mine yards are paved with a "road-mix" topping to prevent dispersion of dust into the atmosphere; such a surface lends itself to good housekeeping and permits an ease of wetting down.

Hoisting shafts can be easily wetted with a compressed air and water mist spray without coursing a stream over supporting shaft timbers. The spray is of consequence when rock hoisting operations are underway.

Water mist sprays can be turned on to wet down haulageways and airways as the occasion arises. These sprays are non-clogging.

One of the more important dust control features in underground mining operations is the proper use of a compressed air and water blast or mist spray. With the general type used by the Anaconda Company, the water flow is controlled by a $\frac{1}{8}$ " diameter orifice in the flexible hose nipple. The hose

cross-over is used to compensate for the varying lengths of service pipe lines. The mist wets down each successive blast as the round in the heading is fired. The mist spray homogeneously wets down the muck pile so that voids are more likely to be filled with water vapor rather than gases from powder ignition. The air displacement at the heading forces the gases out to where the auxiliary ventilation can course the atmosphere to the primary circuit.

Use of the heading environment with and without the use of a compressed air and water blast and with all other factors being kept constant, show the dust concentrations in the heading vicinity soon after the blast are of low magnitude. Cooperative research work with the bureau of mines was accomplished in this respect. The results are published in Report of Investigations #3388.

A compressed air and water mist spray or blast accomplishes the same purpose. This piece of equipment is shielded and can be wedged between the track.

With a compressed air and water mist spray for use in a 3 compartment raise, the amount of water is controlled by an orifice in a union and is readily adaptable to flexibility since it can be pointed toward the back or into the chutes. It can be made to work equally as well in a 2 compartment raise.

With the mist spray in position in a three compartment raise, regular service hoses are used in the drilling operation and are connected to the blast.

A portable compressed air and water mist spray which is connected by dual or twin welding hose from the service lines has application in finger raises of block caving operations and can also be used for wetting down.

Air-conditioning plays a major part in the underground environmental control within several areas of the Butte district. Two large air-conditioning plants of very ingenious design are located in the district. Each plant has the capacity to deliver a yearly average of over 1,000 tons of refrigeration per day.

One plant is now in its 16th year of operation and during its service it has conditioned and delivered into the working areas of the mine approximately one trillion cubic feet of air upon which 3,500,000 tons of refrigeration has been affected.

One of the surface cooling tower units reduces the temperature of the circulating cooling medium to below the wet bulb temperature when desirable.

In the air washing chamber in one of the plants, the air undergoes preconditioning before entering the cooling section.

At the discharge end of one of the 70,000 CFM plants, the circulating water courses in the low pressure circuit to the sprays in the washing chamber. Water resulting from dehumidification drops from the cooling coils and often exceeds 10 gallons per minute.

Frost on the return bends of the heat absorber occurs during the period of greatest mean temperature difference.

The air conditioning plants deliver conditioned air in the heart of the working areas and do not condition near the source of the primary system. It is not a bit uncommon for these plants to lower the wet bulb temperature 20°F.

The plants described are of high pressure, closed circuit type. Low pressure, city water serviced air conditioning plants are used in some instances for remote development headings. In many cases the discharge water is used for leaching soluble copper.

The greater Butte project which embodies a type of mining method differing from those being used in the fissure vein structures presents a new problem in dust control.

Where large tonnages are transported, dust concentrations of high magnitude are dispersed at points of loading, dumping, hoisting and crushing. Since these operations occur in the upstream of intake ventilation circuits it is desirable and necessary to remove the contaminants before the air is coursed to the actual mining areas.

To provide air of high quality the use of electrostatic precipitation is being made. We believe it is the only means by which all of the dust of pathological consequence can be removed from the air stream.

The distinction and important difference between the scale of efficiencies of the various collectors between collection by weight and collection by number concentration is of vital importance in environmental control. For example a collector may have a collection efficiency of 99.5 per cent by weight and only 1.5 per cent collection efficiency by number concentration.

It naturally follows that high collection efficiency of number concentration is desired in environmental control.

It is our experience that collectors range in the following order for dusts of pathological consequence: Electrostatic precipitators. Cloth arresters. Wet collectors. High efficiency, high resistance cyclones. Low efficiency, low resistance cyclones.

Without control, concentrations of high magnitude would emanate at the main hoisting shaft, skip chutes, transfer raises, haulageways and ore extraction zones at the new Kelley mine and pollute the entire airstream from inlet to outlet.

The principle of collection, transport and retention is relatively the same for all locations where the rockstream passes freely through the air and where heavy concentrations may emanate.

For example, in the case of dumping at the skip pockets the dust laden displaced air is drawn into the suction hood. The flat tubular air jet from the plenum chamber forms a horizontal shield mixing with the displaced air and enters the suction hood. The third and major air component is drawn down over the car during the dumping cycle thus preventing contamination into the inlet air stream.

The polluted air is coursed from the collection hood to a wet collector of our own design where number concentration of the contaminant is reduced to a very low percentage. Complete and final removal of air borne dust is accomplished in the electro-matic filter.

The cleaned air courses through 2 direct expulsion type fans operating in parallel and which keep the entire collection system under negative pressure. The clean air flow component joins the main intake air flow from the downcast shaft coursing to the working areas to provide a desirable environment for all concerned.

Dust particles having a maximum diameter of 10 microns or less are considered to

be of pathological consequence. Knowing that 1 micron is equivalent to 1/25,000th of an inch, the relative size of these minute particles can be appreciated.

A particular type of electrostatic precipitator utilizes an ionizing chamber and two vertical curtains of charged plates of alternate polarity.

The grounded or negative plates travel intermittently propelling a wiper. The moving plates course through a viscous bath where adhered particulate material is removed by a stationary wiper and drops as sludge into the sump.

We are told that the acceleration of the negative electrons greatly increases as they approach the highly stressed electrical field surrounding the ionizing wires. The electrons moving at high speed, impact upon gas molecules causing them to loose negative electrons which results in the gas molecules having a positive polarity.

The dust particles which may or may not possess a charge are surrounded by a number of positively charged gas molecules causing a mass attraction effect. The negatively charged plate attracts the particle and retention occurs in the viscous film on the plate.

Velocities through the spaces between the plates must be kept at low magnitude. If the component of velocity exceeds the resultant of electrical attraction in the plane normal to travel, the particle will pass through the electrical field without deposition.

Briefly dust particles are subjected to the effluence of air motion and are careless in nature until they approach the ionizing field where they begin to develop concern and shortly thereafter they are subjected to attraction and retention.

Pollen, mold spores and bacteria have no means of locomotion but can readily choose a dust particle as a means of conveyance. Electrostatic precipitation provides the means for hygienically cleaning the environment.

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