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REPORT ON VISIT TO UNIVERSITY OF CALIFORNIA, CHEMISTRY DIVISION, BERKELEY, CALIFORNIA

AND

ATTENDANCE AT AMERICAN CHEMICAL SOCIETY SYMPOSIUM ON ATMOSPHERE CONTAMINATION AND PURIFICATION, SAN FRANCISCO, CALIFORNIA (MARCH 28 TO APRIL 1, 1949)

CHEMISTRY DEPARTMENT - UNIVERSITY OF CALIFORNIA

Dr. N. Garden, Health Chemistry Division, University of California, was contacted regarding the design and operation of the Garden type glove boxes. Dr. G. Seaborg of the Chemistry Department, and Mr. Browne of the Health Chemistry Division, participated in demonstrating the versatile uses of the various types of boxes built at the University and of their overall efficiency in actual use. The mechanics of the handling of radioactive materials from the initial point of receiving the radioactive material to the finished product in the laboratory was demonstrated.

The "senior cave" type hood was demonstrated. Dr. Garden pointed out that a Hanford irradiated slug could be safely handled in this type hood as equipped with the remote control equipment used in conjunction with the hood proper. The "junior or baby cave" type lead shielded hood was also studied. Currently, work with 50 mgs. radium is going on in the hood. Adjacent to the "junior cave" where the work with 50 mgs. radium is carried on, is a standard Garden type box where work with similar quantities of polonium and americium are carried on. To date, it is reported, no contamination was detected on the outside of the boxes. Special type hoods of California design were shown where specific chemical analyses for strontium and yttrium are carried out. Garden type boxes are so designed that they can be used as "glove box" where hands can be inserted inside the hood using sealed gloves or remote control equipment can be used with a ball-socket type arrangement inserted in the openings on the front side of the hood with remote control equipment attached to manipulate the equipment inside the box.

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Details of the design and construction and estimated costs of these hoods were previously obtained by members of the Design Liason Section of the Health Instrument Divisions. No further information was obtained regarding the efficiency of the glass wool filters used with the hoods.

It was interesting to note that some of the Gardon type boxes were enclosed in panel type hoods with a front sliding glass window and vented by a separate blower. Dr. Garden pointed out that the necessity of such additional hoods was an added protection for the Gardon box if work with large quantities of active materials was performed in the "box".

It is planned to adopt the use of these "Gardon" type boxes in the Methods-Control Group of the H. I. Development Division in the new development building being planned for the Division.

DIVISION OF INDUSTRIAL AND ENGINEERING CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY SYMPOSIUM OF ATMOSPHERE CONTAMINATION AND PURIFICATION, SAN FRANCISCO, CALIFORNIA

General:

Twenty-two papers were presented at the symposium on "Atmosphere Contamination and Purification"; all meetings were attended by the writer. A copy of the official American Chemical Society "Abstracts of Papers" presented at the 115 National Meeting in San Francisco, California, is in the files of the Methods-Control Group of the H. I. Development Division and is available to all those interested.

The abstracts given in the subsequent pages of this report are based on notes taken at the actual presentation of the papers and in personal contacts made with authors of some of the papers which seemed more closely related to our interests at the Hanford Works. Most of the papers presented at the symposium are to be published in the November issue of the Engineering Edition, "Industrial and Engineering Chemistry", official monthly publication of the American Chemical Society. In some cases, where it is believed that detailed information in the original paper is of value to Hanford regarding related problems, requests can be made for a copy of the paper.

Abstracts of Papers Attended:

Introductory Remarks - H. F. Johnstone, University of Illinois

Dr. Johnstone served as chairman of the symposium on atmosphere contamination and purification. Dr. Johnstone and his associates at the University of Illinois are doing a considerable amount of work on the nature of aerosols, measurement of particle sizes, and removal of submicron and micron size particles from the atmosphere.

The remarks of the speaker brought forth the fact that the first meeting ever held that would be comparable to the current symposium was conducted in 1910 when the Cottrell Precipitator was being introduced. The only other meetings of this type were conducted in 1918 and 1938 when interest was centered on air pollution effects produced in the manufacture of potash.

Today, interest is centered in measuring the amounts of air pollutants disseminated to the atmosphere from all sources and in measuring their subsequent effects on plants animals, humans, etc. In addition, studies for the efficient abatement of contaminants in the atmosphere are also in progress. Along with these comments, emphasis was placed on making more accurate and extensive meteorological measurements. The need for devising new and better methods for sampling and analysing gases and aerosols before finding the ultimate solution to polluted atmosphere was stressed.

"A Historical Review of Smoke and Fume Investigations" - Robert E. Swan, Stanford University, California

A brief review of the history of the development of the Cottrell Precipitator with some early studies related to studying damage effects to plant and animal life by polluted atmospheres was presented. Some contributions made to the store of knowledge in eliminating harmful materials in the atmosphere were also stated.

"Legal Regulation of Air Pollution" - H. L. Hartmann, Los Angeles County Air Pollution District, California

Legal regulations of waste materials discharged into atmosphere is almost completely in effect in most industrial communities. The current trend is limiting the permissible quantities of pollutants expelled to the atmosphere. The mechanics of legal regulations in actual practice were explained.

It was pointed out that merely increasing the height of a stack does not necessarily mean that the problem of waste disposal has been properly taken care of; the pollutant discharged from a tall stack will only be carried to points further away from the stack.

Some typical laws passed included a figure of 23% maximum volatiles from solid fuels based on a dry weight of solids. The city of Pittsburg has lowered this limit to 20%. In California, the limit for Pb or ZnO is 0.035 grams/ft^3 dispelled air. No reliable or consistent limits are set up for the halogen elements in general, although strict limits for fluorine, hydrogen fluoride, and iodine are needed. In general, most communities are becoming "air pollution" minded and legislation towards legal regulation is certainly the trend.

No mention was made of radioactive stack gas wastes or their legal regulations.

"The Los Angeles Smog Problem" - Paul L. Magill, Stanford Research Institute, California

The paper concerned itself primarily with the eye irritation effect accompanying a "smog" commonly encountered in the Los Angeles district. It was stated that the meteorological condition is the controlling factor determining the time and duration of eye-irritating smog.

An empirical correlation between certain meteorological conditions and the time of reported eye irritation was established and was shown to be relatively satisfactory in forecasting a smog-eye irritation effect up to three days in advance. Forecasts

to date have been slightly better than 50% correct.

The nature of the specific cause of eye irritation is not yet known. Currently, the problem is centered about the efficient collection and identification of the particles associated with a "smog".

"Nature of Industrial Dusts and Fumes in Los Angeles County" - L. C. McCabe, P. P. Mader, and H. E. McMahon, Los Angeles County Air Pollution and A. L. Chaney, Albert L. Chaney Chemical Laboratory, California

The nature and source of industrial waste gases with accompanying correlated meteorological conditions in the Los Angeles district were presented. In cases where particle size measurements were needed, the electron microscope was employed.

A method for the determination of SO_3 in air was developed. In general, the method consists of passing a known volume of air through Whatman extraction thimbles and titrating the SO_3 absorbed by the paper using dilute NaOH with methyl orange as the indicator. It was stated that the filter efficiency was 95%.

Liquid aerosol in the atmosphere was collected by use of the Sonkin modified cascade impactor.

"Development of Air Pollution Standards" - L. C. McCabe, A. H. Rose, and W. J. Harming, Los Angeles County Air Pollution Control District, California

The primary purpose of this paper was to present some technical basis to control and set limits on the pollution of the atmosphere by industrial wastes. The principal factor to control the concentration of contaminants on the ground was the mass rate of emission from a stack; the standards set up were based on the per cent loss of t the total process weight. Data was collected considering effluent loss to process weight ratio, hourly mass rate of emission, and average mass rate of emission; these data were correlated with the various types of collecting devices and their respective efficiencies. Allowable discharge curves were set up on the above mentioned basis and actual figures were calculated to limit the SO_3, H_2SO_4, and H_2S emitted from any stack.

The allowable discharge curves were based on devices with 80 to 90% collection efficiencies for particles < 44 microns in diameter and for devices of 90 to 99% collection efficiencies for particles > 44 microns in diameter. A calculated allowable discharge curve was given as $(x + 1000)(Y - 0.08) = 400$.

"Use and Limitations of the Midget Impinger For Locating Dust-Producing Areas" - H. B. Charnbury, W. L. Chen, C. C. Wright, Division of Fuel Technology, State College, Pennsylvania

The use of a midget impinger, a modified cascade type impactor was described in relation to locating dust producing areas. Particles of 1 to 10 microns in size could be collected by this method. Good relative results were claimed. The question was asked if this method of collection could be correlated with other methods of collection. It was reported by the author that of the few tests run, extremely poor correlations were obtained.

"Effects of Additive and Atmosphere - Derived Fluorine in Tennessee Soils and Forage Crops" - W. H. MacIntire and Associates, University of Tennessee, Tennessee

The following abstract is the author's own abstract and is included in full in view of the fact that the measurements for fluorine were made in air, rain, domestic water supplies, soil, and vegetation. On an overall basis, these procedures correspond to the sampling program for radioactive contamination at the Hanford Works. Questions directed to the author relative to correlations with atmospheric variations etc. indicated that little if any specific correlations were attempted other than measuring the overall average rainfall. It is interesting to point out that the conclusions on forage in this report were based on 800 samples taken over a period of a year; the Health Instrument Site Survey Group collects about as many samples of vegetation in one month for radioactive contamination measurements in that particular source alone.

Abstract of Paper:

"Insecticidal and fertilizer fluoride incorporations have been studied 20 years in Tennessee through lysimeter, greenhouse, and forage experiments. Inputs of fluorine through barium and calcium compounds (up to 6000 pounds of such per acre) were soil-retained almost entirely against 10 annual 51-inch rainfalls. Rainwater leachings from two moderately limestoned soils carried 0.3 to 1.5 pounds of fluorine per acre per annum from 300-pound incorporations of fluorine as cryolite, MgF_2, NaF, Na_2SiF_6, and through rock phosphate, none of which caused increase of fluorine in lysimeter-grown soybeans. Per acre inputs of 100, 200, and 500 pounds of fluorine as CaF_2, and as KF, induced no clover or alfalfa on two limestoned soils, or those slagged to furnish corresponding inputs of fluorine, whereas those fluorides did raise the fluorine content in like crops on the unlimed soils. Rainwater drainages from quenched calcium silicate slag incorporations showed fluorine concentration 4 times that attained by saturated solution of CaF_2 in the laboratory. Superphosphate incorporations corresponding to 500 0.25 ton incorporations induced no increase in fluorine content of 9 large successive crops. Normal fluorine content was shown by several crops grown on translocated Tennessee and Kentucky soils of high phosphate-fluorine content. A year's collection of 800 samples of forage on two university experimental farms within 5 miles of industrial operations showed fluorine content of 50 to 75 p.p.m. in 40 per cent of samplings; beyond 75 p.p.m. in 32 per cent of samplings; many incidences beyond 100 p.p.m. and none less than 10 p.p.m. for operation F and for operation A 65 per cent of samples showed 10 to 25 p.p.m. of fluorine, with many samples showing well above that range. Corresponding forage from control areas showed less than 8 p.p.m. of fluorine in 86 per cent of cases and less than 5 p.p.m. in 76 per cent of cases. Higher incidence of fluorine was found in rainwaters at both locations.

Apparently, an abnormal incidence of fluorine in forage crops is not induced through either fluorides native to the soil or through rational incorporation of any solid fluoric material in similar soils of reasonable calcium content, or those adequately limestoned. Hence, toxic levels of fluorine in forage are deemed attributable to direct contamination from the atmosphere."

"Sulfur Dioxide in the Atmosphere and Its Relation to Plant Life" - M. Kutz, National Research Council, Ottawa, Canada.

It was shown that concentrations of sulfur in the atmosphere of about 0.4 p.p.m. could be toxic to certain plants. No visible harmful effects on plant life were reported for air atmosphere containing 0.1 to 0.2 p.p.m. even after long continuous exposures.

"Dilution of Waste Stack Gases in the Atmosphere" - P. E. Church, University of Washington, Washington

This paper reported the results of Dr. Church's work on the Hanford stack using oil-fog forced thru the 200-foot stack. This paper covers the material as previously reported during the work at Hanford and is available from the Hanford File.*

"Sampling of Aerosols and Correlation of Sampling Data" - M. A. Fisher, Armour Research Foundation of Illinois, Chicago, Illinois

The limiting factors which should be considered in sampling aerosols were discussed and are briefly outlined as follows:

1. Particle Size
2. Particle Shape
3. Particle Density
4. Physical State
5. Chemical properties of aerosol under study
6. Knowledge of streamline flow and angle of collecting plate
7. Surface of collecting plate

In addition, careful consideration should be given to the choice of sampling location and applying statistics in interpreting the final results.

It was also pointed out that it would be necessary at times to use a combination of sampling methods to adequately cover the desired particle size range of aerosols before good data can be obtained on a given aerosol.

"Measurement of Visibility by Photographic Photometry" - C. Stoffens, Stanford Research Institute, California

The paper concerned itself with the mathematics and experimental phases in recording the relative degree of "murkiness" causing impaired visibility in the atmosphere by photographic methods.

"Method for Determination of Free Sulfur in the Atmosphere" - P. L. Magill, M. Rolston, Stanford Research Institute, California

A modified F. Feigl's spot test for sulfur present in the atmosphere in the free state was reported. It is claimed that as little as 0.005 p.p.m. of free sulfur can be

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*Restricted - "Meteorology Section Report, January 1943 to July 1944" - Dr. P. E. Church, C. A. Gosline, Jr. O. H. Newton, J. F. Mattingly, and L. F. Morkus

CConfidential- "Characteristics of Mixing and the Dilution of Waste Stack Gases In the Atmosphere, P. E. Church and C. A. Gosline - 7-4806

measured in the atmosphere with a 90% accuracy using only one cubic foot of air. Based on this method of measurement, (pyridine spotting prepared thallous acetate paper, H_2S dependent, thru which the air was sampled and comparing the polysulfide spot with known standards) it was reported that 0.2 p.p.m. amorphous and 8 p.p.m crystalline sulfur in the atmosphere would result in eye irritation.

"Dispersion of Gases from Tall Stacks as a Means of Pollution Control" M. D. Thomas, G. R. Hill, J. M. Abersold, American Smelting and Refining Company

Dr. Thomas, in his presentation, discussed the results of fifteen years of monitoring for SO_2 in the atmosphere and trying to fit his results with the equations of Sutton and Bosanquet-Pearson. Two smelting plants were taken as the source of the SO_2 to be measured. Standard Asarco, Lyngberg, Litval, and Coons recorders were used from the source, a 150 foot stack, was used at Selby, California, and three recorders placed 65 to 85 stack lengths from the plant were used at the Garfield Plant in Utah. A ridge about 1500 feet high was located between the source stack and the recorders at the latter location.

The equations of Sutton and Bosanquet and Pearson were reviewed with the qualification that no corrections were made in the data analysis for the buoyancy of air.

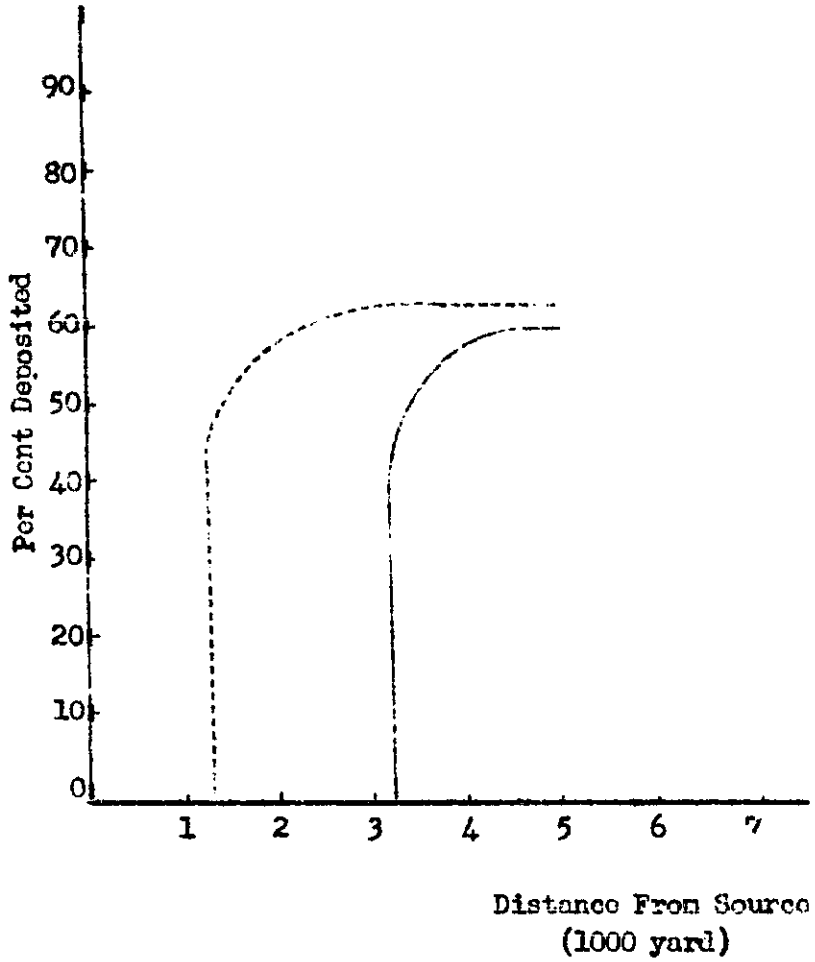
The analysis of the data indicated that the Bosanquet and Pearson formula applied to both stacks studied when comparing the ratios of the maximum recorded concentration to the mass emission of SO_2 from the stack. The maximum ground concentration was assumed to be 10 to 15 stack lengths from the source. The ratios at the Garfield Plant, even with the 1500 foot ridge, agreed reasonably well with the Bosanquet and Pearson formula. Applications of the data to the Sutton analysis did not apply to the data as Sutton uses greater distances for the point of maximum ground concentration from the source that the 10 to 15 stack lengths used by Bosanquet and Pearson.

Here again, as was asked of the author, considerable difficulty was encountered in the attempt to completely correlate meteorological variable conditions with the data.

"Dissemination of Aerosol Particles Dispersed From Chimneys" - T. Baron, E. R. Gerhard, H. F. Johnstone, University of Illinois, Illinois

Dr. Baron approached the aerosol dispersion problem only from a theoretical-mathematical point of view; the deposition of aerosol particles from point sources were based on O. G. Sutton's statistical methods. It was stated that the method presented in the paper modified Sutton's equations to take into account the finite settling velocity of aerosol particles. It was also pointed out that the rate of deposition and the ground concentrations were markedly influenced by meteorological conditions although constant wind velocities were used in the calculations to develop the correction factor. Other limiting factors were the height of the source, distance from source and the particle diameter. One curve shown for the rate of deposition of 50 μ size particles from two different stack heights is roughly indicated on the following page.

EFFECT OF STACK HEIGHT ON DEPOSITION 50 μ PARTICLES



Other general statements by Dr. Baron based on his calculations were:

"During inversion, aerosol clouds with particles larger than 10 μ diameter settle as a whole with turbulent diffusion only of minor importance; for neutral and lapse conditions, both settling and turbulent diffusion are significant, the relative importance of the two depending upon the size of the particle."

The overall general recommendation made was to the Baron modified Sutton equation to study the rate of deposition of aerosols and to use the Bosanquet-Pearson equation for true gas clouds only.

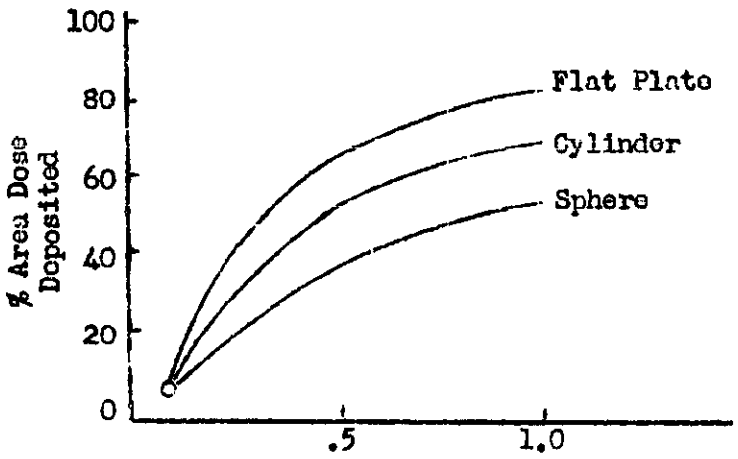
"Deposition of Aerosol Particles From Moving Gas Streams" H. F. Johnstone and M. H. Roberts, University of Illinois, Illinois

Dr. Johnstone's paper concerned itself with the relative efficiency of depositing out aerosol particles on water droplets moving by centrifugal force across a rotating gas stream. The calculation was based on Sell's theory of impaction. Maximum efficiency was obtained for 100 μ diameter droplets; for sizes below 2 μ, impaction efficiency drops rapidly, the author explained. It was claimed that the experimental Venturi scrubber (originally used experimentally for collection of dusts and fumes in high velocity gas streams) was installed on a commercial basis and was operating at efficiencies of 92 to 99 per cent in removal of industry-made fumes. The general recommendations made by the author were:

1. The impaction method for depositing aerosols is not very efficient for particles of < 5 μ diameter. Efficiencies of only 2% were obtained using 0.2 μ diameter particles.

2. Collection of small particles (< 2 μ diameter) by diffusion is better than the impaction technique.

3. A plot of the per cent area dose deposited versus particle collection on different types of collectors by impaction was given to be: (approximation)



d = particle diameter
D = object dimensions
U = wind velocity
P = particle density
u = viscosity of air

$$\theta = 1/18 \ \frac{d^2UP}{uD}$$

"Fundamental Considerations In the Design of Exhaust Ventilation For Solid Materials Handling Operations" - R. T. Prong, J. F. Knudson, R. Dennis, Industrial Hygiene Department, Kennecott Copper Corporation; Utah

Mr. Prong discussed dust as an atmospheric contaminant in industrial plants handling solid materials (feeding, conveying, dumping, screening, etc.) and the proper elimination of them by proper hooding and enclosure. Some discussion was also centered about evaluating proper constants for use in calculating exhaust capacities needed to eliminate dusts of particular size distribution in a particular atmospheric medium.

"A Survey of Atmospheric Pollution in Leicester, England" S. H. Richards, Fuel Research Station, London

Dr. Richards reported the results of monitoring for smoke, deposited matter, sulphur dioxide, and ultraviolet daylight with approximated meteorological effects on concentrations of the contaminants in the city of Leicester and environs. The effects of air turbulence on the dissipation of the smoke and SO_2 in air were noted qualitatively.

"Recent Observations In Electrical Precipitation And Mechanical Dust Collection" - W. A. Schmidt, Western Precipitation Corporation, California

Among the known factors influencing the rate of precipitation, it was shown by Mr. Schmidt that the resistivity of the dust is an important factor to be considered. Temperature and humidity affect the resistivity; the moisture effect is more pronounced at lower temperatures. It was explained that a resistivity of about 10^{12} ohms will make particle collection by electrical precipitation practically impossible.

"Development of the Venturi Scrubber" - W. P. Jones, Chemical Construction Corporation, New York

Work on the commercial "Venturi Scrubber" is still going on but the status of this wet gas scrubbing method for removing sulfuric acid mists and submicron particles (no actual dimensions were given to define submicron as used by the author) at the present time was given. The general principle of the Venturi Scrubber employs a high velocity gas in the throat of a Venturi tube for collision with an atomization of a stationary sheet of scrubbing liquid. One chief advantage of this arrangement is the relatively small volume of water needed in scrubbing large volumes of gases. For example, the author claimed 90% efficiency in scrubbing 1000 ft^3 of gas with 9 gallons water; the efficiency drops to about 80% using 3 gallons water per 1000 ft^3 gas. It was also explained that for coarse dusts (particles > 20 μ in diameter), efficiencies greater than 99% were obtained when using the Venturi Scrubber. Details of the latter were not available as the process was still in the investigation stage.

"Agglomeration of Smoke and Dust Particles by Sonic Waves" - H. W. St. Clair, U. S. Bureau Mines, Marymand

This paper dealt primarily with the theory behind agglomeration of suspended particle by the use of high frequency sound. A discussion was centered about the deviation from known acoustic principles as developed in high frequencies needed in "sonic

agglomeration". The chief factor or principle in agglomerating suspended particles by high frequency sound waves was termed "radiation pressure". Other contributing factors were (a) hydrodynamic forces between particles suspended in a vibrating gas, and (b) varying effects of particles on the vibrating gas. Complete flocccing of suspended particles can take place in less than five (5) seconds, it was reported. Frequencies of about 10^4 cycles per second were used. Some applications of this principle to industrial plants were explained. The effect of radiation pressure was also ably demonstrated by suspending in air a standard American five-cent piece between two parrallel plates, the lower plate housing the sound vibrator.

"Status of the Development of Industrial Sonic Agglomeration and Collection Systems" - H. W. Danser, E. P. Neumann, Ultrasonic Corporation; M.I.T. Massachusetts

A brief review of the historical aspects of sonic agglomeration showed that information of this nature was reported in the literature as early as the year, 1900.

In applying the sonic agglomeration principle for removal of industrial waste gases, it was stated that particles of $>10\,\mu$ diameter could be satisfactorily removed and particles of $<1\,\mu$ diameter could probably be removed with still greater efficiency. It was claimed that particles $<1\,\mu$ diameter were successfully removed at air flows of 10 to 100 cubic feet per minute. In one industrial pilot plant, vibrating sound was generated by the rotor of a 7 1/2 H.P. motor (6 pounds compressed gas was needed) cutting the gas intermittently. This unit was best suited for agglomeration of 1 to 1 1/2 μ diameter particles. One sonic setup was installed in a 300 ton-per-day plant capacity sulfuric acid plant. Here a U-2 sound generator was used with a 75 H.P. motor; the gas flow was 20,000 cubic feet. Schematic drawings of the equipment were shown on slides. At a plant where 24,000 cubic feet per minute of SO_3 passed thru a stack, a similar sonic agglomeration unit (150 d.b. were used) required four (4) seconds to completely remove the waste gas and recover most of the waste as sulfuric acid. It was asked by the author how much such a unit would cost, completely installed plus cost of materials. The author did not state any specific figures but said that if an electrostatic precipitator were installed for similar purposes, a sonic agglomerater as described in this paper would be some figure significantly lower.

GENERAL:

In general, discussions outside the formal meeting times, indicated that the trend in approaching the problem of removing pollutants from the atmosphere introduced by specific industrial processes was not in installing "bigger and better stacks" but in removing the wastes by chemical or physical-chemical means before the wastes even reach the stack.

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