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Discussion

H. F. JOHNSTONE.[5] The authors' reference to the stack-gas investigation being conducted at the University of Illinois warrants discussion of two points mentioned in the paper (*a*) the economics of sulphur-dioxide removal and, (*b*) the application of cyclone-spray scrubbers as gas absorbers.

On several occasions, the writer has published statements regarding the cost of removing sulphur dioxide from dilute waste gases. The most recent of these was the result of a detailed study of what appears, at least from the chemical and mechanical standpoint, to be the best method of accomplishing this purpose.[6] Viewed from any position, it is recognized that the application of any process of sulphur-dioxide removal to large quantities of stack gases requires a large and costly installation. The item of greatest uncertainty and perhaps of greatest cost is the disposal of the recovered material, whether it be as a waste product or as a chemical raw material to which some value can be attached. In any case, much more information is required before it can be stated that simultaneous dust removal and sulphur-dioxide recovery is feasible and that definite savings can be made in the cost of the scrubber installation by removing the corrosive conditions encountered in the circulation of the acid solution.

The paper refers also to the tests made by Dr. Kleinschmidt and the writer on the absorption efficiency of a large dust-recovery unit in which an alkaline solution was circulated for the purpose of the tests. The high efficiency obtained in this case, compared with the known low absorption efficiencies of simple spray scrubbers, can be explained easily on theoretical grounds. For certain purposes, therefore, especially when saturation of the solvent is not desired, the wet cyclone would seem to fulfill the needs of many chemical-engineering absorption problems. Here again, it is unfortunte that more information is not available from other installations. It is particularly desirable to know the effect of the dimensions of the scrubber, of the location and size of the entrance duct, and of the number and type of nozzles on the absorption efficiency. Knowledge of the nature of the flow in the vortex and especially the tendency for the droplets to coalesce would be valuable. While the authors did not mention the latter point, it is obvious that it must be of great importance in dust removal also. Simple calculations will show that, unless the spray from the nozzles is quite uniform, the probability of coalescence of the small drops with larger drops is extremely great at radii above 3 or 4 ft. Consequently, the statement in regard to the relative water requirements of scrubbers of different sizes appears to be subject to some limitation.

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[6] "Recovery of Sulfur Dioxide From Waste Gases," by H. F. Johnstone and A. D. Singh, University of Illinois, Engineering Experiment Station, Bulletin No. 324, 1940. Abstract, *Industrial and Engineering Chemistry*, vol. 32, 1940, pp. 1037–1049.

AUTHORS' CLOSURE

Professor Johnstone has brought out several points which are of interest in connection with gas scrubbing but which the authors felt unable to treat adequately in the allotted time. As to the commercial recovery of sulphur dioxide, it seems that Dr. Johnstone's position is one which arises from his academic point of view. It is unquestionably true that we do not at the present time know all that we would like to know about the economic and industrial problems confronting the recovery of sulphur dioxide. At the same time it is also probable that such complete knowledge never can be and never has been acquired with respect to any commercial process. It is felt that Dr. Johnstone's publications on the subject indicate an adequate basis for a careful commercial study of a large installation which, like all first installations of radically new processes, must be regarded as experimental. The cost figures, which in Dr. Johnstone's opinion do not appear too favorable, include such unknown factors as the percentage of solution lost in carry-over in the gases and other similar losses from the cycle. Such items can only be definitely determined in large-scale operation, and if they become important, as they appear in Dr. Johnstone's figures, they can usually be reduced by proper design or operating procedure. From the authors' own experience, it is concluded that the loss of alkaline solution in the scrubbing step would be practically negligible.

As to the factors affecting the efficiency of absorption, their experience has been that it is a very simple matter to obtain such high percentages of absorption with the present type of scrubber that it is not necessary to go to any elaborate determination of the minimum required equipment except in special cases which might arise. Coalescence of the small drops into larger drops undoubtedly occurs to a certain extent since a spray which scrubs out small dust particles should also scrub out water droplets. Practically, coalescence appears to have little effect on the performance of scrubbers as is indicated by the fact that the actual performance follows rather closely the computed efficiencies.

In view of the many uncertainties involved in applying both the theory and the experimental results previously obtained on other installations to new and different problems, it is believed that further development of the scrubber will be along the lines of engineering development and experience in numerous applications, rather than in any extensive laboratory study of the well-known factors involved.

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