DISCUSSION

OF

"MECHANICS OF MANIFOLD FLOW"

BY

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CER 54-JRB-7

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NOV. 1953

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An excellent job has been done by Dr. McNown in summarizing the basic problem of manifolds in a clear and logical manner, and engineers working on the design of projects involving manifold flow should benefit from the information presented. In a paper of such wide scope, one finds it difficult to present all of the details connected with the research even though some of them may be pertinent to an evaluation of the data. Therefore, it may be profitable at this time to briefly describe some of the experimental techniques and to evaluate the accuracy of the measurements for the experimental work on dividing flow as performed by the writer in 1946 [1].

All discharge measurements were made in weighing tanks and a minimum of two measurements were made for each discharge. A careful study of these data indicated a maximum probable error of about 1 percent. However, the measurements of piezometric head were not quite as accurate. Although capillary tubes were inserted in the lines to damp out fluctuations in both the mercury manometer and the air-water differential gage, some fluctuation still existed. A study of the piezometric head data resulted in an estimated maximum probable error of about 2 per cent with a possibility of 3 per cent error in the vicinity of the lateral where excessive disturbance occurred.

Determination of the proper hydraulic gradient for each pipe was at first a problem, since the individual piezometric head measurements showed some scatter. In order to bypass the repeating decision of "what should the exact slope be on this run?", each lateral and the main pipe were carefully calibrated by making a log log plot of Reynolds number vs.

hydraulic gradient. Each of these plots was based on a minimum of nine different slopes which in turn were based on a minimum of 6 point measurements of piezometric head. With these calibration plots the correct slope could always be fitted to the piezometric head data for individual runs even though the data exhibited some scatter. Of course, in the case of excessive scatter the run was discarded and repeated. A study of Fig. 3 will indicate that a change of slope of any of the hydraulic grade lines could affect the terms Δh and h_f', especially when these terms were small. For this reason the precaution of using the correct slope for each flow measurement is believed to have avoided some errors which might have resulted in a larger scatter of the data plotted in Figs. 4 and 5.

In order to illustrate the usefulness of the author's data as a guide in research or practice, the writer would like to briefly present some findings of a Master's research project completed at the University of Utah in 1949 by Mr. Grant Borg.* With the object of establishing a workable design for the underdrainage system of small rapid sand filters, Mr. Borg ran extensive tests on the discharge characteristics of a perforated pipe underdrain. The research resulted in the establishment of certain relationships which must occur in order to give satisfactory distribution of wash water through the perforated pipe system.

The equipment consisted of one 4-inch manifold 6 feet long with 12 one-inch laterals attached to each side of the pipe on 6-inch centers so that all laterals were in a single plane. Orifices varying from 1/8 inch diameter to 7/16 inch diameter were drilled in the bottom of the laterals on 4.18 inch centers. In this way, the 4-inch pipe acted as a manifold for the lateral pipes which extended about 21 inches from the center of the 4-inch pipe, and each lateral in turn was a manifold system for the orifices which discharged into the atmosphere. Since the orifice discharge was not always at an angle of 90° to the center line of the lateral, Mr. Borg's data cannot be compared in the strictest sense with the author's data, but in some details a qualitative comparison exists which is interesting to note.

Although other comparisons might be made, only one will be included here to illustrate how the author's data would have been useful in the

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*"Design Data on Perforated-Pipe Underdrains for Small Rapid Sand Filters," by Grant Kenneth Borg, M.S. Thesis, University of Utah, 1949.

research at Utah. For small $\frac{D_1}{D}$ ratios, and varying $\frac{Q_1}{Q}$ ratios the flow distribution through the orifices was very uniform as Fig. 5 indicates it should be. For $\frac{D_1}{D} = 1/4$, the ratio of $\frac{h'_f}{V_1^2/2g}$ remains essentially constant over a wide range of discharge ratios $\frac{Q_1}{Q}$. However, as $\frac{D_1}{D}$ increases, the ratio of $\frac{h'_f}{V_1^2/2g}$ varies considerably over a wide range of $\frac{Q_1}{Q}$. The results at Utah clearly illustrated that as the orifice was enlarged, the flow distribution became poorer because the ratio of $\frac{h'_f}{V_1^2/2g}$ varied considerably with Q_1/Q and Q_1/Q naturally varied greatly from the first orifice on the lateral to the last one. The laboratory research at Utah was for a specific purpose, and the work was very well done, but the author's results could have been effectively employed as a guide, thereby reducing the total amount of work required for a significant answer.