An improved method of calculating the percolation rate of water in soils

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In § 1 the Author seems to prefer the septic tank to the centralized sewerage system for sewage disposal in developing countries. However, septic tanks are normally provided in rural areas and out of the way places. In the long run, a centralized sewerage system will be more economical, hygienic and efficient. At best, the septic tank is an emergent device for sewage disposal and not a permanent solution to the problem. Eventually the central sewerage system is bound to replace septic tanks.

19. In § 2 the shortcomings of the percolation test as a method for soaking away water are stated. These inherent shortcomings are due to the soil conditions, its properties and so on, and these cannot be improved by the proposed method.

20. Accuracies of about 0.1 cm (§ 5) are too much to expect with the type of measuring equipment used in a practical test, especially with water in the hole below the ground level.

21. In § 6, to minimize errors, the Author advocates taking more readings in a one-hour test than the two readings (S_{50} and S_{60}) specified in the standard test. The chances of making errors in taking twelve readings will be greater than in the case of taking two readings. Moreover, there would be many practical difficulties in taking readings every five minutes, especially when readings in a large number of holes are to be taken over a wide area. These difficulties would become more apparent in a four-hour test.

22. What were the dimensions of the test holes shown in Fig. 2?

23. The percolation rate that should be taken into account should be closer to the rate of percolation of the effluent from the septic tank. The initial percolation rate will be higher in any case, and thereafter a more or less steady state will be obtained. This is clear from the values of the incremental drop in water levels in Table I. The observations for the first 30 min of the test are unnecessary. For example, for test 4, using the data from $t = 30$ min to $t = 60$ min and the Author's mathematical model, the rate of percolation is 45.36 min for 2.54 cm. This value is closer to the rate that is actually measured than that arrived at using the mathematical model considering all the twelve readings from the beginning of the test to $t = 60$ min. Consistent with practical limitations and accuracy of percolation rates, we suggest that four readings—at $t = 40, 50, 60$ and 70 min—are sufficient. Again, from these readings, the percolation rate will be calculated based on the S_{50} and S_{60} readings. A reading before the fiftieth minute and another after the sixtieth minute is sufficient to indicate the accuracy of the S_{50} and S_{60} readings and to provide a more rational and practical approach.

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In the second column of Table 4 the second location should be Ikeja 3 not Yaba 3.

25. I do not in fact prefer the septic tank to the centralized sewerage system. The superiority of the latter in municipal sanitation has never been in doubt. What I tried to emphasize in the Paper and elsewhere^{6,7} is the formidable nature of the problems associated with the central sewerage system in towns in developing countries, which will make this system, desirable as it is, unattainable in many of these towns for a long time. Most important is the capital cost of the system which is very high relative to other engineering and social services like water supply, electricity, schools and hospitals, all of which have a greater political appeal.

26. Since about 1928 consultants have submitted at fairly regular intervals proposals for the sewerage of Lagos to the Federal Government and the Lagos State Government. The estimate for a combined sewerage and solid waste disposal scheme in 1963 was £178 million for an ultimate population of 4.35 million forecast for the year 2000 (i.e. £41 *per capita*), the solid waste disposal component being £1 *per capita*. Water supply projects being constructed in towns in neighbouring Western Nigeria at the same time cost an average of £4.62 *per capita* and electricity projects just under £4 *per capita*. It is this high capital cost of the central sewerage scheme relative to the government budget and the competing needs of other and cheaper areas of development in Lagos that resulted in none of the proposals for the sewerage of the city being implemented. I believe that the situation in Lagos is typical of other big towns in Nigeria and West Africa, even when adjustment has been made for the harsh geography of Lagos. It is for this reason that the septic tank is not only popular but also a by-law requirement in new building development in Lagos and other cities in Nigeria.

27. I disagree with Dr Seetharaman and Dr Krishnamoorthy in most of what they say in § 21. I agree that the chances of making errors is greater in taking twelve readings than in taking two, but the chances are that the proportion of the readings subject to error will be less in a test of twelve readings than in a test of two readings. An error in one of the two readings in the latter case would have a 50% effect and an error in both would have a 100% effect on the percolation rate calculated from the two readings. Errors in one, two and three readings in a test of twelve readings would have only 8.3%, 16.7% and 25% effect respectively on the percolation rate calculated from all twelve readings adopting the method advocated in the Paper. This method is therefore to be preferred.

28. The tests in the Paper covered three holes at a time. There was no difficulty in taking and recording the measurement in one hole and moving on to the next hole for a measurement exactly one minute later. Indeed up to five holes could be covered this way. The difficulties envisaged in § 21 in taking measurements every five minutes in a large number of holes can be overcome by modifying the method to take measurements every ten minutes instead of every five minutes. Where more than ten holes are involved in a single test two or three operators could be involved each taking measurements in a group of not more than ten holes.

29. With regard to § 23, I agree that the rate of percolation in the latter 30 min of the one hour test will be closer to the true rate of percolation of a septic tank effluent. However, my application of the model $S = 1.64 t^{0.42}$ in test 4 from $t = 30$ min to $t = 60$ min results in a percolation rate of 32.7 min for 2.54 cm, as opposed to 45.36 min. The rate calculated from actual measurements at $t = 30$ and $t = 60$ is 42.33 min, which is not close to 32.7 min. In any case the standard percolation test specifies that the percolation rate be calculated from measurements in the last ten minutes of a one hour test or the last 30 min of a four-hour test. The suggestion of using the measurements at $t = 30$ min and $t = 60$ min in a one hour test would therefore not satisfy the requirement of the standard test.

30. The suggestion that the test be limited to four measurements at $t = 40, 50, 60$ and 70 min may be an improvement on the standard method of taking measurements only at

$t = 50$ and 60 min. However, there is the possibility that both S_{40} and S_{50} may suffer from the same measurement error, in which case S_{40} is no longer a check on the accuracy of S_{50} . Similarly if S_{60} and S_{70} suffer from the same measurement error S_{70} can no longer be a check on the accuracy of S_{60} . The percolation rate calculated from both S_{50} and S_{60} would in the circumstances absorb all the shock of the measurement errors in S_{50} and S_{60} .

31. The holes in the tests reported in the Paper were 10 cm in diameter and 45 cm deep. Bendixen *et al.*⁸ have established that the percolation rate is not affected by the shape or the size of the test hole.

References

6. ALUKO T. M. Problems of waterborne sanitation in Nigeria. *J. Niger. Med. Ass.*, 1971, 4, July, 137-142.
7. ALUKO T. M. *The upgrading of privy methods of sewage disposal by the biodisc process*. PhD thesis, University of Lagos, 1976.
8. BENDIXEN T. W. *et al.* *Studies on household sewage disposal systems*, part II. U.S. Public Health Service, Environmental Center, 1950, Cincinnati, Ohio.