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DISCUSSION OF THE PAPER, "ON THE RELATIONSHIP BETWEEN THE FORMATION FACTOR AND PROPAN-2-Ol DIFFUSIVITY IN MORTARS"* BY Peter J. Tumidajski and A.S. Schumacher

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This paper has provided valuable data on diffusion coefficients calculated by two different methods, but fails in its interpretation of these data. The stated purpose of the paper is to "... confirm the validity of Eq. 8 for ordinary Portland cement mortars and for mortars which incorporate silica fume, fly ash or blast furnace slag." "Eq. 8" refers to the equation used to calculate diffusivities by the electrical conductivity method.

The data which is to be used to confirm the validity of the electrical conductivity method was presented in Table 2 and Figure 1. These data show that diffusivities measured by the propan-2-ol method and the electrical conductivity method do not agree for the systems studied. The paper interprets this difference as evidence that the electrical conductivity method provides incorrect values for the diffusivity. The paper presents no evidence upon which a conclusion can be drawn as to which method provides the more accurate measurements. However, there are reasons to expect the propan-2-ol method to be less accurate than the electrical conductivity method.

Both measurement methods attempt to determine the effective diffusivity of a compound within a porous structure. The propan-2-ol method does so by measuring the diffusion of a pure solution of propan-2-ol into the porous solid and diffusion of water out of the pores. The electrical conductivity method determines the effective diffusivity so by measuring the electrical conductivity of the solid and the porewater within the solid. The paper correctly points out that our application of the electrical conductivity method assumes that published values of the diffusivity of a compound in dilute solution can be used as an estimate for the diffusivity of the compound within the porous solid. This is an approximation, because it is known that diffusivities vary with concentration and ionic composition of the solution. However, this difference is relatively small. The following table compares reported diffusivities (Handbook of Chemistry and Physics, 51st Edition, Robert C. Weast, ed., Chemical Rubber Company, Cleveland, Ohio, 1970) for different concentrations and different ionic compositions. In no case do the diffusivities vary by more than 3.1% from their average values due to concentration differences. Therefore, the use of reported diffusivities in the electrical conductivity method cannot be the result of the differences reported in this paper, which are close to being different by a factor of 50. (Figure 1 in Tumidajski and Schumacher).

The propan-2-ol method measures a diffusion coefficient for propan-2-ol in the porous solid. Some assumption must be made to use this value to predict diffusivities of any

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	Diffusivity ($m^2/s \times 10^9$)		
	Concentration		
Compound	0.01 M	0.10 M	1.0M
NaCl	1.545	1.483	1.484
KCl	1.917	1.844	1.892
$CaCl_2$	1.188	1.110	1.203

compound in a porous solid. Therefore, the propan-2-ol method will be subject to the same errors of approximation that are applied to the electrical conductivity method. Furthermore, the propan-2-ol method is prone to errors due to the wide range of concentrations of propan-2-ol that occur during the test. At the beginning of the test the mole fraction of propan-2-ol in the pores of the solid is zero, and at the end of the test the mole fraction is 1.0. At the early times, transport will be that of propan-2-ol through water. At later times, it will be the transport of water through propan-2-ol. If the diffusivity varies with concentration, the largest errors possible would be expected due to the widest possible differences in concentration. Because water must leave the pores as propan-2-ol comes in, the measured diffusion coefficient is actually a combination of diffusion coefficient for propan-2-ol in water and water in propan-2-ol. Another potential problem with the propan-2-ol method is that it uses very thin sections (1.14 mm in Tumidajski and Schumacher) that can be easily cracked. A cracked specimen would give overly high estimates for diffusivity. The reported values of propan-2-ol diffusivity in Tumidajski and Schumacher are much larger than those found by the electrical conductivity method, so cracks could be the reason for the differences.

In summary, this paper does not meet its stated goal of evaluating the accuracy of the electrical conductivity method. It provides evidence that the propan-2-ol method gives different estimates for the diffusivity than the electrical conductivity method, without providing any data that could be used to determine which is more accurate. Furthermore, there are sound reasons to believe that he propan-2-ol method is more likely to be in error.