

Summary and Conclusion

The DMT-HFO method of Freese *et al.* (1995) is an effective method to study the phosphate desorption kinetics of soils and does not have the drawbacks of other methods. If the diffusive resistance through the dialysis membrane is brought in consideration, it seems that the method of Freese *et al.*, (1995) will be more effective in investigating the phosphate release kinetics of soils with slow phosphate desorption rates (like most South African soils) than soils with relative high desorption rates, like the Belgium and German soils which Freese *et al.*, (1995) and Lookman *et al.*, (1995) tested it on. However, the method of Freese *et al.*, (1995) has however two drawbacks:

1. Some of the silt and clay fraction of the soil tend to accumulate on the plastic clips (from Medicell International Ltd) used by Freese *et al.*, (1995) and Lookman *et al.*, (1995) and has to be removed meticulously if the soil is used in conjunction with a phosphate fractionation method.
2. Because of the continuous shaking of the samples on the shaker, friction develops between the dialysis membrane and the soil when there is direct contact. This continuous friction weakens the dialysis membrane at this point of direct contact, and sometimes causing it to rupture, especially in the case of sandy soils.

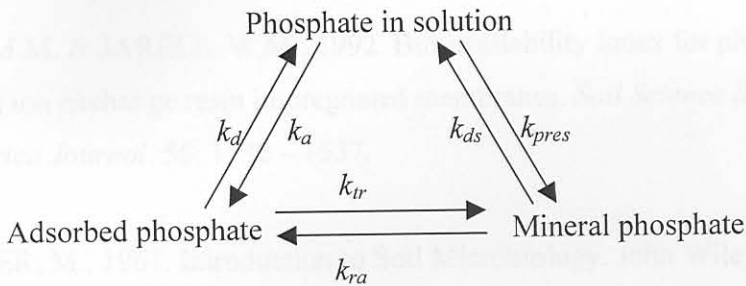
This study supports findings by Armstrong & Helyar, (1992) and Ball-Coelho *et al.*, (1993), who found that the participation of the presumably “less soluble fraction” OH-Pi fractions previously been underestimated. The fact that the correlation between the weekly decrease in the OH-Pi fraction and the phosphate desorbed was higher than the correlation between the HCO₃-Pi fraction and phosphate desorbed. The fact that most of the phosphate desorbed came from the OH-Pi fraction, indicated that the OH-Pi fraction was more actively involved in the desorption process. The weekly change in the OH-Pi + HCO₃-Pi fraction showed the best correlation with the weekly phosphate desorbed. The reason for this is that the OH-Pi fraction and the HCO₃-Pi fraction represent a continuum of easily extractable phosphate associated ferric and aluminium oxy hydroxides and ferric

and aluminium phosphate to less extractable phosphate associated ferric and aluminium oxy hydroxides and ferric and aluminium phosphate rather than two separate phosphate pools (Tiessen & Moir, (1993).

No desorption maximum was reached, in this study on a soil with a relatively low phosphate status and high phosphate sorption capacity. The desorption kinetics of the soil were describe relatively well ($R^2 = 0.9730$ for the control and $R^2 = 0.9528$ and $R^2 = 0.9870$ for R75 and R150 respectively) with the two component first order model. The more exchangeable pool A of the different treatments were depleted within the 56 day period, extrapolation of the data showed that in the long term, desorption kinetics is controlled by less exchangeable pool B. The extrapolation of the data showed that the 56-day desorption period represented only a small window on the long term desorption kinetics of studied soil, if the rate constants of the respective phosphate pools stay constant it will take ± 800 days before the cumulative desorption curve will reach a plato. Using the two component first order model, the total exchangeable phosphate was calculated at 16.36 mg kg^{-1} , 23.62 mg kg^{-1} and 34.28 mg kg^{-1} for R, R75 and R150 respectively with two component first order model and the data obtained in this 56 day period. The calculated total exchangeable phosphate of R, R75 and R150 were $\pm 54\%$ of the day 1 values of the OH-Pi fractions and roughly half of the day 1 values of the $\text{HCO}_3\text{-Pi} + \text{OH-Pi}$ fractions. If the HFO-DMT simulates phosphate uptake by plants then the calculated total exchangeable phosphate represents the long-term plant available phosphate. For this particular soil it seems that roughly half the phosphate extracted with NaOH (24 hours) gives an estimate of the long-term plant availability of applied phosphate. However, the method of Freese *et al*, (1995) must still be extensively tested on different types of soil and crops to correlated it with plant uptake and desorption studies longer than 56 days also have to be conducted to verify the extrapolated desorption kinetics.

The phosphate desorption kinetics of a soil is also influenced by the experimental condition, and the rate constants obtained are therefore conditional rate constants. To obtain rate constants that are true for all conditions the influences of pH changes and ionic strength changes and temperature changes have to be quantified.

The inorganic phosphate dynamics in the soil can alternatively to **equation 1.1** be illustrated as follows:



Where k_a = rate constant of adsorption.

k_d = rate constant of desorption.

k_{ds} = rate constant of dissolution.

k_{pres} = rate constant of precipitation.

k_{tr} = rate constant of transformation of adsorbed phosphate to mineral phosphate.

k_{ra} = rate constant of re-adsorption of dissolved mineral phosphate.

Figure 3.15. An alternative representation of the inorganic phosphate dynamic in soils

The main difference between **equation 1.1** and **Figure 3.15** is that in **Figure 3.15** all the solid phases equilibrate directly with phosphate in solution; there is not an equilibration with an intermediate labile phosphate pool first, as in the case of **equation 1.1**.