termine the conditions appropriate for the necessary uptake of nutrients by plants. Various factors such as soil bulk density, soil moisture content, pH and $CaCO_3$ content have been found to affect the diffusion of metallic ions in soils[1-4].

Rowell *et al*[5] studied self-diffusion of sodium in soil and found an increase in the diffusion coefficient of ^{22}Na with an increase in moisture content. Recently Staunton and Nye[6] reported that the ^{22}Na diffusion was independent of moisture content and bulk density. The present study was conducted to test the effect of soil bulk density and moisture content on ^{22}Na self-diffusion in silt loam soil of pH 8.5.

The diffusion coefficient (D) was measured by the method of Rowell *et al*[5] using the following equation of Schofield and Graham-Bryce[7] for the analysis:

$$Q_t/Q_\infty = \tfrac{1}{2}L(D.t/\pi)^{1/2}$$

where Q_t is the amount of ions which had diffused from active to non-active soil of the two half cells Q_∞ is one half of the total ^{22}Na in soil system, L is the length of cell in cm and t is the diffusion time (sec).

The results presented in table 1 indicate significant relationship between soil bulk density and moisture content. At 10% moisture level, as the bulk density increased from 1.25 to 1.6 g/cm^3, due to compaction the pores were probably filled giving continuous liquid phase by bringing water films into close contact. On further increasing bulk density to 1.75 g/cm^3 the soil particles were pushed much closer together. Hence the diffusing ions were forced to move around the particles which increased the tortuousness of diffusion path, resulting in the decrease in diffusion coefficient at 1.75 g/cm^3. The ^{22}Na ion-soil particle interaction was minimum at soil bulk density of 1.6 g/cm^3.

Further, the value of ^{22}Na self-diffusion coefficient increased with increase in the moisture from 10% to 20% (table 1). When moisture increases, the thickness of water films around soil particles increases reducing the chemical interaction of ^{22}Na ions with soil particles. Due to higher moisture content, the continuity of liquid phase increases resulting in increased diffusion coefficient.

Table 1 *^{22}Na self-diffusion coefficients.*

Effect of bulk density at 10% moisture		Effect of moisture content at 1.75 g/cm^3 soil bulk density	
Soil bulk density (g/cm^3)	D × 10^7(cm^2/sec)	Moisture content (W/w)	D × 10^7(cm^2/sec)
1.25	3.4 ± 0.3	10%	17.8 ± 1.2
1.45	12.1 ± 0.9	15%	26.2 ± 1.9
1.60	19.7 ± 1.3	20%	38.1 ± 2.8
1.75	17.8 ± 1.2		

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CATALYTIC DECOMPOSITION OF N_2O ON La_2MnMO_6 (M = Ni, Cu and Zn)

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THE structure of a double perovskite allows stabilization of transition metal ions in their unusual oxidation states[1]. This has stimulated considerable interest in identifying oxide systems crystallising in this structure to understand the relation between solid state properties and catalytic behaviour[2]. The activity of La_2MnNiO_6 in the catalytic decomposition of 2-propanol has been reported earlier[3]. The catalytic activity of the compounds La_2MnMO_6 (M = Ni, Cu and Zn) towards the decomposition of N_2O is briefly discussed in this note.

The compounds have been synthesized by the solid state reaction between the component oxalate mixtures, by heating them in appropriate proportions in a Pt crucible, in air, at 960°C for 28 hr, with intermittent grindings. The compounds have been characterized by x-ray analysis, conductivity measurements using a two

probe cell and magnetic measurements on a Guoy balance[4]. The decomposition has been carried-out on an all-glass static reactor provided with a recirculation assembly. The temperature range employed is 350–480 C at initial pressures of 50 and 200 Torr of N_2O. The kinetic parameters have been evaluated using the corresponding no/strong inhibition rate equations, as shown below respectively.

$$-dP_{N_2O}/dt = k_1 P_{N_2O} \qquad (1-NI)$$

$$-dP_{N_2O}/dt = k_2 P_{N_2O}/(P_{O_2})^{1/2} \qquad (2-SI)$$

The results are reported in table 1 along with the solid state properties.

N_2O adsorption [corresponding to (1)] is found to be rate limiting on La_2MnNiO_6 at both the pressures whereas on La_2MnZnO_6, oxygen desorption[4] is the slowest step. The compound La_2MnCuO_6 exhibited strong and no inhibition by oxygen at 200 and 50 Torr respectively, portraying the effect of pressure on the rate limiting step.

High magnetic moment on the catalyst (as in La_2MnNiO_6) facilitates the decoupling of the spins of the O^- ion in the oxygen desorption step[5], whereas the increases in E_a for conduction and lattice parameters along a series (table 1) decelerate the diffusion of O^- ions on the surface. Based on these grounds, the applicability of different rate equations on these catalysts could be well understood.

Table 1 *Physicochemical Properties of* La_2MnMO_6

Property	Catalyst		
	La_2MnNiO_6	La_2MnCuO_6	La_2MnZnO_6
Symmetry	Cubic	Cubic	Cubic
Cell Parameter, a (Å)	7.76	7.80	7.81
E_a for conduction (eV)	0.26	0.30	High resistivity
μeff (BM)	2.813	2.047	1.391
Sign of Seebeck Potential	+ve	+ve	−ve
Binding Energies (kcal/mole)	59.34	55.98	55.90
Rate Equation obeyed at 50 Torr	NI	NI	SI
Rate Equation obeyed at 200 Torr	NI	SI	SI
E_a for reaction at 50 Torr (kcal/mole)	16.3	4.2	5.3
E_a for reaction at 200 Torr (kcal/mole)	14.3	13.9	3.7
lnA for reaction at 50 Torr	4.6	−3.0	5.3
lnA for reaction at 200 Torr	2.6	4 2	3.7

At 50 Torr, the order of activities based on percentage conversions (table 1), for the three catalysts, in the temperature range 350–450°C, is

$$La_2MnZnO_6 >> La_2MnCuO_6 > La_2MnNiO_6$$

In nitrous oxide decomposition reaction, *n*-type oxides are generally much less reactive than *P*-type oxides[6]. But in the present investigation, La_2MnZnO_6, eventhough it is an *n*-type oxide, exhibited highest percentage conversions at all temperatures. This may partly be due to the highly isolated Mn^{3+} ions present in the inert oxide matrix[7], which are the result of slight non-stoichiometry of the compound.

When the present series of compounds is compared with the series La_2TiMO_6 (M = Ni, Cu and Zn) for N_2O decomposition at 200 Torr[8] (table 2), the very low E_a for reaction and lnA values suggest a larger multipoint-mode of adsorption[9] on the series La_2MnMO_6. One can visualize different types of clusters on mixed oxides of the type discussed here. Clusters of the type Mn-O-M are probably the active sites in the series La_2MnMO_6, owing to the availability of d electrons on the Mn ion. The lower lattice parameters for the Mn-substituted series also favour multipoint-adsorption. The lower M-O binding energies in the series La_2MnMO_6 as compared to La_2TiMO_6 may reduce the E_a for reaction to certain extent.

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Table 2 *Results of* N_2O *decomposition at* 200 *Torr on* La_2TiMO_6

Compound	Rate Eqn. obeyed	E_a (kcal/mole)	lnA	Binding Energy (kcal/mole)
La_2TiNiO_6	SI	3.6	−3.0	71.21
La_2TiCuO_6	SI	21.5	10.1	67.89
La_2TiZnO_6	SI	40.7	19.0	67.81

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CHEMISTRY OF LICHEN PRODUCTS—PART III: SYNTHESIS OF A NEW BENZOTHIAZOLE DERIVATIVE FROM PULVINIC DILACTONE AND ITS PHYSIOLOGICAL ACTIVITY EVALUATION

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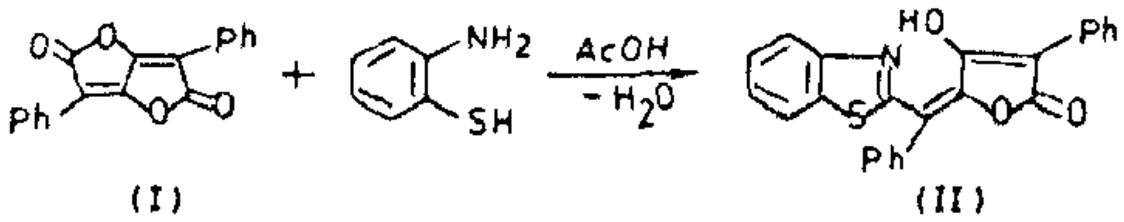
PULVINIC dilactone[1], a lichen metabolite, possesses the tetronic acid ring system which is the essential feature of some biologically active natural products *viz* vitamin C and the cardenolide, digitoxigenin. Antibiotic activity of variabilin, strobilinin and tetrenolin which contain 4-ylidene tetronic acid system is well known. 2-substituted benzothiazoles are shown to be active against dermotophytes, protozoans, gram-positive bacteria and even against the bacterial strains which are resistant to penicillin and viruses[2]. Fungicidal activity of 2-amino derivatives is also well known[3]. With a view to synthesize new derivatives using lichen metabolites and to screen them for their antimicrobial activity, the present investigation was taken up. Pulvinic anhydride, which was prepared synthetically according to the procedure by Volhard[4], was condensed with *o*-aminothiophenol in acid medium to yield the compound (II) (scheme 1). An excess of *o*-amino thiophenol did not alter the reaction from being equimolar suggesting the stability of the second lactone ring in the compound (I).



(I) (II)

Scheme-I

The IR spectrum of the compound showed no absorptions either due to -SH group near 2850 cm^{-1} or amide carbonyl around 1620–1650 cm^{-1} region. It displayed a weak but broad absorption at 3400 cm^{-1} assignable to an enolic hydroxyl, a strong peak for lactonic carbonyl function at 1750 cm^{-1} and a peak at 1580 cm^{-1} due to C=N-stretching.

The PMR spectrum showed only two signals, one a cluster of complex multiplets in the region 7.4–8.5 ppm(14H) due to aromatic protons and a neat singlet at 13.6 ppm for enolic hydroxyl proton which was D_2O exchangeable.

High resolution mass spectrum of the compound confirmed the proposed structure. While the M^+ ion at m/z 397 corresponding to a formula $C_{24}H_{15}O_3NS$ was the second most intense peak, a signal at m/z 252 appeared to be the base peak. This M-145 fragment was formed by eliminating a neutral moiety which was characteristic of the compounds containing 4-ylidene tetronic acid skeleton. The other prominent peaks with sizeable intensity were at m/z 224 and 223 the first of which was formed from m/z 252 ion due to the loss of CO and the latter losing a hydrogen from the daughter ion. Other spectral fragmentations with their elemental analyses supported by the spectrum are shown in chart I.

Antibacterial Activity:

Antibacterial activity was studied *in vitro* using the cup plate method[5]. The bacteria employed were *Bacillus Polymixa*, *Bacillus pumilus* and *Streptococcus albus* (all gram positive) and *Proteus vulgaris*, *Pseudomonas ovalis* and *Acetobacter aerogenes* (all gram-negative). While the compound showed no activity against gram-positive bacteria it was moderately active against the gram-negative ones.

Antifungal activity:

The fungicidal activity[6] of the compound (II) was assayed against two phytopathogenic fungi *viz*. *Drechslera rostrata* and *Alternaria alternata* by spore germination method in acetone. The compound exhibited strong fungicidal activity against both the organisms inhibiting the growth completely at 200 μg/ml concentration. The log Ed_{50} values for *D. rostrata* and *A. alternata* were 2.2 and 2.08 respectively.

Melting point determined in an open capillary was uncorrected. Homogeneity of the compound was checked by TLC on plate coated (0.25 mm) with