J. Pharm. Pharmac., 1976, **28**, 710

COMMUNICATIONS

Augmented solute migration in the drying of fixed beds by infrared radiation

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When infrared radiation is used to dry a fixed bed composed of kaolin granules wet massed with salt solution, solute migration can deplete the bottom layer of granules so that it contains barely one quarter of the initial salt content. This depletion is much greater than that occurring when a similar bed is dried by convection (Travers, 1975).

King & Newitt (1955) reported that the cooler interior of wet glass beads increased in moisture content during conduction drying. In this case the evolved vapour had to pass through a cooler region to atmosphere. In infrared drying of beds, where the top layers dry quickly, vapour can escape via this hot region without condensation. It is possible however, that some vapour could diffuse backwards into cooler regions. Thus Kuzmak & Sereda (1957) in some work on soil moisture movement, demonstrated that vapour flow leading to moisture transfer, occurred between two saturated solids separated by an air gap. Temperature differences within thermal insulation can result in water logging if vapour condenses in the cooler regions and it is normal practice to seal the surface against this diffusion (Levy, 1963). This communication presents evidence that vapour diffusion and condensation can account for augmented solute migration during infrared drying. Experimental details, where not stated, are as given by Travers (1975).

Heavy kaolin B.P. was wet massed with a 10% w/w solution of sodium chloride and granulated through a 2800 μm sieve. Granules retained on a 1680 μm sieve were used. The bed consisting of approximately 35 g of wet granules rested on the pan of an Oertling balance and was heated from above by a low voltage 200 W input which heated two elements to cherry red. After partial drying to a set weight the layers were separated, dried to constant weight and analysed for salt content. Separate experiments were made with a copper constantin thermocouple with its hot junction inserted between adjacent segments of the bed and positioned at various depths below the surface (Table 2).

The moisture and salt contents of the layers are given in Table 1. As drying proceeded, the bottom layer lost an appreciable amount of salt but the moisture content was still close to the initial content. If moisture movement is due to capillarity (Cealgske & Hougen, 1937), then salt depletion should be roughly proportional to the degree of moisture movement. The results also suggest that the absorbed radiation quickly dries the top three layers, establishing a zone of drying around the level of the fourth layer. Vapour then has to travel through the dry zone to the atmosphere and the resistance to its flow would establish a high partial pressure of water vapour at the drying zone. Back diffusion of some of this vapour to the base of the bed yields further

Table 1. *Salt and moisture content of the bed layers.*

	A		B		C		D	
Depth (mm)*	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1·65	0·007	28·0	0·003	27·2	0·004	28·0	0·002	27·0
4·95	0·013	29·3	0·008	28·3	0·004	28·7	0·002	27·3
8·25	0·137	24·2	0·006	29·6	0·003	31·3	0·008	29·4
11·55	0·218	23·2	0·013	32·8	0·019	35·3	0·025	35·2
14·85	0·247	25·8	0·124	27·0	0·137	25·3	0·071	22·1
18·15	0·277	23·4	0·244	14·1	0·222	15·4	0·143	13·1

* Mean depth below bed surface.
Moisture content (1) g g^{-1} dry solid and salt content (2) mg g^{-1} dry solid.
Four determinations A, B, C and D dried to different final moisture concentrations.
Calculated mean solute content 26·0 mg g^{-1} dry solid.
Calculated initial moisture content 0·244 g g^{-1} dry solid.

Table 2. *Variation of temperature (°C) with time at stated bed depth.*

Depth (mm)*	Time of heating (min) 5	10	15	20	40	80	120
3·1	47	55	60	65	87	98	123
9·3	36	44	52	56	74	90	98
15·5	23	28	33	38	46	45	46

* Depth below bed surface.

moisture which on condensation is then available for more solute migration. This circulatory movement should increase with an increase in temperature gradient. This was confirmed by prolonged drying with the base of the bed resting on ice. After 4 h the bottom layer, though still moist, contained a negligible salt content.

Table 2 illustrates that pronounced temperature differences existed within the bed which would be sufficient to cause back diffusion.

Rates of drying obtained from weight loss measurements were also consistent with recirculation. Beds dried by convection in air normally show a constant rate period of drying (Cealgske & Hougen, 1937) which was absent in the present work. Instead there was an initial period when the rate was falling rapidly which corresponded to the rapid drying of the top layers. This was followed by a period at a slowly falling rate when moisture could be moving to the drying plane and recirculating as postulated. Finally, another steep fall in rate was recorded as the plane of drying receded deeper into the bed.

Drying by radiation in a vacuum might bias the vapour pressure gradient towards the surface and would therefore prevent this circulation. Travers (1975) showed that granules suspended in a vacuum oven showed very litle intergranular solute migration on drying and this may be partly due to the absence of recirculation.

March 11, 1976

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Meso-dimercaptosuccinic acid a chelating agent for the treatment of mercury and lead poisoning

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It is known that meso-dimercapto succinic acid (DMS), a water soluble vicinal dithiol, reduces the mercury concentration in organs of mice and guinea-pigs (Friedheim & Corvi, 1975) and rats (Magos, 1976) exposed to mercury dichloride and methylmercuribromide. We now report experimental findings concerning the effect of DMS on repeated exposures to methylmercuribromide in guinea-pigs and to lead acetate in mice.

General procedures. Groups of 5 mice or 2 guinea-pigs were injected intramuscularly with aqueous solutions of salts of the metals and then intraperitoneally with solutions of DMS or D-penicillamine or EDTA, in schedules differing in size, number and spacing of metal compounds and chelating agents, and the interval between metal doses and treatment, and treatment and autopsy. The same organs of each group were pooled, homogenized and dried to constant weight at 110°. Bone was represented by the skull caps. Blood was obtained by heart puncture. Mercury and lead were determined in aliquots of the homogenates by flameless atomic absorbtion. The results are reported as means of 3–5 analyses in Tables 1 and 2. Individual analysis varied ±3·2% for mercury and 5·4% for lead.

Mercury. The effects of seven doses of DMS, or penicillamine, alternating with seven doses of methylmercuribromide, on the build-up of mercury concentrations in liver, kidneys, brain and blood in guinea-pigs, are reported in Table 1.

DMS or penicillamine, applied alternately with repeated doses of methylmercuribromide, reduced the build-up of mercury concentrations in liver, kidneys and blood, DMS significantly more so than pencillamine. In brain the mercury concentration was reduced to half by DMS, but was increased above the control value by penicillamine.

Lead. The effects of several dose levels of DMS or penicillamine or EDTA on lead concentrations in liver, kidneys, brain, spleen, blood and bone in 9 groups of 5 mice pretreated with lead acetate, are reported in Table 2.

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