

It is estimated that one thousand population discharges 156 pounds of solids and 260 gallons of urine each day. It appears to me to be a wilful waste to have all that valuable manure converted into hydrogen, and blown away for every plant to share in it, when by spreading it on our land it would enrich the land and increase the crops.

Sewage that is allowed to stand and ferment as it is in the sewage irrigation works at Berlin, Ont., and which contains about the usual amount of organic matter per gallon, will give out  $1\frac{1}{2}$  cubic inches foul gas per hour per gallon. This shows that irrigation works where the land is allowed to get waterlogged, as the land does in Berlin, is a menace to the health of the country.

The average composition of the sewage in the small towns of Ontario is about as follows, viz. :

Organic matter.....	27.72	grains to each gallon.
Nitrogen .....	6.21	" "
Phosphoric acid .....	1.57	" "
Potash, about .....	2.03	" "

When some of this weak sewage is placed under a powerful microscope it is shown to contain various dead and decaying matters, also multitudes of bacteria, but few of the higher class of microbes; neither does the heavier sewage, and when a new bacteria filter is started it must be supplied with a sufficient number of colonies of the sewage destroying kinds. So in the first place it must be filled by an effluent running from another filter and allowed to stand for a time until the bacteria can sufficiently increase.

#### ROLLER BEARINGS.\*

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The application of rolling motion to bearings has been rendered practical within the last year or two. The author referred to (a) the advantages which might reasonably be expected to accrue from the use of roller bearings, (b) the requirements of satisfactory bearings constructed on this principle, and (c) some of the results which have lately been obtained from the adaptation of such bearings to rolling stock and other purposes.

(a) *As to the advantages arising from the use of roller bearings.*—It is an interesting fact that although full knowledge has existed from the earliest days of the advantages of rolling motion when applied to tractive purposes, as shown by the use of wheels or rollers, for reducing the effort required to transport heavy loads, it is only within comparatively recent times that serious attempts have been made to substitute such motion for the ordinary rubbing or scrubbing friction between the axles or journals of such wheels or rollers and their bearings. If by the introduction of rolling motion between the journals and bearings of the rolling stock or between the wheels and axles of the road vehicles, as the case may be, a further and very considerable reduction in the effort required to move any given load can be obtained, and this at a comparatively small additional monetary expenditure, far out-balanced by the consequent economy, it would seem that such application must become general. The following are, amongst others, the principal advantages claimed for roller bearings: Great reduction in starting effort; decreased tractive effort; decreased revolving effort; economy in lubrication.

The reduction in the effort required to start vehicles or shafts fitted with roller bearings, as compared with those fitted with ordinary bearings, is of such importance that it were the only advantage it would warrant the neces-

sary additional monetary expenditure. Although it is not claimed that the reduction in tractive force will be so large in proportion to that in starting effort, it must be remembered that this force is in application during the whole of the time a vehicle is running on level ground or ascending gradients; this point, therefore, becomes of great importance when the total amount of work done is calculated.

The decreased revolving effort is of great economical value in all cases of heavily loaded shafting, as careful experiments have shown that the amount of power required to drive the main and counter shafts in workshops, all the tools being idle, amounts to as much as from 50 to 80 per cent. of the power required when all the tools are in full work; these figures show that there is ample room for improvement in shafting bearings. The economy in lubrication is a considerable item, seeing that a perfectly constructed roller bearing does not require any lubrication but only sufficient oil need be applied to prevent the rusting of the various parts.

The various parts must be proportioned with reference to their relative movements, so that nothing but rolling motion takes place between the surfaces engaged. The bearing rollers must be kept parallel with the axis of the axle or journal upon which they run, that they must not be allowed to touch each other, and that they must be of sufficient diameter and length to bear the fatigue of the duty they have to perform. Adequate provision must be made to meet the end thrust, not only of the rollers, but also of the axle or shaft when revolving within a fixed bearing, or of the bearing itself, when revolving upon a fixed axle. The bearing must contain as few working parts, and these as simple as possible. The most important from a commercial point of view is that the bearings shall be produced at reasonable cost.

For many years the only successful application of rolling motion to bearings was the well-known "ball-bearing" so universally adopted for cycles, and although these bearings have been found most satisfactory when subjected to light loads, all attempts to apply them to heavy ones have, so far as the author knows, resulted in failure, these failures arising chiefly from the balls indenting the paths or races upon which they run. Directly this takes place the balls begin to lose their friction-reducing properties. If a semi-circular trough be constructed which accurately fits a ball, and after the ball is placed therein, one end of the trough is lifted until movement of ball takes place, it will be found that the ball moves by sliding and not by rolling; this is indentation carried to its extreme limit. Another defect in the ball bearing is that the balls are allowed to touch each other, and as the touching points of any two balls are revolving in opposite directions, there must be a certain amount of scrubbing friction.

Improvements which have been made recently in the use of roller bearings are making their employment in general traction more common, and are seen on a number of English railways, on some of which the tests were made, from which the following data were compiled:

A passenger train of six carriages, fitted with roller bearings throughout, has been running for two years between Brighton and Kemp Town, with a total mileage of over 70,000, and has shown a saving of from  $12\frac{1}{2}$  to 15 per cent. in the consumption of fuel, which saving has been obtained under most disadvantageous circumstances, inasmuch as the engine has to be kept in steam for about 16 hours per diem, whilst its actual running time is under seven hours.

A tramway car fitted with ordinary bearings and

\* Abstract of a paper read before the Toronto meeting of the British Association for the Advancement of Science.