No. 21/1906

HONGKONG.

REPORT ON REFUSE DESTRUCTORS BY MR. T. L. PERKINS.

Laid before the Legislative Council by Command of His Excellency the Governor.

HONGKONG, 15*th March*, 1906.

In accordance with your instructions I beg herewith to forward plans* showing proposed Reclamation of land at Kennedy Town together with the designs for a Destructor to be placed on the site when reclaimed.

As regards the reclamation, it is intended that only the area required for the Destructor site and the road bordering it should be reclaimed in the first instance and this is all that the appended Estimate provides for. The completion of the Reclamation Scheme could be undertaken at a later date, the remaining area being gradually filled in with the residue clinker produced by the Destructor.

His Excellency has stated that provision should be made for dealing with 100 tons of refuse per day and the Destructor has been designed accordingly. Sufficient room has however been provided in the proposed building to enable two more cells to be added.

It is necessary, before commencing to design any scheme, to assume that some particular type of cell will be used, as the differences in the various types of Destructors are in many cases such as to necessitate an entirely different arrangement in planning. I append a Table* containing particulars of the various types in use in several large towns and, after considering it carefully, have adopted the Horsfall Destructor in the design submitted. The following are some remarks upon the various kinds of Destructors in use.

It will be seen from the Table that the Fryer Cell, manufactured by Messrs. MANLOVE & ALLIOTT of Nottingham, is apparently the most popular. This is however accounted for by the fact that the Fryer Cell was on the market for some years before any other cell of repute was brought out, having been first erected at Manchester in 1876. A modification of this cell has been recently erected at Shoreditch where it is worked in connection with the Electric Light Station and this has received more attention, been more praised and more criticised than any Destructor yet erected. Its success, which is undoubted, has not however been due so much to the cell as to the installation of Halpen's Thermal Storage System, which consists of a cylinder so constructed and insulated with non-conducting materials and closely packed reservoirs that the loss by radiation is reduced to a minimum. In this cylinder heat is stored up during the day and utilized during hours of heavy load at night. I have had 7 years' personal experience in the working of the Fryer Cells. After completion and trial for some time they had to be altered by applying forced draught to the furnaces, which resulted in increasing their capacity by 2 tons per cell per day.

In the case of refuse which will burn readily the Fryer Cell has its advantages—the first cost is not so heavy as for some others, it does not get easily out of order and it lends itself to an economical design of Building. It will be seen from the Table however that in several instances the Horsfall Cell has been substituted for this make.

Another of the cells claiming attention is the Meldrum, manufactured by MELDRUM BROS. It is claimed for this cell that it destroys a very large amount of refuse per day. It is undoubtedly a very good one, but its records, so far as I am aware, are principally in connection with other works such as Sewage, Pumping and Electric Light works, where the question of high steaming power has been the first consideration and the refuse has been rich in calorific value. At Hereford, for instance, where one of these was installed in connection with the Sewage works, the calorific value of the refuse was equal to evaporating 1.34 lbs. of water per 1 lb. of refuse.

* Not printed.

The Beaman & Deas Destructor has also recently come into prominence from the large amount of refuse destroyed per cell. The same remarks however apply to this as to the Meldrum above referred to, it being nearly always used for high steaming. In both these cases auxiliary coal firing takes place at the same time as the refuse is being destroyed, and it is well known amongst Municipal Engineers that the results achieved by cells under such circumstances have to be received with a considerable amount of caution.

Next to the Fryer, the Horsfall Cell appears to be in most general use. It has been introduced much more recently than the Fryer and is similar to the latter in that it allows of an economical design of Building, and also like this cell its primary object is to destroy the refuse, steaming being an after consideration. It has not therefore been used to any great extent in connection with Electric Light or Power Stations, although a considerable amount of power is utilized in nearly every case where it has been installed.

At the Powderhall Destructor Works, Edinburgh, it was proved in an action that noxious gases and dust from the existing cells (the Fryer) were emitted in such quantities as to cause a considerable nuisance and upon expert advice the Horsfall Co. were called in to substitute the Horsfall for the Fryer Cells, the ground for complaint being subsequently proved to have been removed by this alteration.

At Bradford, Huddersfield and Blackpool also the Fryer Cells were replaced by the Horsfall, some of the largest installations of the latter being at Bradford, Brussels, Edinburgh, Hamburg, (the largest Destructor in the world consisting of 36 cells), Hull, Leeds, Sheffield, and Fulham.

The Warner "Perfectus" Destructor, made by Messrs. GODDARD, MASSEY & WARNER of Nottingham, is somewhat similar to the Fryer in general arrangement. It has achieved a fair success but has not been adopted to the same extent as others previously mentioned. It is now in use at Hornsey, Sheffield, Bournemouth, Madras, Sydney and several smaller places.

The Heenan & Froude Twin Cell has also been adopted to some extent, over 100 cells of this type having been erected within the past few years. The makers claim an average of over 10 tons per cell destroyed per day. It is to be found in use at Gloucester, Barrow-in-Furness, Northampton, Wakefield, &c.

In addition to the cells above referred to there are numerous others on the market that have been adopted to some slight extent; such as the Willoughby, the Mason, the Stirling, the Garlick and Christenson in India, and there are still other makes in use in America.

Speaking generally there is a great sameness in the results when examined in detail, and each type appears to have accomplished at one place or another quite as successful results as its competitor somewhere else.

As a matter of fact town refuse varies to a great extent not only between one town and another but between different districts and between different days in the same town. In a case which came under my personal observation the refuse from two districts of a city could not be burnt by itself. It had to be either mixed with fuel or with the refuse from other districts which was of a much higher calorific value.

It is important however that a Destructor should be first designed to destroy refuse and to do this thoroughly; in fact to ensure that no unburnt refuse should escape among the clinker and no dust should leave the chimney top or cake around it.

Adopting this view, the cells for high steaming power, such as the Meldrum and the Beaman & Deas, may be discarded but it might be considered desirable to invite tenders from the following makers of cells, in addition to the Horsfall Co., under certain conditions and modifications: the Fryer (MANLOVE & ALLIOTT), the Warner Perfectus (GODDARD, MASSEY & WARNER), and the Heenan Twin Cell (Messrs. HEENAN & FROUDE).

The Horsfall type has achieved uniformly good average results and is a thoroughly up-to-date cell, its design being an exceedingly good one. It is claimed that the use of steam jets to produce forced draught has an advantage over simple forced draught in that it produces water gas in passing through the incandescent fuel which materially aids combustion. This is however doubtful in the case of refuse which already contains a considerable amount of moisture to be driven off before burning, as it can hardly be improved by injecting air saturated with moisture. I would therefore suggest that whatever type of cell may be

adopted, it should be made a condition that *the forced draught should be supplied from a fan*, and that the fan should be of sufficient power to give a pressure of not less than 2″ of water in the ashpit. Fans may be somewhat more expensive to instal but they can be driven with 5 % of the steam raised from refuse, whilst a steam jet will probably absorb 4 times this amount.

As already mentioned, the Horsfall Cell has been adopted in the design herewith submitted. 12 cells have been provided to deal with 100 tons per day which will allow for an average of slightly over 8 tons per cell per day. This is less than the average quantity destroyed by these cells at home, but I have thought it advisable to assume a low average. I find, since commencing this report, that Singapore, after erecting the Garlick & Christenson Cell now considers the Horsfall Destructor better adapted for the incineration of refuse of the kind collected in Singapore.

The Singapore cells required about 1 ton of firewood to every 140 tons of refuse destroyed and there is no doubt that the refuse to be dealt with here will require some fuel to assist its combustion; probably more than was used in Singapore. It is possible that the small quantity of fuel used there accounts for the poor result obtained. I would suggest 2 % of coal as the probable quantity required but, whatever the amount may be, the temperature must be raised to something over 1200° F. before the whole of the noxious gases can be cremated.

In the earlier use of the Fryer Destructor, when a temperature of only about 800° F. was obtained, the fumes were further dealt with by passing them over a coal furnace called a Jones Cremator, being first used by Mr. JONES, Borough Engineer of Ealing. This has however now been entirely superseded by the forced draught system which gives extremely high temperatures in the furnaces.

Since it is necessary to obtain this high temperature, the heat produced might profitably be utilized to perform some useful work and provision has therefore been made in the design for 2 Babcock & Wilcox Boilers, and for the necessary Engine and Machinery for lighting the works with Electric Light, hauling the trucks up the approach road, crushing clinker and making concrete slabs, and grinding mortar.

To determine the size of the boilers and the probable horse-power obtainable, it is necessary to examine the results obtained in other places, and these results vary greatly.

For instance at King's Norton near Birmingham the furnaces generated 3 lbs. of steam for each 1 lb. of refuse: this is a very high proportion.

At Bermondsey also a very high average is obtained, the Engineer accounting for it by the wasteful extravagance of the poorer classes who inhabit that district and who throw away partially burnt fuel.

The average of several tests carried out at combined works (Electric and Destructor) was 1.1 lb. of steam per 1 lb. of refuse, but some places show a result as low as .60 lbs. of steam. To be on the safe side will be advisable to assume that the refuse destroyed here will produce .40 lbs. of steam per lb. of refuse and on this assumption the horse-power works out as follows:—

100 tons refuse destroyed per day = 4.2 tons per hour = 9,408 lbs. per hour.

9,408 × .40 = 3,763 lbs. of steam produced per hour.

As 30 lbs. water evaporated per hour at 70 lbs. pressure equals one horse-power;
$\frac{3763}{30} = 125$ h.p.

Babcock & Wilcox boilers will evaporate about 3 lbs. of steam per square foot of heating surface from and at 212° F. therefore $\frac{3763}{3} = 1{,}254$ square feet of heating surface required.

In order however not to work up to the limit of the boiler power I would suggest that two of the B. & W. standard boilers 22′0″ long × 6′10″ wide × 13′0″ high with 1,098 feet of heating surface be utilized and these have been provided for in the scheme.

The buildings are proposed to be of brick with granite dressings, the chimney being carried to a height of 120 feet. This height is not necessary for the purpose of creating a draught but it will probably obviate future complaints of the emission of fumes. Coolie quarters for 300 coolies and Superintendent's house are also provided in the scheme.

The estimate of probable cost is as follows but, owing to the makers' prices of the cells selected not being obtainable it must be accepted only as approximate although I believe it to be fairly accurate :—

ESTIMATE.

		$ c.	$ c.
Reclamation, ...	Reclaiming land for site of Destructor only, 200,400 square feet at 70 cents, say, ...	140,300.00	
	New 50-foot Road, say, ...	20,400.00	160,700.00
Destructor, ...	Buildings, ...$ 42,500.00		
	Piling for do, ... 30,600.00	73,100.00	
	Approach Road, ...	12,000.00	
	Chimney and Dust-catcher and piling for do, ...	9,000.00	
	Corrugated iron boundary fence, ...	4,000.00	98,100.00
Machinery, ...	12 cells and furnaces with fan and engine for forced draught and two B. & W. boilers at $5,900 per cell, ...	70,800.00	
	1 Engine and condenser, ...	3,500.00	
	Steam piping, ...	1,000.00	
	Crushing and slab-making machinery, Weigh-bridge, Tanks, &c., ...	3,700.00	
	Train lines and trucks for Clinkers, ...	2,000.00	
	Dynamo wiring, &c., ...	1,500.00	82,500.00
Coolie Quarters, &c.	Buildings, ...	60,000.00	
	Piling, ...	15,000.00	75,000.00
	Superintendent's Quarters, ...	...	15,000.00
	Total, ...$		431,300.00

The new Road and the Coolie Quarters are hardly part of the scheme so far as the Destructor is concerned and I presume would not be included in the capital cost.

The actual cost of dealing with the refuse per ton estimated on a weekly basis is as follows :—

European Superintendent at £250 per annum .....$	48.00
3 Working gangers, one for each shift at $4	12.00
18 Firemen at $2.50	45.00
3 Labourers at $2	6.00
10 Tons Coal at $11	110.00
Repairs and Renewals	50.00
Interest and sinking fund; say	400.00
	$671.00

Number of tons dealt with per week = 700.
Cost per ton = $\frac{671}{700}$ = .96 cents.

Against this 96 cents there would be a profit made from slabs manufactured, &c., so that it is unlikely that the actual nett cost of dealing with the refuse will be more than 75 cents per ton.

T. L. PERKINS.

The Honourable The Director of Public Works.