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| (1) 150 lbs. per square inch steam pressure. | Because at pressures above 150 lbs. per square inch the volume becomes small and leakage percentages are increased, with only a small gain in B.T.U.'s available. |
| (2) 150 degrees superheat. | Because there is no appreciable gain in plant over all economy above 150 degrees superheat. |
| (3) Highest possible speed | Already commented on. |
| (4) Best vacuum possible. | Because it is the strongest feature in turbine working, and it will pay to maintain as high a vacuum as possible. |

**Condensing Equipment and Vacuum.**

The condensing plant is the most important detail of the plant, and yet how often is it neglected, or, one should say, no: paid sufficient attention to. A vacuum should be selected with an equivalent temperature about 25 degrees above the available temperature of circulating water, and this gives a commercially obtainable and maintainable vacuum. Having once obtained this, see that it is always maintained. If a vacuum of 28½-in. can be obtained, never let it drop to 27½-in., which it will easily do with a little inattention and neglect of glands, joints, sluice, and automatic valves, etc. An inch down in vacuum will mean a 5 per cent. rise in the coal bill. Work this out in expenditure per annum and it will draw its own moral. The writer has found a vacuum recorder kept under lock and key worth considerably more than its weight in gold. The writer is of opinion that the field for improvement in condensing plant is even greater than in turbines.

As regards types of condensing plant in use, this again depends on circumstances. There are three main types:—(1) Surface; (2) low-level jet; (3) barometric.

(1) Surface can be sub-divided as follows:—(a) Ordinary, viz., generally consisting of surface condenser, air pump, and circulating pump. (b) Parson's Augmenter Surface, which is as in (a) with the addition of a steam jet and auxiliary condenser, which allows smaller cooling surface, and less circulating water to be employed. Further, the hot-well temperature is higher than with (a). This is, in the writer's opinion, undoubtedly the best form of surface condensing plant. (c) Counter-current, an arrangement of (a) with compartment drainage. From the point of general works economy, as a rule, the capital cost of surface condensing plant will be rather higher than either jet or barometric condensers.

(2) Jet condensers are made in many highly successful ways, and require, if anything, rather more power than surface plants. Upon account of air entrained with the circulating water, very complete air-extracting apparatus is necessary.

(3) Barometric condensers are a very satisfactory form of plant, provided every precaution is taken to prevent air leakage, and ample passage way given to steam and water. The power taken for pumping is, however, slightly in excess of other types of condensing plant, but from the writer's experience it makes a very satisfactory installation. A great point is the uniformity of the vacuum which can be maintained owing to the absence of cooling surfaces which become dirty and therefore inefficient. In some cases no air pump is installed, but where a high vacuum is essential a really powerful dry air pump is necessary. It is probable that this type of condensing plant has been kept back owing to the fact that when used with reciprocating engines the presence of oil in the exhaust steam put difficulties in the way of using the hot-well water for boiler-feed purposes. With turbines this difficulty has, of course, disappeared, and it is possible that barometric condensing plants will be more heard of in future; they are certainly more easy to maintain at their best than surface condensers.

**Reliability of Turbines as Prime Movers.**

Sunderland experience has shown the Willans-Parsons turbine to be absolutely trustworthy. For over 16 months the bulk of the work has been done by the 2,000-kw. turbine plant of this make, running at 1,500 revolutions per minute, and during the year ending March 31st last, the total units generated in the works were 9,207,227, of which no less than 8,009,000, or 87 per cent. of the whole output, were generated by the one turbine plant.

This turbine has with very few exceptions, been put on load every Sunday at noon, and has run through without any stop until the following Sunday, at about 1 a.m. During the night the load drops, as a rule, to about 400 kw., and the day peaks have been about 2,300 kw.; when this has been exceeded, one or more 700-kw. reciprocating sets have been paralleled. Throughout the day the work has consisted of about three-quarters shipyard and one-quarter tramway load, and it is of a very fluctuating character.

During the whole of this time any sudden mishap to the turbine would have shut the whole system down, because in no case has there been sufficient plant in parallel with the turbine to take the load up temporarily, but in no instance has there been a hitch in any way attributable to the turbine; it runs through week after week with an entire absence of incident. It will be realized that these are severe and exacting conditions, and such dependence upon a single unit calls for the utmost reliability, and after fairly lengthy experience of both high-speed piston valve and slow-speed Corliss valve reciprocating engines, the writer trusts the turbine with equal confidence to either of these alternatives.

**Maintenance of Turbine Plant.**

The writer is of the opinion that maintenance costs on steam turbine plant (consisting of turbine, alternator and condensing plant) complete, should not exceed, say, $500 per annum per 10,000,000 units generated, and if careful record were taken in some of the larger turbine works, and fair maintenance debits were allocated against units generated, it would be found in many cases less than this amount. As a matter of fact, the maintenance of the Sunderland 2,000-kw. plant for the year ending March 31st last, including opening the turbine twice to measure clearances, came to less than $175, and while it is true that the set was under the contractor's maintenance, a detailed and careful check was taken of all that was done to the plant, including the renewal of exciter brushes, etc., and the figure given is a liberal allowance of what it would cost the Corporation to do the same work, although the contractors will have expended more than this, by reason of men's travelling expenses and out-money.

**Exhaust Steam Turbines.**

The advantages of the application of the exhaust-steam turbine do not appear to be fully appreciated, even at the present time. As compared with a high-pressure turbine, an exhaust steam set requires about double the steam, and the gain due to high vacua is more than twice as great. The machine can be of robust construction owing to there being no necessity for fine clearances, and, moreover, the temperature distortions are small. The Impulse type can be of very simple construction for exhaust steam working, but does not, upon the other hand, lend itself so well to economical working as the Reaction type, as it works with higher steam velocities, and if the steam is wet, as is usual, the friction losses due to this cause are high.

Many present-day condensing engine plants, with a good supply of cold water for circulating, could be increased in output by 25 per cent. without any appreciable extra expense, save the capital cost of the exhaust turbine installation; it is, however, the exception to find such plants in electricity works, but their installation seems such an absolutely sound scheme that it is a wonder the development has not been more rapid.

**Economies to be Obtained from Turbines.**

Sunderland experience shows the cost of working with turbine plant to be much lower than with reciprocating engines. The writer has already dealt with maintenance costs, and as regards steam consumption, it has been argued against the steam turbine that it does not maintain its economy, but