

DUTY TRIALS ON PUMPING ENGINES AT JOHN STREET STATION, TORONTO.*

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ALL of the water used by the city of Toronto is pumped through the main pumping station at the foot of John Street. This station is equipped with a number of steam-driven pumps and also a number of electrically driven units, the latter receiving electric current from the general city supply. In so far as the electrically driven units can be operated without raising the city's power peak, they are kept in service, but whenever the electrical operator finds that the peak is being approached, he has one or more electrical pumps stopped and then the delivery pressure of the station may slightly decrease while a steam pump is being brought into service, but, on the whole, these variations in pressure and in supply are not noticeable in the city.

Description of the Units.

Some few years ago it was decided to increase the pumping capacity of the main station, and, with this in view, a new pump room with adjacent boiler room was built. The pump room now contains five pumping units, two of which are driven by induction motors, and three of which have been built by the De Laval Company, and are driven by steam turbines. It is with two of the latter pumps that this report deals.

Each unit consists of a De Laval steam turbine connected through a reduction gear to a pair of centrifugal pumps, which are connected so as to work in series. The units are exact duplicates. The turbines are of standard De Laval construction for steam pressure of 150 pounds and a vacuum of 29 inches, the normal speed being 3,430 revolutions per minute. Each is direct-coupled to a speed reduction gear having a ratio of 33 to 197, so that the pump shaft rotates at normal speed of 575 revolutions per minute.

The steam supply pipe is $4\frac{1}{2}$ inches, with 36-inch exhaust to a standard Wheeler surface condenser, so placed that all the water delivered by the unit passes through it as cooling water before reaching the main pumps.

The vacuum pump is a 20-inch x 40-inch Rotrex pump built by the C. H. Wheeler Company, and is direct connected to a 7-inch x 7-inch engine designed for a normal speed of 200 revolutions per minute, but which ran at a much lower speed during the trials. The exhaust from this engine is delivered back into the steam turbine somewhere near the middle stage, and is made use of in doing work there.

The boiler feed pump is chain-driven from the pump shaft. It is a Goulds single acting triplex plunger pump with plungers $3\frac{1}{2}$ -inch diameter and 6-inch stroke, and in one of the units the crank shaft driving the plungers turns at about 47 revolutions per minute, a speed which is too low to supply the necessary feed to the boiler for this pumping unit; in the other unit the speed is 66 revolutions per minute, which is satisfactory.

There are two single-stage double-suction pumps on each unit, the two pumps being piped together in series. There are no outside guide vanes, but the castings are of the volute form and the pumps run very quietly. The name-plate states that the pump is designed for a total

head of 250 feet, and a discharge of 20,000 U.S. gallons per minute (which is equivalent to 24,000,000 Imp. gallons per 24 hours) at a speed of 575 revolutions per minute.

The water piping begins with a 42-inch suction, which is the size of the inlet to the condenser. At the condenser outlet the diameter is reduced to 36 inches and this is again reduced to 24 inches where it enters the pump. The series piping between the pumps is 30 inches, being reduced to 24 inches at the point of connection with each pump. To the discharge end of the pump a 24-inch x 36-inch tapering enlarger has been attached to connect with the 36-inch discharge main. The inlet and outlet openings on all the pumps are 24-inch diameter. The pump impellers are of bronze.

The Duty Trials.

The duty trials on the machines were run on March 6th and 8th, 1917, respectively, and in order to see that the conditions were uniform before the tests began, the machines were run for at least an hour under full load immediately preceding the duty trial.

The boiler fires were properly cleaned, and everything put in as good condition as possible to insure uniformity, but some slight variations naturally occurred. It was necessary to run the trials during the daytime, owing to the demand for water in the city, and therefore an effort was made to start as near seven o'clock in the morning as possible, although in both cases the trials did not begin till nearly an hour later.

The city's electrical power peak occurred shortly after the trial began in each case, and the electrical pumps were therefore shut down, causing a heavy draught on the pump under test. There was a consequent decrease in pressure, but as the discharge increased at the same time, the load on the steam turbine driving the pump did not vary greatly. Throttling of the pump discharge was temporarily resorted to, in order to prevent undue fluctuations, and another steam pumping unit elsewhere in the station was put into service as quickly as possible, but the extra draught of steam from the boilers caused some slight variations in steam pressure. All of these variations, however, were of short duration and were productive of but slight inconstancy in the general conditions, and the machines were given exceptionally steady loads during their entire trials.

Conditions Governing the Trials.

In the contract dated August 14th, 1914, the conditions governing the conduct of the duty trials are given, and the following clause referring thereto is copied here for reference:—

"59. While the duty specified for the steam turbine driven unit is 120 million foot-pounds, tenders are requested to state any higher duty they are prepared to guarantee, and any higher duty guaranteed, together with the contractor's ability to fulfil same, in the opinion of the commissioner, will form a factor in the awarding of the contract. Should the contractors guarantee a duty in excess of that specified, when using saturated steam containing not more than $1\frac{1}{2}$ per cent. of entrained moisture, the duty guaranteed will be substituted for this amount, and for each one million (1,000,000) foot-pounds in excess of the guarantee the corporation shall pay to the contractor the sum of fifteen hundred dollars (\$1,500), and pro rata for fractional parts, but the total bonus shall not exceed seven thousand five hundred dollars (\$7,500). Should the duty as shown by the official trials be less than the guarantee the commissioner shall deduct from the

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