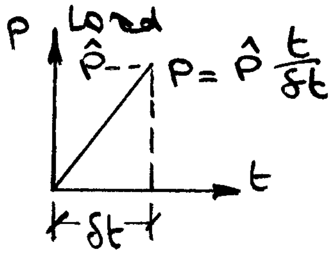
1. The basic equation for equivalent load is

$$P_e^n \Delta t = \int_0^{\Delta t} P^n \, dt$$

where, for a triangular waveform



$$P = (\hat{P}/\delta t) \, . \, t$$

$$\therefore \int_0^{\delta t} P^n \, dt = (\hat{P}/\delta t)^n \int_0^{\delta t} t^n \, dt = \frac{\hat{P}^n}{n+1}\,\delta t$$

Applying this to the given cycle :-

$$P_e^n . 60 = \frac{1}{n+1}\left(7.5^n \times 10 + 1.5^n \times 50\right) \text{ whence}$$

for $n = 2$ $P_e = 1.94$ kW

$n = 5$ $P_e = 3.66$ kW

Note that power has been used here, rather than torque, since essentially at constant speed.

(a) For P_e of 1.94 kW, a 100LA motor is indicated.

Check on peak torque at $n_f = 1430$ rpm

$$\hat{T} = 7.5 \times 10^3 / \tfrac{1430}{60} \times 2\pi = 50.1 \text{ Nm}$$

whereas the breakdown torque of this motor is

$$T_b = 15.0 \times 3.2 = 48.0 \text{ Nm}$$

i.e. motor is unsuitable since $T_b < \hat{T}_{load}$

Trying larger motors, the smallest with $T_b > \hat{T}$ is 100LB, with $T_b = 20.0 \times 3.3 = 66$ Nm.

So select 100LB, though even with this, the peak torque is rather excessive.

(b) For $P_e = 3.66$ kW, try 112M motor ($P_f = 4.0$ kW)

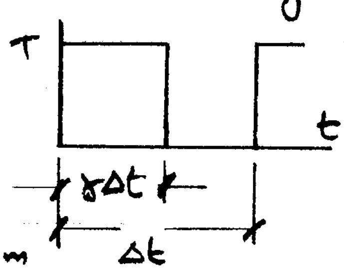
$T_b = 27.0 \times 3.3 = 89.1$ Nm $> \hat{T}$ — OK.

With a cycle time of 1 minute, the number of starts per hour is relevant. However load increases gradually rather than square wave, so ignore here. Also don't know load inertia.

A flywheel might profitably be considered here to reduce the peak torque seen by the motor.

2. There are two aspects to consider - intermittency and frequency of starts.

Let the cyclic duration factor be γ



From the basic equation

$$T_e^n . \Delta t = \int_0^{\Delta t} T \, dt = (T^n \gamma \Delta t + 0)$$

$$T_e = T . \gamma^{1/n}$$

with $n = 5$, $T_e = 25 \times \left(\frac{20}{40}\right)^{1/5} = 21.8$ Nm

Alternatively using $n = 16/3$, $T_e = 22.0$ Nm. - which approximates manufacturer's recommendation.

So a 112M motor is indicated ($T_f = 27$ Nm).

Now check for frequency of starts.